PN-ACY-746

Potential Institutes for Co-Hosting Forums
By
U.S. and Indian Organizations

for the

GEP-CCS

Greenhouse Gas Pollution Prevention Project

Climate Change Supplement

Prepared for

USAID-India

by

LBG

Louis Berger Group, Inc.

C-6/7 Safdarjung Development Area [SDA]
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July 31, 2000

CLIN 4
Communication and Information Outreach
Task 4A

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Scope of Work for CLIN 4

Purpose

The goal of the Greenhouse Gas Pollution Prevention Project [GEP] is to reduce the volume of emissions of Greenhouse Gases by promoting the development of clean and less greenhouse gas emitting energy technologies. The project will further this objective by engaging in private, government and non-government stakeholders in India to build their capacity to participate in international efforts to control climate change while promoting sustainable development.

Under CLIN 4, dealing with "*Communications and Information Outreach,*" LBG will establish a forum for increased collaboration between U.S. and Indian institutions or researchers for integrating evaluations of climate change impacts on the economic development of India. Relevant topics will be selected for joint papers on the potential impacts and mitigating factors of GCC on India. The forums will be designed to provide an interactive dialogue between experts to discuss topical issues. This document is the deliverable for Task 4 A "*Shortlist of US and Indian organizations to co-host forum.*" It briefly discusses the proposed mechanism for enabling the interactions and methodology followed in identifying the suitable institutions in the US and India to co-host the forums.

Methodology

The core team of LBG, in consultation with the USAID E^3 office interacted with several potential institutions, which are known to be working on the Climate Change issues, on research, or promotion. This work was also accomplished through the thorough review of reports of the CCOA phase, and further interaction with the attendees of the round table meetings held during the first phase. These interactions led to identification of the proposed institutions. Based on the possible mechanism of working of the forum as discussed in the LBG response to the RFP, necessary information and *in principle* acceptance was provided by 13 organizations listed below. It may be noted that further short listing and consortium formation among these institutions would be carried out subsequently. Suitable MOUs would be designed and entered into subsequently, in consultation with the CTO – GEP.

Indian Forum Institutions

The following list provides a summary of Indian institutions who have agreed, in principle, to participation in the forums:

Name of Institution	Location
Confederation of Indian Industry (CII)	New Delhi
Development Alternatives (DA)	New Delhi

THE Louis Berger Group, INC.
2300 N Street, NW
Washington, DC 20037 USA

The Louis Berger Group, Inc.
Contract No. 386-C-00-00-00058-00
Sandeep Tandon, CTO

Indian Institute of Management (IIM-A)	Ahmedabad
Indian Institute of Technology (IIT-M)	Mumbai
Indira Gandhi Institute for Development Research (IGIDR)	Mumbai
National Chemical Laboratory (NCL)	Pune
National Institute of Advanced Studies (NIAS)	Bangalore
Tata Energy Research Institute (TERI)	New Delhi
Federation of Indian Chambers of Commerce & Industry (FICCI)*	New Delhi

* To provide Information system support to all the forum institutions.

US Forum Institutions

The following list provides a summary of US institutions who have agreed in principle to participation in the forums:

Name of the Institution	**Location City/State**
Business for Social Responsibility (BSR)	San Francisco CA
Global Energy Partners, LLC (GEP) (for EPRI)	Lafayette, CA
Virginia Polytechnic Institute and State University (VT)	Blacksburg, VA
World Resources Institute (WRI)	Washington, DC

This report presents a comparative summary of the attributes of each organization and the potential resources that can be provided to facilitate a productive forum.

Proposed mechanism (steps) to be followed for completion of CLIN 4 Forum

Under this GEP – CCS component, a wide dialogue on issues of importance in climate change will be held among the research and practicing community. This research and outreach forum work is proposed to carried out in the following broad steps:

Step1: At a proposed Indian Forum meeting (tentatively scheduled for September 2000) several issues related to Global Climate Change and their impact on the India's vulnerability to the adverse effects due to GHG emissions would be discussed. This meeting would be hosted by one of the short listed institutions. At this meeting, about 5 – 8 topics, of critical importance would be short listed. The deliberations at the meeting would also help in identifying individual author / institution. This meeting would be hosted by one of the Indian Forum Institutions. It is proposed to invite 1 – 3 experts from the US to attend the discussions for this meeting.

Step 2: Following the Indian forum meeting, a similar meeting would be convened in the US to discuss the topics short listed at the Indian

forum. At the US Forum meeting, US experts would be identified to work in collaboration with the Indian authors, based on mutual agreement, interest and expertise.

Step 3 Under this step individual authors / institutions from India and the US would be identified based on their experience on the selected topic, to provide an authorship for the research paper. These authors would *mould* their ongoing research work to incorporate the real world problems, and focus on one of the five topic areas to assure all areas are covered.

Step 4: Under this step, a Joint Meeting between the identified 10 authors from US and India would be held, essentially to finalize the paper design, formats, contents and the schedule. This meeting would be facilitated by LBG GEP team and is the appropriate time for authors to outline their joint papers and divide responsibilities..

Step 5: This step would be carried on in parallel in US and India where the pairs of the five authors would jointly work on their respective papers. Draft papers cross-reviewed by the individuals would then be prepared.

Step 6: The draft papers would be presented to a wider audience at a *Drafters Meeting* ideally at an international conference. This meeting would help in a *Peer Review* by the international research community.

Step 7: Based on the views expressed at the Drafters Meeting, the papers would be finalized by the respective authors. These finalized papers would be edited and published in one compendium, graphically designed document.

In addition to the joint consultation, the authors may decide to solicit views on their draft papers through a web-based discussion. This research would be helpful in arriving at key recommendations to both the Governments. The structure of the working of the forum is presented in the enclosed Graphic.

The above mentioned steps are depicted on the attached Graphic 1.

The Louis Berger Group shall provide the support to both the Indian as well as US forum institutions. The structure of this is as shown in the attached Graphic 2.

Graphic 1: CLIN 4 - Flowchart of Activities

Step 1: Indian Forum

Indian Forum:

20-30 attend; move from long topic list to 5-6 final topics; ID possible authors

*note: envisaged that 1-3 experts from US attend discussion

Step 2: US Forum

US Forum:

20-30 attend; work with short topic list from India forum; ID US authors

*note: envisaged that 1-5 Indian experts (likely the authors of papers) will be in attendance

Step 3: Short listed Indian Authors
For five topics where Papers will be jointly Produced

Topic 1: Author
Topic 2: Author
Topic 3: Author
Topic 4: Author
Topic 5: Author

Step 3: Short listed US Authors
For five topics where Papers will be jointly Produced

Topic 1: Author
Topic 2: Author
Topic 3: Author
Topic 4: Author
Topic 5: Author

Step 4: Joint Meeting
Indian & US Counterparts
Finalize arrangements

Joint Forum:

10 Authors attend; finalize paper design and formats; drafting schedule; begin work

*note: Meeting facilitated by LBG GEP team

Step 5: Draft Papers Produced
Joint authors work over Time writing draft papers

Step 6: Present Draft Papers
To other authors & conference

DRAFTERS MEETING

Authors meet to present final draft papers; peer review; ideally piggyback event on international conference

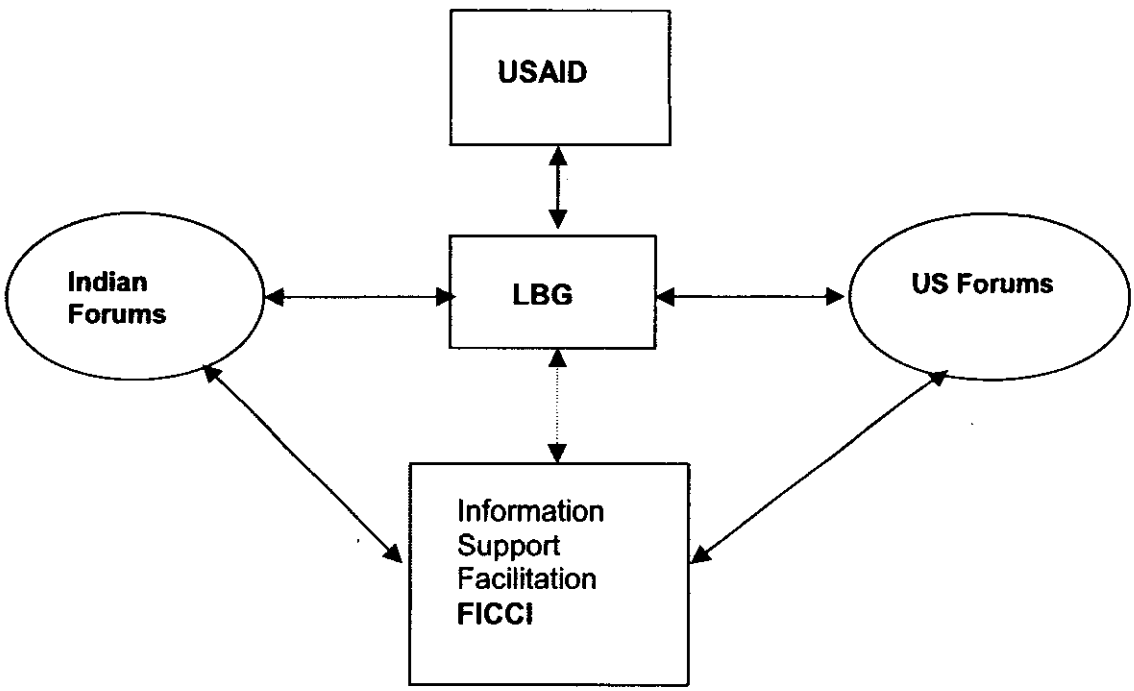
Step 7: Finalize Papers & Publish Compendium

Assumes final edit, preface, layout & final publication of one book containing all work

***** CLIN 4 Milestones *****

4A: List of Forum Hosts for US and India
4B: Indian Forum Meeting (Step 1)
4C: US Meeting & Topics (Step 2 & 3)
4D: Draft Papers Complete (Step 4 - 6)
4E: Compendium Published (Step 7)

Graphic 2: Possible Structure for the GHG Forum under CLIN 04



It may be noted that FICCI has established the Environmental Information Center under earlier USAID/India program. EIC has offered to provide its services to the forum institutions for information support facilitation. These could include posting the draft research papers on the net to solicit views on them and also to float the papers after finalization.

INDIAN

FORUMS

INDIAN INSTITUTIONS FOR FORUM

ORGANIZATION	CII	DA
	Confederation of Indian Industry	**Development Alternatives**
General		
Address	Confederation of Indian Industry Gate No.31, Nehru Stadium, Lodi Road New Delhi 110 003	Development Alternatives B - 32, TARA Cresent, Qutab Institutional Area, New Delhi 110 016
Telephone	(011) 436 5246(D), 436 6225/273/276/281-2	(011) 696 7938, 656 5370, 685 1158
Fax	(011) 436 6271/ 426 7844/ 436 6311	(011) 686 6031
E-mail	vr@sai.cii.ernert.in	
Type of Institution	Industry Association	NGO
Contact	Mr. V. Raghuraman	Mr. George Varughese
Designation	Senior Advisor - Energy	Vice President
Location	New Delhi	New Delhi

ORGANIZATION	TERI	IGIDR
General	**Tata Energy Research Institute**	**Indira Gandhi Institute for Development Research**
Address	Tata Energy Research Institute Darbari Seth Block, IHC Complex, Lodi Road New Delhi 110 003	Indira Gandhi Institute for Development Research General Vaidya Marg, Goregaon (E) Mumbai 400 065
Telephone		(022) 840 0919
Fax		840 2752, 840 2026
E-mail		sreddy@igidr.ac.in
Type of Institution	Research Institution	Research Institution
Contact		Dr. Jyoti Parikh
Designation		Senior Professor
Location	New Delhi	Mumbai

ORGANIZATION	IIT - Mumbai	NCL	NIAS
General	**Mumbai**	**National Chemical Laboratory Pune**	**National Institute of Advanced Studies Bangalore**
Address	Indian Institute of Technology Powai Mumbai 400 076	National Chemical Laboratory Pashan Road, Pune 411 008	National Institute of Advanced Studies Indian Institute of Science Campus Bangalore 560 012
Telephone	022 576 7788	(020) 589 3359, 589 3058	(080) 331 0969
Fax	022 572 3480	589 3943	(080) 334 6634
E-mail	anand@cc.iitb.ernet.in	sdevotta@pd.ncl.res.in	dahuja@nias.iisc.ernet.in
Type of Institution	University/ Research Institution	Research Institution	Education/ Reseach Institution
Contact	Prof. Anand Patwardhan	Dr. S. Devotta	Dr. Dilip Ahuja
Designation	Professor, School of Management	Deputy Director & Head Process Development	Director
Location	Mumbai	Pune	Bangalore

ORGANIZATION	FICCI	IIM - Ahmedabad
General	**Federation of Indian Chamber of Commerce & Industry**	**Indian Institute of Management Ahemedabad**
Address	Industry FICCI House, Tansen Marg New Delhi 110 001	Indian Institute of Management Vastrapur, Ahemedabad 380 015
Telephone	(011) 372 1503, 373 6307	(079) 630 7241, 630 8357
Fax	(011) 332 0714, 372 1504	(079) 630 6896
E-mail		shukla@iimahd.ernet.in
Type of Institution	Industry Association	University/Educational Institution
Contact	Mr. M A Jeyaseelan	P. R. Shukla
Designation	Executive Director	Professor
Location	New Delhi	Ahemedabad

CONFEDERATION OF INDIAN INDUSTRIES (CII)

CII is the association of Indian industries with the largest representation. Apart from bringing the companies and providing a platform for raising issues of importance with the GOI it's goal is also to develop Indian industry and to ensure that government and society as a whole, understand both the needs of industry and its contribution to the nation's well-being. For this, CII works:

- To identify and strengthen industry's role in the economic development of the country
- To act as a catalyst in bringing about the growth and development of Indian Industry
- To reinforce industry's commitment to society
- To provide up-to-date information and data to industry and govt.
- To create awareness and support industry's efforts on quality, environment and consumer protection
- To identify and address the special needs of the small sector
- To promote cooperation with counterpart organizations
- To work towards the globalization of Indian industry and integration into the world economy

This is done by adopting a proactive and partnership approach with the government on various national and international issues concerning the Indian economy. CII closely interacts on policy issues at both the central and state levels. Extensive dialogue and interaction is held with members and all sections of the community, and build consensus.

ORGANIZATIONAL STRUCTURE

CII operates through a federal structure: the national council, regional councils and state and zonal councils. It has 36 specialized committees, 23 industry divisions, besides affiliated associations (ASCON) and institutions. The main function of these units is maintaining a direct line of communication with members, to get feedback and also to be able to provide relevant services- information, advisory and/or problem solving.

CLIMATE CHANGE

CII's Climate Change Center (4C) was established under a USAID supported initiative with the following objectives:

- Spreading awareness of Climate Change issues within the Indian Industry
- Promoting consensus on Climate Change mechanisms, particularly Clean Development Mechanism (CDM) within the Indian Industry
- Building local capacity to develop Climate Change mitigation projects.
- Developing at least five climate change projects by May 2000

These objectives are achieved through the following activities:

- Developing position papers on climate change policy issues
- Facilitating dialogue between Indian & US business executives to set the tone for collaborations on Climate Change mitigation projects.
- Conducting seminars and training workshops

GHG Impact:

Excessive accumulation of Greenhouse gases (GHGs) in the atmosphere is causing entrapping of heat / energy resulting Climate changes. It is one of the most universal & global issues affecting the human mankind. It poses a serious threat to our environment in terms of energy, water resources, eco system, agriculture and in the social & economic sector.

Though, most of the greenhouse gases, such as Carbon dioxide, Methane and Nitrous oxide occur naturally in the environment, but a wide variety of economic development and industrial activities and processes have resulted in further accumulation of these gases above alarming levels. Of the above the most troublesome & of greater concern to the industry is CO_2 as it is primarily a byproduct of burning fossil fuel as well as land use (deforestation releases carbon stored in biomass) & CO_2 is estimated to be resident in the atmosphere for a period of 50-200 years.

It is believed that the increasing concentration of GHGs will ultimately lead to rise in atmospheric and oceanic temperature, in frequency / intensity of storms and extreme weather conditions, rise in sea levels and changing ocean circulation patterns, increased coastal flooding, damage to the natural ecosystem and the spread of tropical diseases etc.

CLIMATE CHANGE PROJECT INFORMATION BANK (CCIB)

CCIB has been created with the objective of collecting information on climate change project concepts from companies who are interested in exploring funding options for assessing the feasibility or implementation of the project mentioned herein. CII assists in shaping climate change project ideas into a potential climate change project. CII also helps industries to discuss the project with possible funding agencies/consultants/partners. It provides feedback to the concerned industry for further action on their part.

Confederation of Indian Industry
Gate No. 31, North Block,
Jawaharlal Nehru Stadium, New Delhi 110 003
Phone : 4366225 / 4366273 / 4366276 / 4366281-82
Fax : 4366271 / 4367844
email:ci@sai.ci.emet.in
internet : www.ciionline.org

July 26, 2000

To

The Louis Berger Group Inc.
C-6/7, Safdarjung Development Area
New Delhi-110016

Dear Sirs,

GEP-CCS Project: CLIN 04- Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above. We are glad to confirm our in principle acceptance to host a forum for the research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners & National Committee on Climate Change, who may extend their support for the related activities on this issue.

The modalities for conducting research and publishing papers would be on mutually agreed terms. If necessary, a MoU in this regard could be signed with agreed terms of reference.

Thanking You,

Yours faithfully,

V Raghuraman

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Information needed for Forum Institution

General

Organization Name	**CONFEDERATION OF INDIAN INDUSTRY**
Address	Gate No. 31, North Block Jawaharlal Nehru Stadium New Delhi 110 003.
Type Institution : Academic; Research; Industry	Industry
Contact Name	**V Raghuraman**
Telephone	011-4365246 / 4366225 / 273 / 276
Fax	011-4366271 / 7844 / 6311
E-mail	v.raghuraman@ciionline.org

Facilities available at each potential location

Conferencing Facilities

Size of meeting / conference rooms	20 to 80 (in house) + 80 (can be arranged)
Catering facilities for participants	Available
Technical facilities available; computer projectors, copying etc.	Adequate
Recent conferences and forums at organization location	Enclosed Calendar of Events

Accommodation / logistics

Housing accommodations nearby (rates)	
Local and international transport available	

Miscellaneous

Working Environment: busy, tranquil, noisy, quiet, etc.	Cozy
Facilities Environment: City, urban, academic, rural	City / Academic
Potential entertainment / recreational activities nearby	As requested

Technical / GCC

Technical experts / specialists on GHG located at facility	List enclosed
Research reports on GHG at facility or organization	Enclosed
Related expertise available at energy efficiency, conventional / renewable power generation, transportation, solid waste etc.	We are above 4000 industry member association with about 400 companies related to Energy Sector. The companies act as resource to the work at CII and provide technical expertise as and when required.
Additional related resources available : research labs	We have tie ups with all IITs, Technical Institutions and some international institutions.
Special Characteristics of facility / organization	Enclosed CII Brochure
Approach of Organization to GHG concepts	Yes, the GHG mitigation offers Financial inflow to the country as well as technical collaborations. We need to develop partnership, institutional set up and demonstrate project to highlight and realise potential. It will also attempt to restrict the carbon emission growth and support sustainable development.

CII NATIONAL COMMITTEE ON CLIMATE CHANGE

Members

1. Mr R V Shahi, BSES Ltd. **Chairman**
2. Mr Vijai Sharma, Ministry of Environment & Forests
3. Mr Shashi Shekhar, Ministry of Power
4. Mr A K Mangotra, Ministry of Non-Conventional Energy Sources
5. Mr K G Ramachandran, BHEL
6. Dr Uddesh Kohli, Power Finance Corporation
7. Mr R Chandramouli, L&T ltd.
8. Mr Jayanta Chakravorty, Balagarh Power Company Ltd.
9. Mr Dipes Guha, CESC Ltd.
10. Mr B N Ojha, NTPC
11. Mr C R Vevaina, Tata Electric Co. Ltd.
12. Mr N P Ghuwalewala, Gujarat Ambuja Pvt. Ltd.
13. Mr R Kanan, General Manager, ICICI Ltd.
14. Dr G C Datta Roy, DCM Shriram Consolidated Ltd.
15. Mr Abhay Nalawade, Thermax Ltd.
16. Mr M K Singhi, Shree Cement Ltd.
17. Mr Ram Thayagarajan, Thiru Arroran Sugar Ltd.
18. Dr T S Sundararaman, Venkatesh Coke & Power Ltd.
19. Mr R L Lakhotia, Century Pulp & Paper
20. Mr P Jayakumar, Tata BP Solar Ltd.
21. Dr V Bakthavatsalam, IREDA
22. Mr. Yogesh Mehra, Managing Director, Enercon Ltd
23. Mr Hemant Joshi, CRISIL
24. Mr P R Shukla, IIM Ahemdabad

CII Experts

1. Mr K P Nyati, Senior Adviser – Environment
2. Mr T K Bhaumik, Senior Adviser – Policy
3. Mr S Raghupathy, Senior Adviser – Energy Management Cell
4. Mr V Raghuraman, Senior Adviser – Energy

Confederation of Indian Industry

CHARTING CHANGE

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Global Business Networking

CII has successfully created fora that facilitate business interaction, sharing of information and the creation and pursuit of opportunities worldwide.

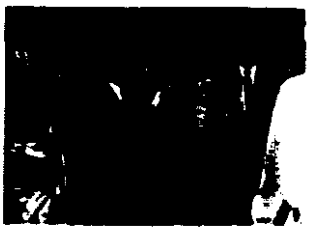
Forging Partnerships Worldwide

CII's International Division seeks to provide a global perspective to Indian industry and build upon it, to establish mutually beneficial economic linkages. Its objectives are achieved by working closely with foreign governments and industry, embassies and counterpart organisations abroad.

:

e platforms for interaction between the Indian usiness community, the Government of India iness and political leaders via annual events ip Summit and India Economic Summit World Economic Forum)
ormation related to markets, distribution bilities to Indian and foreign companies c development programmes with d development agencies like UNIDO, nk, UNDP, UNFP, FAO, USAID,

ts to promote Indian industry s global competitiveness, CII's Trade Fair ganises world class international hich showcase the best of Indian products and services broad at "Made in India Shows" and also gets the best of the world to display their wares in India. Its flagship event, the biennial Indian Engineering Trade Fair (IETF) is Asia's largest all industry fair. After over two and a half decades of mega success, IETF now enters the new millennium with a new identity - INDIA EXPO, more reflective of its ever widening product coverage. CII also organises a number of specialised fairs. Among the sectors covered are : automobiles, environment, information technology, agriculture and food processing, mining, welding, railways and telecommunications.



INDIA EXPO

AUTO EXPO

IRCE

Catalysing Development

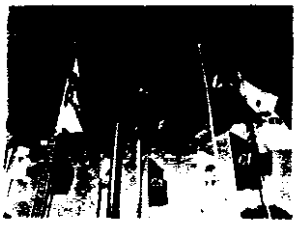
Development is best engineered when government, industry and society contribute as one in identifying challenges and work in partnership to find solutions.
CII has taken on the role of a catalyst in this process and focussed its efforts on three main objectives :

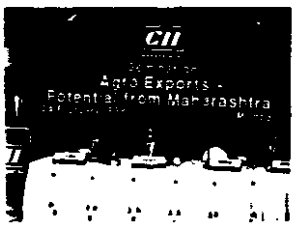
- working closely with the central and state governments
- creating a better environment & developing and expanding business opportunities for industry and membership
- projecting a positive business image

Jus
add C

Policy Focus

CII's specialised committees on individual subjects present industry perspectives to the government and play a vital role in policy formulation related to a wide range of issues like :
• Taxation and finance • Export & international trade • Public sector reforms • Industrial policy • Financial sector reforms and capital markets • Industrial relations • Foreign investment • Energy • Environment • Technical education & training



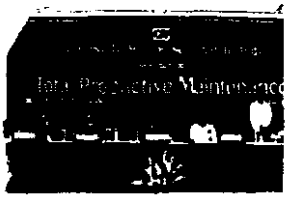


The Small Sector

CII works towards keeping small enterprises at the forefront of change with updates on the latest in technology, market opportunities and finance. Its MoU with the Small Industries Development Bank of India promotes ancillary linkages.
CII has also evolved a unique, tailor-made "cluster approach" that helps SMEs implement ISO 9000 Quality systems.

The Federal Core

CII operates through a federal structure : the national council, regional councils, state councils & zonal councils. It also has specialised committees, industry divisions and affiliated associations and institutions. The federal structure facilitates interaction with all sections of industry and business and makes CII recommendations more representative and acceptable.



CII

GLOBAL CLIMATE CHANGE
GREEN FINANCING MECHANISM

Vol. 1 No. 1 (April - June, 1999) *Newsletter*

GLOBAL CLIMATE CHANGE: CHALLENGES AND OPPORTUNITIES FOR THE INDIAN INDUSTRY

There is increasing evidence that human activity is having discernible impact on Global Climate Change due to emission and accumulation of greenhouse gases (GHG).

Historically, the developed countries have been responsible for the bulk of emissions of GHG and hence the onus for GHG abatement lies directly with these countries. On the other hand, given the large potential for economic growth in developing countries, bulk of future emissions will be accounted for by developing countries as they move towards higher standards of living. Because of higher levels of efficiency attained in the developed countries, cost of GHG abatement is higher there. According to one estimate, to carry out abatement of one ton of carbon, it will cost $400 in Japan, $175 in US and $25 in India. Hence transferring more efficient clean technologies to developing countries offers a cost effective solution to the problem of climate change, potentially benefiting both set of countries in the process.

Efforts are underway at the international level to develop measures to curb the release of GHG emissions. Decisions made in these international fora could significantly impact the Indian Industry and Indian economy. One of the emerging measures called the Clean Development Mechanism (CDM) offers the potential for mutually beneficial co-operation between developed and developing countries.

Under this mechanism, developed countries with a commitment to reduce emission of greenhouse gas emissions will invest in developing countries using their resources, particularly advanced efficient technologies. The developed countries will thus be able to meet part of their carbon reduction commitments at relatively low cost while developing countries will benefit economically by having access to efficient technologies with innovative financing arrangements.

However, many issues connected with the working of this mechanism are not yet clear and to ensure that CDM proves a fair bargain for all parties involved, all its features should be made transparent. The rules of the CDM are in process of being finalized and once operational, CDM would involve the Industry in a big way. Therefore it is important for the Industry to get involved in the CDM process and try to ensure that its interests are properly addressed.

The establishment of Global Climate Change Information and Facilitation Center within CII is therefore timely and most welcome. USAID is actively supporting this effort. The Center will provide feedback on Climate Change issues which are of relevance to the Industry. The Center will also help to foster partnerships for CDM related projects which could be role models for future activity in this area.

I wish CII all the success in its endeavour.

Mr. R V Shahi
Chairman, Core Group-Transmission & Distribution
Confederation of Indian Industry

CLEAN DEVELOPMENT MECHANISM

Sanjeev S.Ahluwalia, CERC*

The Clean Development Mechanism (CDM) is the exception to the general rule that, instruments evolved under the Climate Change negotiations, either ignore the role of the private sector in developing countries, or are too far off into the future, for business to spend time and money on them now. The CDM will be effective April 1, 2000 and focuses on private to private contracts as the basis of the mechanism.

The CDM, along with Joint Implementation and Emissions Trading is one of the 'flexible" instruments identified by the Kyoto Protocol. It permits Annex 1 (developed) countries to meet their emissions reduction targets from carbon savings (Certified Emissions Rights (CER)) accruing from their investments in eligible projects in developing countries. Since carbon abatement costs in developing countries are much lower than costs in developed countries, this is an efficient outcome, a "no regrets" option, with benefits all around.

The CDM is an ambitious proposal with a number of unsettled issues. Environmentalists and the EU, would like the use of this facility to only supplement, not replace, other efforts at reducing emissions. They would like the facility capped so that profligate economies, like the US, cannot postpone domestic action indefinitely. How does one ensure the additionality of carbon savings, over savings, which would happen in any way with or without the CDM? How should the baseline be defined to calculate additionality? Who must define eligibility of projects; national governments, multilateral fora or the Climate Change Secretariat, or a combination of all three? Should host countries tax the carbon savings, to bank them for future use, when they themselves may have emission targets? Does the institutional capacity exist to monitor, measure and verify emissions in developing countries?

Clean Development Mechanism

Key features

- CDM was designed to assist
- *Non Annex I parties to achieve sustainable development*
- *Annex I parties to achieve compliance with their commitments on quantified emissions limitation and reduction*
- Private and/or public entities may participate in a project
- Climate change mitigation benefits to be real, measurable and long term reduction
- Reductions in emissions additional to any that would occur in the absence of the certified project activity
- Independent auditing and verification to ensure transparent, efficient and accountable project activities
- Projects can begin as early as 2000 , and credits are banked until needed to meet commitments in 2008-2012

Today, only the broad contours of the mechanism are visible. The CDM provides an additional, as yet unquantified revenue stream, in the form of Certified Emissions Rights (CER) for investors in clean technologies. How will CERs be valued? Their value will reflect the cost differential of efficient and inefficient technologies and the cost differential between mitigation options in developed and developing countries. Their value will also depend upon the liquidity with which these are tradable and the transaction cost involved to earn a CER. The higher the value of a CER, the more the opportunity for passing on benefits to eligible projects in the developing countries. The specific processes and procedures, by which the CDM will function, are expected to be agreed at the Fifth Conference of the Parties at Bonn in October 1999 (CoP-V).

Why then, should business bother, when the mechanism is still so ill defined?

1. **Early action:** The near term prospects for start up of the mechanism, coupled with the poorly defined process, provides an excellent opportunity for business to get into the process at the design stage itself so that it could be crafted for maximising benefits. What might these benefits be?

2. **Lower effective cost of capital:** At its highest stage of development, the CDM can induce a global market for CER. Carbon savings from eligible projects in developing countries would be the supply source while demand would originate from the emission reduction needs of developed countries, thereby creating financial flows from the latter to the former. At the other end of the spectrum, in its most nascent form, investors from developed

* Views expressed in this article are personal and do not reflect the views of the CERC (Central Electricity Regulatory Commission)

countries will invest in projects in developing countries, with the intention of individually benefiting from the earned CERs. The additional revenue stream from such CERs will reduce the effective cost of foreign capital for developing countries. Potential investors would factor in the revenue stream from CER as additional return, the cost of which would be borne by developed countries themselves. The effective reduction in the cost of capital will induce investment and generate income in developing countries. Indian business stands to gain directly through joint-ventures or indirectly through the growth enhancing aspects of incremental investment.

3. **Efficient technologies:** More significant than the capital flows is the technology transfer potential of the CDM. By definition, reductions in carbon emissions under the CDM must be additional to those under a baseline scenario. Hence technologies not otherwise available or available only with significant upfront costs can be transferred under this mechanism to developing countries.

4. **New business opportunities:** The process related tasks of monitoring, measuring, verifying emissions, developing baselines and certifying projects, associated with the mechanism, provide additional business opportunities for diversification into research institutions and laboratories

Addressing some concerns

1. **Does the CDM subsidise otherwise unattractive technologies:** Is not placing a value on a CERs the same as a subsidy for commercially unattractive technologies, possibly still in their developmental stage? Will subsidisation of such technologies not make domestic industry non-competitive? The answer is negative in both cases. CER internalise the benefits of efficient technologies. The incremental savings of carbon are a positive externality, hitherto unvalued. Placing a value on such savings, via a market mechanism, is nothing but better accounting of the benefits of the project and cannot be considered a subsidy. Secondly, far from inducing import competition for domestic industry, the mechanism provides a business opportunity for upgrading domestic technologies. Open and competitive economies with strong manufacturing capabilities, supportive investment regulations and stable macro environments should be able to rapidly internalise these technologies thereby rapidly improving efficiencies and diluting the potential import pressure.

2. **Will the CDM benefit only foreign investment financed projects?** How does domestic industry benefit? Clearly, to benefit directly, domestic industry must be a partner with a foreign investor. The CERs would then be the joint property of the partners. Under the CDM, only those projects are to be taken up, which would not otherwise have happened. Partnerships in such projects are therefore clearly an additional business opportunity. This is why the issue of ensuring true additionality of investment is so important for developing countries. CDM is most useful when it "leverages" domestic resources.

3. **Is a cap on foreign equity required?** Since CERs accrue to the investors the benefits to domestic industry will vary with the level of stake taken on by the Indian partner. 100% foreign owned projects will benefit domestic industry only indirectly. Hence it is reasonable to expect the government to encourage domestic participation in such projects. Towards this end the government may use differential tax, related to the share of foreign ownership, as an incentive for foreign investors to take on Indian partners. Differential tax will be a preferred alternative to prescriptive minimum levels of domestic ownership for this purpose. 100% foreign owned projects would face a higher level of tax as compared to joint ventures. Most developing countries are considering imposing such an "adaptation tax" on the revenue stream, of the CERs. This tax base is expected to generate either a bank of CERs for future use or can be liquidated in the global market for meeting domestic sustainable development priorities.

What role should government play?

1. **Degree of government involvement:** How closely should the government regulate activities under the

CDM : How it might work

- Indian and Annex I country private developers propose a CDM project that meets sustainability criteria of host country
- Developers estimate carbon savings of the CDM project in comparison to a project that would have happened otherwise
- A monitoring and evaluation plan is included
- Project is registered with the Indian Government, the UNFCCC and Annex I party Government
- Project implementation is monitored, and the resulting carbon savings are reported to the above entities
- Savings are verified by the independent auditors
- Annex I country government counts an agreed portion of these carbon savings in 2008-2012

CDM? Government must be proactive, on a consultative basis, with industry and environmental groups, at the negotiation and design stage but subsequent intervention in the implementation of the CDM should be minimised.

CDM negotiations timetable

- 31 March 1999 - Proposals for principles, modalities, rules and guidelines submitted
- 9 to 15 April 1999 - UNFCCC Bonn Workshop on Kyoto Mechanisms
- October 1999 - Fifth Conference of Parties in Bonn (CoP-5)
- January 2000 - Certified Emission Reductions (CER) begin to accrue
- November/December 2000 - modalities and procedures for CDM finalized at Sixth Conference of Parties

2. **Screening technologies:** Government may notify a negative list of technologies, or sectors, which will not be open to CDM. These may typically be low capital and technology intensity areas with low mitigation costs, which are best, reserved for domestic mitigative action, if universal emission reduction targets be enforced in future. However, having identified the negative list, government must give complete commercial autonomy to the investor regarding choice of technology, scale of operations, choice of institution for monitoring and verification of emissions. Investment opportunities under the CDM will need to be globally competitive. While the intention is not to indulge in competitive immiserisation, we must recognise that institutional rigidities in India are significant barriers to trade and investment in general. Hence "light handed regulation" would be the order of the day.

3. **Regulatory structure for CDM:** By and large, the CDM must fit into the prevailing pattern of industrial regulation. Departures from the norm, either to provide incentives, like fast track clearances, or disabilities, like additional import taxes on capital goods, should be minimised.

4. **Selection of agencies:** The selection of certification agencies, monitoring and verification agencies should be done on global competitive basis. There is little point in insisting on restricting the certification and verification business to national agencies. Firstly, this will increase the risk perceptions of foreign investors. Secondly, Indian institutions will lose out on business opportunities in Asia and Africa where they may otherwise be competitive due to low overheads and past familiarity with the business environment.

5. **Reasonable tax levels:** Adaptation tax levels should be affordable and not kill the mechanism.

6. **Tax all flexible mechanisms:** Government must resist the attempt by developed countries to propose a tax on the CDM alone, to the exclusion of joint implementation and emissions trading, in generating an international fund for economies, especially vulnerable to climate change. Any cess or expropriation, for this purpose, should tap all three instruments.

7. **No cap on CERs:** The proposal for supplementarity, or capping of the CDM, is not in the interests of developing economies. This will reduce the demand for CERs and hence investor appetite for the facility. It is false to say that the availability of the CDM will postpone research and development of clean technologies. Firstly, the availability of CERs is not expected to be sufficient to meet the entire emissions reduction targets of developed countries. Hence it cannot be the sole strategy of developed economies for meeting the targets. Secondly, technological developments are not motivated by the need to reduce carbon emissions alone. Competitive forces to continually reduce costs and enhance efficiency are significant drivers of technological development. These drivers are not invalidated by the existence of the CDM.

In conclusion, the CDM needs to be closely reviewed by Indian corporates in energy intensive sectors. Given the adoption of appropriate procedures and processes at the CoP V in October 1999, the CDM is a near term strategy for improving the efficiency of energy use, reducing the share of conventional energy in manufacturing costs and most importantly for entering into partnerships, with investors from countries, like the US, which are bullish on the mechanism, as a least cost option for global sustainable development.

Climate Change Outreach and Awareness Programme

CII has set up a Climate Change and Outreach Awareness programme within the Energy division. It has the active support of USAID. The inspiration of this programme is the newly emerging financing mechanism called the Clean Development Mechanism under which Annnex I and non-Annex I countries will work co-operatively to reduce emission of greenhouse gases. Th major objective of this programme is to expand awareness of climate change negotiations especially CDM and its possible impact on Indian economy and Industry and enable the industry to take up issues with the Government of India for negotiations in the climate change fora.

Roundtable on
" Climate Change and Indian Industry: Preparing for the year 2000"
April 6 1999, Hotel Oberoi, New Delhi

The first step in the effort to involve the industry in contributing to Climate Change negotiations process was to conduct a one-day business roundtable. It was attended by 25 industry leaders along with representatives of multilateral development agencies, NGOs and others. The US Ambassador to India, Mr. Richard Celeste was the Chief Guest on this occasion. The Roundtable wrapped up with the following general conclusions:

- The CDM represents substantial new financial flows to Indian industry, US$150 billion over the next 40 years, that would otherwise not be available.
- The rules that will govern the CDM are being negotiated now and Indian industry must make its position known in these negotiations to protect its own interests.
- The CDM will make available to Indian industry technology which it otherwise would not have access to for several years. Significant amounts of training and technical assistance will be required to help prepare Indian industry to take advantage of this new technology.
- An urgent effort must be made to understand the optimal position for Indian industry in the critical issues of CDM, and how Indian government and industry must organize itself to be prepared to capture the benefits of the CDM early in the process.

The next steps CII intends to take under the Climate Change Outreach and Awareness Program, include:

- Launch an Indo-U.S. Business Dialogue on Climate Change on 29th April, 1999 at New Delhi
- Conduct a two-day Indo-U.S. Business Dialogue meeting in Washington, D.C. on May 20th and 21st comprising of top CEOs from each country
- Conduct a five-day study tour in conjunction with the May 20th meeting for persons committed to working on CDM-related issues from Indian industry and other organizations
- Initiate in-depth research into the critical CDM issues and develop the optimal positions for Indian industry
- Engage in the national and international policy process regarding CDM rules and other aspects of the Kyoto Protocol in order to shape the rules to the benefit of the Indian Industry

OPPORTUNITIES FOR INDUSTRY UNDER CDM

1. Energy efficiency projects

a. Energy supply & conversion
- Combined heat & power systems
- Installing regulating valves and thermostats
- Replacing oversize common industrial systems
- Improving systems, controls and instrumentation
- Upgrading transmission & distribution power systems through reconductoring, construction of new lines and /or installation of efficient transformers and capacitors to reduce energy losses
- Powerplant refurbishment and modernization

b. Residential & commercial
- Use of energy efficient appliances to moderate heat gains
- Use of heat shielding materials
- Use of passive solar energy
  Use of heat pumps
- Installation of individual metering devices
- Efficiency improvements in water heating, refrigeration, washing machines

c. Manufacturing

Chemical industry
- Improved process control
- Waste heat management

Iron & steel
- Blast furnace modifications

Pulp & paper industry
- Better motor drive systems
- Co-generation
- Recovery of process heat through use of heat exchangers, recuperators & vapour compression systems

Cement production
- Technology improvement such as instrumentation and product quality control
- Improving the efficiency and quality of electrical supplies to cement facilities

Other

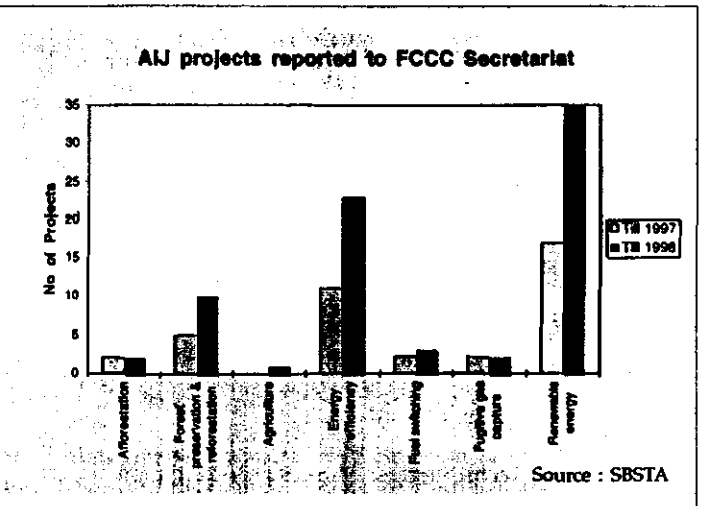
- Projects that increase energy usage from waste products of the industry.

d. Transportation

- Fuel switching, low emission modes

2. Renewable energy projects

- Wind
- Photo-voltaics
- Bio-mass
- Bio-fuels
- Geothermal
- Micro-hydro
- Run of the river hydro



Source : SBSTA

GLOSSARY: CLIMATE CHANGE

1. **Activities implemented jointly** (AIJ)(or Joint Implementation): is a concept where industrialized countries meet their obligations for reducing their greenhouse gas emissions by receiving credits for investing in emissions reductions in developing countries.
2. **Additionality**: refers to the issue of whether greenhouse gas emissions reduction or sequestration in a Joint Implementation or Clean Development Mechanism project occurs over and above the baseline and constitutes a new reduction that would not have otherwise occurred without the existence of the project.
3. **Annex I parties** or *Annex B parties*:in climate change negotiations refer to industrialized countries that are trying to return their greenhouse emissions to 1990 levels by the year 2000 as per Article 4.2 of the Kyoto Protocol.
4. **Baseline:** Greenhouse gas emissions levels that would occur in the absence of any measures to carry out greenhouse gas abatement.
5. **Certified Emission Reduction:** or certified emission reduction units are verified and authenticated units of greenhouse gas reductions from abatement or sequestration projects which are certified by the Clean Development Mechanism.
6. **Conference of Parties (CoP):** is the supreme body of the UN Framework Convention on Climate Change. It comprises 170+ nations that have ratified the Convention.
7. **Flexibility mechanisms** as established by the Kyoto Protocol seeks to increase the flexibility and reduce the costs of making emissions reductions; the three primary mechanisms contained within the Kyoto Protocol are the Clean Development mechanism, emissions trading and Joint implementation (or activities implemented jointly)
8. **Kyoto protocol** is an international agreement struck by 159 nations attending the Third Conference of Parties (CoP-3) to the United Nations Framework Convention on Climate Change (held in December 1997 in Kyoto, Japan) to reduce worldwide emissions of greenhouse gases.
9. **United Nations Framework Convention on Climate Change:** is the centerpiece of global efforts to combat global warming. It was adopted in June 1992 at the Rio Earth summit and entered into force on March 21, 1998. The Convention's primary objective is the 'stabilization of greenhouse concentrations in the atmosphere at a level that would prevent dangerous anthropogenic (man-made) interference with the climate system. Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner.

For more information visit:
www.weathervane.rfl.org/glossary/index.html

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CII

GLOBAL CLIMATE CHANGE
CLIMATE CHANGE PROJECTS

Vol. 1 No. 2 (October, 1999) *Newsletter*

From the Editor's Desk

The CII Climate Change Center is pleased to bring out the second edition of the newsletter on "Climate Change Partnership" projects. This newsletter series was conceived at the time Center was established at CII and is a key element of our dissemination efforts climate change. Our objective in starting this series is two-fold. (a) to increase awareness of climate change issues and its business implications within the Indian Industry (b) secondly, to provide inputs and other necessary support to the Industry in order that they may contribute to strengthen the negotiating position of Government of India at the international fora on climate change.

Our first newsletter was focussed on the awareness aspect and our activities as covered in the first newsletter basically reflected that concern. The period between Fifth Conference of Parties (CoP) to be held in October-November this year and sixth CoP scheduled for later next year is likely to see an intense activity to give shape to climate change mechanisms as mentioned in the Kyoto Protocol. This according to some estimates will trigger off significant project based global capital and technology flows to developing countries in a couple of years if not earlier. All this holds tremendous business opportunities for the Indian Industry. These impending developments are reflected in our recent activities and in this newsletter.

Even though significant capital flows associated with climate change activity will start in a couple of years, our activities will henceforth involve engaging Indian Industry in developing and structuring climate change projects by utilizing all available domestic and international climate change funds. This process will offer at least three benefits. Firstly, designing projects that meet the criteria of available climate change funding sources will provide insights into how an efficient climate change project development cycle should look like and provide valuable inputs to Government of India in its effort to frame an effective climate change policy. Secondly, industries can avail of benefits of a variety of climate change funding available for both feasibility studies as well as project development. Thirdly, the whole process of project development will contribute to capacity building within the Indian Industry to develop, structure and implement climate change projects. Since India has the potential to be a big player in climate change mitigation activity, capacity building will give our Industry an edge over other competitive users of funds when curtain is finally raised for a full fledged global climate change mitigation activity.

To give further fillip to our outreach activities, the Climate Change Center will launch a website in October.

In our efforts to reach out to Indian Industry, we will be pleased to have any suggestionsyour suggestions will be most welcome.

WORLD BANK'S PROTOTYPE CARBON FUND

The World Bank's Board of Executive Directors approved the establishment of the Prototype Carbon Fund (PCF) on July 20, 1999. The Fund is intended to finance carbon emission reduction activities within the framework of two flexibility mechanisms of the Kyoto Protocol: project-based transfer of emission reduction units among Annex I Countries (Article 6, which includes countries with economies in transition), and transfer of certified emission reductions under the CDM between Annex I and non-Annex I Countries (Article 12, which refers to developing countries.

The PCF has three objectives:

- To illustrate how project-based emissions reductions can promote sustainable development in developing countries;
- To provide an opportunity to "learn by doing" while the guidelines for emissions trading under the UNFCCC and/ or the Kyoto Protocol are still being negotiated; and
- To demonstrate the mobilization of new resources from both public and private sources to assist developing countries while pursuing environmental goals.

The World Bank Prototype Carbon Fund (PCF) is a vehicle designed to create and pool carbon offsets into a fund that is attractive to buyers and sellers. It is also a vehicle for furthering internationally accepted guidelines for carbon offsets, and for creating confidence in the market. The PCF intends to introduce a high-quality, reliable product into an untested market for buying and trading GHG emission reduction credits among countries. It will also oversee independent, third party verification of those reductions and will distribute emissions credits, in proportion to their investment, among the contributors to the Fund.

Investors in the PCF, or "participants", a select group of international corporations and governments of industrialized

nations, will help to finance efforts to reduce greenhouse gas emissions for potential World Bank and IFC projects. While the eligible investments for the PCF will include efforts to promote energy efficiency and fuel switching, the emphasis will be on financing renewable energy technologies.

The Bank, as trustee of the Fund, will enter into separate agreements with host countries and, where appropriate, with related project entities. Hosts will initially receive from the Fund financing for such projects followed by periodic payments upon the delivery to the Fund of the emission reductions from the financed project. Each participant will receive a pro rata share of the emission reductions that are generated by the investment of the Fund, based upon that participant's relative contribution to the Fund. The Fund is not involved in and will not conduct activities in relation to "emissions trading" or the trading of assigned amounts (Article 17 of Kyoto Protocol).

Project Selection Criteria

The selected projects will adhere to all current and future guidelines, modalities and procedures adopted by the Parties to the UNFCCC (United Nations Framework Convention on Climate Change) . Particular attention will be given to operationalize the provision for real, measurable and long term reduction in greenhouse gas emissions. These conditions have a direct bearing on the baselines and monitoring and verification protocols for projects. Additionality criteria and sustainable development criteria required by the mechanisms will also influence the project selection. In addition to these criteria, the PCF will require the project to fulfill requirements summarized below.

Consistency with Relevant National Criteria: As a matter of policy, all activities of the World Bank Group must be compatible with and supportive of national environment and development priorities in the client countries. These principles will also guide the design of the Fund's Projects. In addition to the environmental and developmental guidelines of Host Countries, individual Parties to the UNFCCC may establish their own criteria for acceptance of projects, such as capacity building and transfer of appropriate technology. All PCF projects will be consistent with these criteria.

Consistency with the Bank's Country Assistance Strategy: As a part of its regular lending activity, the World Bank periodically agrees with respective governments on a Country Assistance Strategy ("CAS") which guides most World Bank activities in that country. The Projects will be designed to be consistent with, and supportive of, the current CAS, and the country's own development objectives.

Funding Alternatives and Complementarity with the GEF: *Recognizing the need to use limited resources effectively for financing the global environmental agenda, Projects are expected to be designed to be complementary with the goals of the GEF (Global Environment Facility), which is the designated financial mechanism of the UNFCCC. The World Bank intends to coordinate the Fund's portfolio development with the GEF to ensure complementarity and so that, consistent with an understanding reached between the Trustee and the GEF, Projects do not compete either with the GEF's long-term operational programs or with its short-term response measures.*

Additional Characteristics of Fund Projects: *Projects will be selected to mitigate various types of risk. Projects should generally entail manageable technological risk. The technology to be used in a Project should be best available but must have been demonstrated in a commercial context in-country or elsewhere in the world and be subject to the usual commercial performance guarantees. The technical competence in the Host country to manage this technology should be established in the course of project appraisal. Projected Emission Reductions over the life of the Project must be predictable and should not involve unacceptable uncertainties. Emission Reductions must also be amenable to standardized Validation and Verification processes with existing methodologies.*

Project Portfolio Considerations

In addition, the PCF will develop a Project portfolio with the intention that during the term of the Fund:

1) A broad balance will be achieved in the number of Projects undertaken in economies in transition and in developing countries.
2) Emphasis should be directed at development of projects in the area of renewable energy technology such as, but not limited to, geothermal, wind, solar and small hydro energy;
3) No less than approximately 2% or more than approximately 10% of the PCF's assets should be invested in any one Project. This would imply that PCF component of the project should not be less than US$ 2 million and not greater than US$ 10 million. Within these limits, it is expected that the total size of the project may be in the range of US$ 5 million to US$ 50 million.
4) No more than approximately 20% of the PCF's assets should be invested in Projects in the same Host Country to ensure a geographical balance for equity and portfolio risk management ; and
5) No more than approximately 25% of the Fund's assets should be invested in Projects using the same renewable energy technology for primarily risk management within the portfolio.

The Next Steps

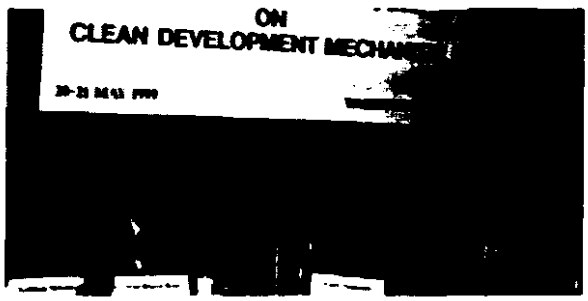
The PCF will be formally open for subscription on November 15, 1999 and will be capped at $150 million. The subscription will close when formal "Participants Agreements" totaling $150 million are signed, or on February 1, 2000. The Fund has a cap of $150 million. The governments of Finland, the Netherlands, Norway and Sweden and 18 corporations have agreed to date to consider participating in the PCF.

Please refer to the website for more details on the PCF's operations, organization, etc. http://www-esd.worldbank.org/cc/ click on "The Prototype Carbon Fund" or contact Chandra Shekhar Sinha at csinha@worldbank.org (Tel +1-202-458-7475; Fax +1-202-522-2130).

Indo US Business Dialogue on Clean Development Mechanism
Washington May 20-21, 1999

On May 20-21, 1999, the Indo-U.S. Business Dialogue on the Clean Development Mechanism (CDM) took place in Washington, D.C. The objectiveof this forum was to conduct thoughtful discussion amongst a group of leading CEOs and senior managers from India and the U.S. on the challenges and the opportunities presented by the CDM. Fifty business leaders participated in the Dialogue, joined by a select group of government officials and NGO leaders.

The participants agreed that the focus at this phase should be on partnerships and contractual arrangements, rather than on speculations as to the magnitude and future movement of a global carbon emissions market. It was felt that the Government of India could contribute to the effort and significantly advance its own desire to meet pressing environment and development challenges in India by establishing its own national framework that clearly identifies priority development sectors in which CDM-type projects would be welcome, and concisely articulated approval processes that would apply to these projects. Participants strongly agreed that sustainable development priorities and greenhouse gas reduction priorities could be advanced simultaneously through well-designed CDM projects.



(L-R) Mr Arun Bharat Ram, Vice President, CII, Hon'ble Larry Summers, Secretary, US Dept. of Treasury and Mr Rahul Bajaj, President, CII

Global Climate Change-Operationalizing Projects and Partnerships
Mumbai – July 12, 1999

A Roundatble on "Global Climate Change-Operationalizing Projects and Partnerships" was organised on the above theme at Mumbai on July 12, 1999 in colloboration with Indian Institute of Management, Ahmedabad. This event marked the first step towards development of climate change projects, the key feature of the event being the presentation of project ideas by three senior Industry leaders. Over 85 people representing industry, NGOs and academia participated in the seminar which witnessed intense discussion on key climate change issues.

(L-R) Hon'ble K McGinty, Senior Visiting Fellow, TERI, Mr Pramod Deo, Secretary, Energy & Environment, Govt. of Maharashtra, Prof. Shukla IIM(A), Mr Raghuraman, Senior Advisor, CII and Dr J Sathaye, Senior Staff Scientist, Lawrence Berkeley, National Laboratory

Climate Friendly Project Development Workshop
Chennai, September 27-28, 1999

(L-R) Dr Mark Trexler, Mr Raghupathy, Adviser, CII Dr K Hanekar, Senior Visiting Fellow, TERI, Mr R Burrable, JUEP and Mr J Armstrong, Senior Vice President and COO - Hagler Bailly Inc. Services

CII organised a two day workshop on **"Climate Friendly Project Development Workshop"** to continue the process of developing climate change projects which was initiated at a joint CII-IIM(A) roundtable held in Mumbai on July 12, 1999. Over 45 participants representing both public and private sector covering a wide spectrum of Industries participated in the workshop. The hall mark of the workshop was the presentation climate change project ideas by five industries This was followed by a structured discussion of the projects by a panel consisting of Indian and International climate change experts to evaluate the eligibility of projects for available climate change funding and gain insights about how certain contentious issues specific to climate change projects could be addressed.

The Opportunity for GHG Emissions Reductions in India is Large

Investment projects in India can produce substantial reductions in greenhouse gas emissions (GHG), particularly carbon.

The country's large generation capacity is largely coal based and produces high emissions. It offers an excellent opportunity to improve generator efficiencies and emissions management. Substantial efficiency gains are also possible from improvements to India's transmission and distribution systems. In addition, coal washing to reduce ash content presents $1.8 billion of potential investment, while switching from coal to natural gas (imported LNG) in coastal areas presents an additional $3.1 billion.

In the longer term, the adoption of new, more expensive coal technologies such as integrated gasification combined cycle combustion and renewable energy development (especially bio-mass conversion through co-generation and gasification technologies) offer great promise. In the near term, these options may not offer the lowest-cost carbon benefits. Eventually, however, India's power development demands, environmental policies, and a well developed carbon market may work together to make such projects viable.

A recent study of ten energy-intensive sectors in India estimated that an investment of $1 billion could eliminate the 20% lag between Indian facilities and international best practice in the area of energy use, while allowing their export industries to become more cost-competitive in global markets. The simple payback for this investment would be four years. Of the ten industries examined, iron and steel, textiles, and aluminum accounted for nearly 70% of the efficiency potential.

Other climate change mitigation opportunities could come from increased efficiencies in building and consumer technologies. Such initiatives will require institutional support and/or agreement on carbon benefit verification mechanisms.

In the near term, most climate change investments in India are likely be made in the industrial and power sectors. This is because:

- These are the two largest sources of carbon emissions
- The investments will be large, both individually and in aggregate
- The transaction costs of processing climate change projects will be a manageable portion of the overall investment
- The technologies are well known and proven
- Both the Indian and foreign investment partners are financially sophisticated.

The table below gives a consolidated picture of characteristics of different mitigation opportunities.

Technical Characteristics of Climate Change Mitigation Opportunities

Project Category	Emissions Mitigation Opportunity	Size of Opportunity	Overall Investment Potential	Energy Benefits Expected	Carbon Reductions Expected
Electric Generation					
Coal Washing	Reduce ash content from 40% to 30%	5,000 to 6,000 MW of capacity	$1.8 billion	5,500 Btu/kilo coal	11 million metric tons annually
Fuel Switching	Imported LNG in current coastal coal plants	3,800 MW	$3.1 billion	0.15 kilograms carbon per kWh	4 million metric tons annually
Conventional Efficiency	Improve thermal efficiency 1.5%	6,500 MW	$0.15 billion	Not available	4 million metric tons annually
IGCC Power	Install IGCC technologies	10,000 MW	$10 billion	2,000 Btu/kWh	5 million metric tons annually
Renewables	Wind, solar, bagasse and mini hydro	35,000 MW annually	$25 billion	0.35 kilograms carbon per/kWh	60 million metric tons
Industrial Sector					
Caustic Soda	Conversion of cell mercury cell process to membrane	900,000 metric tons of capacity	$8.4 billion	500 kWh per metric ton produced	120,000 metric tons annually
Cement	Upgrade from wet to dry process	45,000,000 tons of capacity	$ 4 billion	90 kWh per metric ton produced	1.1 million metric tons annually
Aluminum	Upgrade to Hall-Herault Process	Balco and Indal Plants	$8.4 billion	1,500 kWh per metric ton	?
Project Category	Emissions Mitigation Opportunity	Size of Opportunity	Overall Investment Potential	Energy Benefits Expected	Carbon Reductions Expected
Steel	Update open hearth process plants	?	$4.3 billion	2.8 MMbtu per ton of clinker	0.8 million metric tons annually

Climate Change Funding

A number of funding options are currently available or may be available in the near term for climate change projects. These funding sources differ with respect to the nature of projects which are entertained, conditions for funding, type of funding and approvals which are required for accessing these funds. The salient feature of the projects are captured in the table below.

Financing Mechanisms

Organizations and Programs Activities Implemented Jointly (AIJ – Pilot Project)	Target Investments Any GHG reducing projects	Types of Financing Grants	Focus Regions Global	Required Approvals AIJ national offices	Level of Funding (US$) $50,000 – $5 million
E&Co. renewables	Energy efficiency & investments	Loans and equity	Developing countries	None	Loans and equity investments from $25,000 to $250,000
Environmental Enterprise Assistance Fund (EEAF)	Energy efficiency & renewables	Loans and equity investments	Developing countries	None	$100,000 - $750,000
GTZ (Germany)	Energy supply and conversion	Grants	Countries with high levels of GHGs	Host country government	$100,000 - $300,000
Global Environmental Emerging Fund (GEEF)	Clean energy or water projects	Equity investments	Global	None outside the GEEF (OPIC) Fund	Up to $18 million
Global Environment Organizations	Energy efficiency & Target Investments	Grants and loans Types of Financing	Countries Focus Regions	Host country Required Approvals	All levels Level of Funding (US$)
Facility (FEF)	renewables and other CHG reducing projects		eligible for funding under the World Bank	focal points	
International Climate Change Project Fund (ICCPF)	Energy efficiency, energy supply, renewables, offsets, and trading	Grants	Countries receiving USAID funding	Letters of agreement with host country and corporate commitments	Average of $300,000
International Finance Corporation (IFC)	Power sector reform, market development	Loans and equity investments	Global	Project specific	$100,000 and up
ICICI	Clean technology/GHG reduction in key industries	Loans and conditional grants	India	Fund specific	Max Rs 35 million
International Utility Efficiency Partnerships (IUEP)	Any CHG reducing projects	Competitive grants	Developing countries	Corporate commitments	$50,000 $200,000
Oregon Climate Trust	Any GHG reducing projects	Open to project design	Global	With State of Oregon for CERs	Less than $500,000
Prototype Carbon (PCF)	Complimentary to GEF projects	Loans	Global	Host country	Estimated to be $2-$12 million
Triodos Bank	Renewable, energy efficiency, efficient building	Loans and equity investments	None	Unknown	All levels

Some interesting websites on Climate Change

- www.bcse.org - the Business council of Sustainable Energy
- www.weathervane.rfl.org- Wethervane
- www.unfccc.org- United Nations Framework Convention on Climate Change
- www.esd.worldbank.org/aij/india- World Bank
- www. Tomarrow-web.com- Tomarrow Magazine Global Environment Business
- www. iggc.org/igc/issues/ac/index.html-Econet, Atmosphere & Climate
- www.globalchange.org Global Change Magazine
- www.greenpeace.org/~climate/-Greenpeace, Climate crisis
- www.usia.gov/topical/global/environ/envcl.html- USIA Environment, Climate Change
- www.unep.ch/ipcc/ipcc95.html- IPCC, Climate Change 1995: The IPCC second assessment report
- www.cdc.noaa.gov/-US National Oceans & atmosphere administration, Climate Change diagnostic Center
- www. iciei.org/sbtoc.html-International council for local Environment Initiatives, CO2 briefing
- www.unep.ch/iucc/-Information unit on climate change. An office of UNEP
- www.unep.ch/ipcc/-Intergovernmental panel on climate change. (IPCC)
- www.hq.nasa.gov/office/mtpe-NASA Mission to earth
- www.ucsusa.org/global/climate.html-unit of concerned scientists, understanding of climate
- www.usia.gov/topical/global/environ/climfac.html-US department of state fact sheet on Global Climate Change
- www.usia.gov/topical/global/environ/FACT_197.html-US department of state fact sheet on the US Climate Change protocol
- www.usgcrp.gov/- The U.S. global climate research programme
- www.geocities.com/~combusem/enenrgy1.html_contains a large number of good climate change links

INFORMATION REQUIREMENT FOR A CLIMATE CHANGE PROJECT PROPOSAL

Developing a climate change project would require information that is additional to what is required for a normal project. Given below is the outline of minimum information that will be required by most Climate Change funding agency/programme. If you have any questions get in touch with us at vr@sai.cii.ernet.in .

OUTLINE OF A PROJECT PROPOSAL

1. **Overview of Sponsor's Company**

   a) Business lines (what does it do, location[s], ownership, markets)

   b) Energy consumption (provide estimates of total energy consumed, captive generation, energy costs as a percentage of total costs)

   c) Prior relationships, if any, with institutional support from such bilateral or multilateral agencies as USAID, World Bank, etc.

2. **The Proposed Project**

   a) Objective

   b) Project description

   c) Text narrative of proposed project

   d) Timetable

   e) Proposed technology, source of new technology, whether the technology has worked elsewhere in India

   f) Implementation: How the solution will be implemented, whether any portion of the project is likely to proceed if a financial contribution for climate change benefits is not identified, and if so, the likely cost of the smaller-scale project

   g) Performance indicators

   h) Baseline energy use (i.e., in the absence of the project)

   i) Projected change in energy use (resulting from the project): annual and total for projected life of project

   j) Projected carbon benefits (to the extent these have been calculated using a rule-of-thumb of carbon savings per kWh reduced or per Btu or kcal of thermal energy reduction)

   k) Other environmental and social costs and benefits (such as reduction in local pollutants {SOx}, employment)

   l) Project cost (in Rs. and $)

   m) Projected source of funds – e.g., feasibility study grants, sponsor's equity, loans, foreign investment, etc.

   n) Percentage of project finance requirements already arranged, and remaining gap (amount and type of financing required)

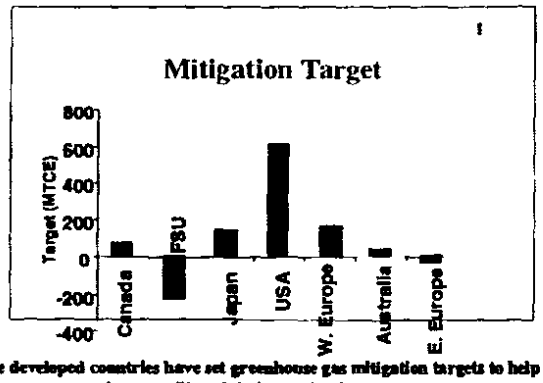
   o) Indicate size of current financial gap as cost per ton of carbon

   p) Project risks

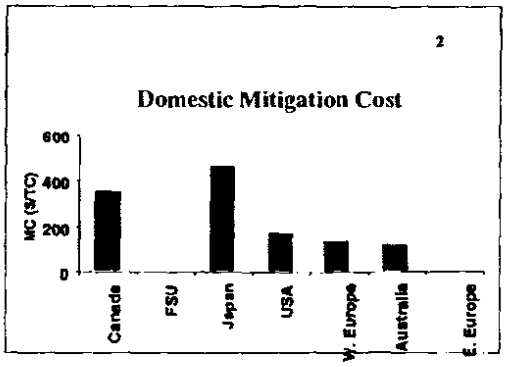
   q) Sustainability of GHG savings (caused by market demand, business case, etc., and whether the savings can be measured/monitored)

   r) Sponsor commitment

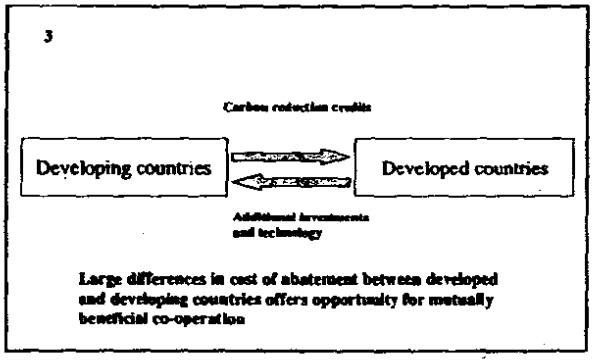
THE RATIONALE & POTENTIAL OF CLIMATE CHANGE PARTNERSHIP PROJECTS



Some developed countries have set greenhouse gas mitigation targets to help in controlling global warming impacts



... but cost of mitigation per ton of carbon is very high in these countries compared to developing countries where it is estimated at below $25 per ton



Large differences in cost of abatement between developed and developing countries offers opportunity for mutually beneficial co-operation

- NORMAL PP DRIVERS
  - HOST COUNTRY ENVIRONMENT
  - MARKET PROSPECTS
  - REGULATORY FEATURES
- DRIVERS SPECIAL TO CC-PP
  - DEMAND AND SUPPLY OF OFFSET PROJECTS
  - TRANSPARENT EVALUATION,MONITORING AND VERIFICATION CRITERIA AND SYSTEM
  - HOST COUNTRY GOVERNMENT PESPECTIVE ON ABATEMENT PROJECTS

4

The drivers for Climate Change Project Partnerships (CC-_PP) will be additional to those for normal FDI

[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
PAPER	266	[illegible]
CEMENT	203	4
STEEL	N.A.	10
OTHERS	116429	15
TOTAL FOR INDUSTRIES	174482	100

*1.8.91 TO 30.9.98
(Rs crores)

6

COUNTRY	Foreign I in India (Rs crores)	No. of collaborations
USA*	135698	459
UK*	44907	204
GERMANY*	21558	254
JAPAN*	19064	147
AUSTRALIA*	4317	61
ALL COUNTRIES	548913	2325

*countries with commitment to reduce GHG emissions

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CII

GLOBAL CLIMATE CHANGE
EMERGING GREEN OPPORTUNITIES

Vol. 2 No. 1 (March 2000) *Newsletter*

"if we are committed to successfully address the challenges of sustainable development, and hence of environmental conservation, then it will require an international movement, the like of which has never been seen before."

Atal Bihari Vajpayee
Prime Minister of India

"I hope we have broken the old idea that a nation can only grow rich if it despoils the environment"

William Jefferson Clinton
President of The United States of America

From the Editor's Desk

The inauguration of the Green Business Center (GBC) at Hyderabad by President Clinton of the United States during his first visit to India is an aspect of Indo-US collaboration on efforts to make fossil fuel energy clean and more efficient. Being the world's largest emitter of greenhouse gases, the United States has a big responsibility in meeting the challenges of climate change. Rightly, the Kyoto protocol binds the United States to bringing down emissions by 30% from the level projected for the period 2008-2012.

Global warming threatens the well being of millions of people in different parts of the world, and adoption of non-polluting energy options requires the utmost urgency. In so far as the Kyoto agreement offers the basis for a multilateral framework against the spread of global warming, this must receive considerable support.

This was duly recognised by India and the United states in the Joint Statement on Cooperation in energy and related environmental aspects issued on October 26, 1999 by the Indian External Affairs Minister and the US Energy Secretary (see page 2). Such recognition must be reflected in energy- related practices in diverse developing countries. Clearly, energy users in various industry segments and individuals alike have a big part to play and the Hyderabad Center is offered as a focal point for promoting awareness of the imperatives of 'greening' as against 'warming'. Any equipment that is energy-based has to be designed and utilised to achieve the maximum efficiency. Obviously, the responsibility has to be shared by equipment suppliers and users, wherever they are--in factories and in homes.

Consistent with US commitments to the fulfillment of Kyoto goals, President Clinton has sought U.S Congressional assent for a federal budget provision of $ 2.4 billion towards the cost of several measures designed to reduce the harmful effects of global climate change. The allocation mooted is 42% more than what the Congress had approved in the previous year. The thrust is going to be on facilitating globally environment-friendly technology in the energy sector. Developing countries led by China and India, which are embarking on measures to reach a high growth path, will need substantial energy resources and they have to access state-of-art technology and adequate finance. As per a recent assessment by the White House, these countries together will constitute a market for technology and energy products in the range of $ 4 to 5 billion two decades from now.

Half a century later, developing countries will account for as much as 75 percent of the projected global increase over these fifty years. Cooperation between the developed and developing countries will be greatly needed to reduce global energy intensity. While the FDI flow in the energy sector needs to be accelerated, it must be made certain that state-of-art, clean energy and environment technologies are accessed.

India, for its part, is wedded to energy conservation as well as efficiency. The Energy Conservation bill has been introduced in the current session of Parliament.

In this context, the Green Business Center would seek to advance the public policy goals of sustainable development, efficiency and equitable growth by catalysing private sector businesses. Towards this end, the GBC would assist Indian businesses create the demand for appropriate, effective and efficient energy systems as well as environmentally sound technologies and appropriate financing.

INDO-US JOINT STATEMENT ON COOPERATION IN ENERGY AND RELATED ENVIRONMENTAL ASPECTS

1. The United States of America and India, the two largest democracies in the world and endowed with abundant natural, scientific and skilled human resources, have a long history of mutually beneficial cooperation in the fields of science and technology, industry and trade, health and environment and culture and education. The two countries, recognizing the immense promise for advancing their social and economic goals through cooperation in the energy sector, have decided to intensify their cooperation in this area.

2. The two countries recall the past cooperation that established the framework for several joint initiatives between the two Governments and their agencies for research and development in the energy sector, as well as stimulated private cooperation in conventional energy projects in India.

3. The two Governments, noting the progress made in these collaborative projects, and recognizing the immense opportunities for fruitful cooperation in the energy sector, have decided to further enhance their cooperation in the energy sector such as conventional energy projects, renewable energy, clean coal technology, energy efficiency and related environmental aspects.

4. They also recognize that future development of the energy sector must take into account the growing demand for energy, the importance of judicious utilisation of limited resources of the planet in the most efficient and equitable manner and the need to protect our environment.

5. India, which was the first country to establish a full-fledged Ministry for Non-conventional Energy Sources, is working to make renewable energy sources a viable and significant part of India's energy supply. India is one of the largest users of wind energy and solar energy in the world and has also made impressive advances in generating energy from wastes. In the field of conventional energy, India is increasingly making fossil fuel energy clean and more efficient.

6. The United States is taking several major initiatives to meet its energy requirements in an increasingly climate friendly manner. For example, the US Government has set a goal of tripling US use of bio-energy and bio-projects by 2010, which may reduce greenhouse gas emissions by 100 million metric tonnes of carbon. The US Government has ordered every federal agency to reduce greenhouse emissions from buildings by 30% by 2010 from 1990 levels. The US Government continues to invest billions of dollars in clean energy and energy efficient technologies and is working with American industry and communities to reduce pollution and greenhouse gas emissions and move to cleaner and healthier energy sources.

7. The two Governments, in the spirit that characterizes their own initiatives to mitigate the impact of energy production on environment and climate, accord high importance to these aspects in their bilateral energy cooperation.

8. They also resolve to work closely together and with other countries, in keeping with the principle of common but differentiated responsibilities, to advance the goal of protecting the people of the world from the threat of climate change, while promoting economic growth.

9. As the world's largest emitter of greenhouse gases, the United States recognizes its responsibilities to help lead international efforts to address the challenge of climate change. The Kyoto Protocol sets forth a binding emissions target for the United States, which would result in a reduction of roughly 30% from the projected levels in 2008-2012.

10. The Government of India recognizes the need for voluntary "no-regrets measures" at the national level, which will have the additional benefits of dealing with air and water pollution, urban transportation and other important sectors of the domestic economy.

11. The two Governments agree to cooperate and to work together in appropriate forums for advancing the goals of the UN Framework Convention on Climate Change, in accordance with the decisions of the Conference of the Parties to the UN in its various sessions.

12. The Governments of the United States and India agree to cooperate within the framework of the Conference of the Parties and its subsidiary bodies of the UN Framework Convention on Climate Change, to work towards an early agreement on the elements of the Kyoto Mechanisms.

13. In particular, the Governments of the United States and India agree that the Kyoto Mechanisms could offer the opportunity to achieve mutually beneficial partnerships between industrialized and developing nations. The Governments of the United States and India resolve to work closely together with other countries to develop agreed international rules and procedures for the Kyoto mechanisms, including the Clean Development Mechanism.

14. The Governments of the United States and India, guided by the objective of using the immense opportunities and their vast pool of resources and skills for fruitful cooperation in the energy sector, in both the bilateral and international context, resolve to take appropriate measures to foster private sector energy ventures, cooperation in research and development, and greater utilization of environment enhancing and climate friendly energy sources and technology for balanced and sustainable economic development.

CII LAUDED FOR INITIATIVES ON CLEAN DEVELOPMENT MECHANISM

The U.S. Energy Secretary, Bill Richardson utilised his address at the CII Environment Summit 1999 to focus on key issues.

I want to thank the Confederation of Indian Industry for its leadership role in working with industry here to promote the Clean Development Mechanism, which I will be discussing a bit later, and for raising this idea with the Government of India. I spoke with some of you last May when your organisation convened in Washington, and I am pleased to join you again to discuss this issue of great importance.

CII and Katie McGinty are really to be congratulated. Recognizing the dangers of climate change, they also saw the tremendous opportunity for India presented by the CDM. And they are right. For India, the CDM means new investment flows and transfers of new clean technology, even while it is a tool to reduce global pollution. The CDM is indeed a "win-win" for India and the U.S.

A Task for Developing Nations

Reducing emissions involves all members in the family of nations. Developing countries, as they grow, face a decision that will have consequences not only for them, but also for us all.

Do they practice business as usual? Or do they follow the path of clean energy, which draws upon more efficient and environmentally friendly technology to change course.

While developed countries also face these choices, the greater growth in developing countries affords the opportunity to overtake scientific evolution and adopt the technologies of tomorrow.

Emissions Trading

Emissions trading is another international route to promote sustainable development and address climate change issues. An effective international emissions trading regime – free of arbitrary constraints – would help countries reach their emissions targets under the Kyoto Protocol. The more trading partners, the more effective this tool will be.

India would benefit financially from assuming a target under the Kyoto Protocol because only parties with emissions targets can take advantage of all the benefits – particularly international emissions trading – under the Protocol's flexibility mechanisms.

Through this system, any country would be able to trade its surplus emissions to countries with high abatement costs. For India, a country with many opportunities for low-cost abatement, the revenue stream could exceed $1 billion annually.

US Is Ready To Chip In

The U.S. Government and American energy firms stand ready to help achieve such regional energy integration, which could significantly improve the quality of life for the people of South Asia.

Some other examples of cooperation we are looking at include putting trees to work reducing amounts of carbon dioxide in the air by planting 2,500 orchards in the Karnataka State in South India, and establish a teak plantation in the State of Tamil Nadu.

India is already a global leader in its use of renewable energy technologies, and our two nations have a history of cooperation in this field. One recent example is the Ramakrishna solar energy project in West Bengal, and I am pleased to announce that U.S. Government funding for the project has been restored.

There are opportunities for cooperation in the area of clean energy development as well. U.S. companies can deliver investment capital to fuel India's economic growth and offer managerial and technical expertise.

India has made progress towards reforms in its energy sector, and from our own ongoing experience, we in the U.S. know just how difficult that is. What is needed now is the political will to accelerate these reforms, including restructuring India's energy enterprises, establishing independent regulation at the state and national levels and being more open to competition.

Beyond Government Policies

But government policies alone cannot solve this problem. It will require a global solution in which the private sector and governments work together.

In the Industries of the Future program, the Department of Energy is helping seven of the most energy-intensive industries in the United States devise a voluntary framework for reducing greenhouse gas emissions. It brings benefits to the environment and helps these industries cut their energy costs.

And the partnership among the three major U.S. automobile makers and the U.S. government is developing a vehicle that is three times more efficient than the cars on the road today. These vehicles could have an enormous long-term impact on emissions, and help our auto companies prepare for the market of the 21st century.

A Revolution of Sorts

To meet our goals will require a revolution of sorts, of the way we think, the way we treat our world's resources, the way we conduct business. And all revolutions face resistance. Some industries are reluctant to come on board because of initial capital costs or concerns with pending legislation such as the restructuring of our electricity industry. Despite these obstacles, the United States is committed to doing its share to improve the global environment.

And today we reach out across the globe to your great nation. In forming a partnership on the climate issue and in particular in support of the Clean Development Mechanism, we are witnessing a revolution. A revolution in thinking. A revolution that says industrialized and developing countries can and must prosper together: "win-lose" strategies are going by the wayside in favour of "win-win" partnerships. We have to be in it together, pulling for – rather than against – each other.

THE GREEN BUSINESS CENTER

The Green Business Center (GBC) is the natural culmination of recent Indo-US bilateral initiatives that CII has been privileged to host. Under USAID sponsorship, CII has initiated activities aimed at enhancing energy efficiency, environment protection and the commercial development of renewable technologies. CII is also the designated center for USAID's Global Climate Change Awareness & Outreach program aimed at promoting business partnerships to reduce greenhouse reduction (GHG) emissions.

Recognizing that cooperation on climate change needs to be built on a common understanding between developed and developing country businesses, the CII initiated the process by organizing in May 1999 an Indo-US Business Dialogue between a group of leading CEOs and senior business leaders from India and the U.S. This initiative was furthered during the visit of US Energy Secretary, Bill Richardson in October 1999. The visit was marked by the signing of the Indo-US Joint Statement between Jaswant Singh, Foreign Minister, and Secretary Richardson where the two countries agreed to cooperate within the framework of the Conference of the Parties and the UN Framework Convention on Climate Change, and work towards an early agreement on the elements of the Kyoto Mechanisms.

A Logical Conclusion

The Center proposed by CII and the Government of Andhra Pradesh is, thus, a logical conclusion to the preceding sequence of Indo-US events aimed at promoting and fostering energy efficiency and clean technologies in India. It is expected that the proposed US support through the participation of President Clinton will provide a high degree of visibility and recognition in India, US and the rest of the world. This would enable the Indian sponsors to rapidly build upon the goodwill and international support that would surely follow.

The center would advance the public policy goals of sustainable development, efficiency and equitable growth through catalyzing private sector businesses. To this end, the Green Business Center would follow two guiding principles: First, it will assist Indian businesses create the demand for appropriate, effective and efficient energy systems and environmentally sound technologies, i.e. available commercial technologies that provide energy and industrial processes and products at the least cost, both economically and environmentally. This would entail assisting Indian industry to develop the technical and analytical skills to use the technology and to design least cost green house gas emissions reduction strategies. Second, the private sector would be the primary means of technology transfer through international trade in goods and services and investment. This would entail promoting and fostering opportunities available through global agreements such as the Clean Development Mechanism (CDM) for mitigating carbon emissions.

State-Of-Art Facilities

When fully functional, the Green Business Center will have state-of-art facilities for networking, conferencing, training, library services and documentation and information dissemination on clean energy and the environment. It will perform the following functions:

- Facilitate GHG reduction and clean energy projects
- Work with the Government of Andhra Pradesh on State-level policies to attract CDM investments in a globally competitive market place.
- Build the capacity of in-country partners (such as CII, other state and central industry assns.) to promote technology cooperation.
- Identify prospective sites and partners for GHG mitigation projects
- Educate prospective business partners on the green technologies, the legal and institutional environment and sources of financing.
- Facilitate interaction between prospective business partners, industrial facility managers and financiers.
- Support companies with technical assistance for project development
- Provide guidance and assistance to project partners in accessing financing
- Conduct a regular series of private/public forums to identify barriers and solutions to market development
- Involve the Government of Andhra Pradesh, Government of India and U.S. in the development of this initiative as a model for technology cooperation under the FCCC.

Projects and Programs

In fulfillment of the above areas of functioning, the Center will focus on the following illustrative projects and programs:

- Clean production technologies;
- Energy efficiency/DSM projects in supply and use;
- Renewable energy technologies and programs;
- Policy planning and research;
- Climate change awareness programs;
- Business development and demonstration of GHG mitigation projects and technologies;
- Facilitating ISO 14001 implementation and certification;
- Environmental benchmarking; and
- Greening the supply chain

It is proposed that the Green Business Center is established through the partnership of the Government of Andhra Pradesh and CII (with the support of its corporate members from industry), and with the initial sponsorship of USA through technical assistance and other forms of support that are possible under USAID's bilateral energy/environment programs.

It is expected that the activities of the Green Business Center, when fully functional, will receive funding from Indian companies, Government of India agencies, multilateral banks, UN agencies and bilateral donors.

FROM A MOVEMENT TO A COMMERCIAL FACILITY

The Green Institute, Minnesota

The Green Institute is a non-profit making economic development organization focused on sustainable enterprise. Incorporated in 1993, the Institute originated from an environmental justice movement against the location of a large garbage transfer station in a residential area of the Phillips neighbourhood of Minneapolis.

In the early 1980s, the Hennepin County razed 28 homes and five businesses to clear a 10-acre site for a garbage transfer station, but Phillips residents resisted the plan and ultimately prevailed. Residents then turned their attention to a more sustainable vision for the vacant site and the greater community. A plan emerged for a new commercial facility for high-growth, innovative businesses that develop products and services to help restore the environment. Early efforts towards sustainable development included the establishment of the ReUse Center, the Institute's first wholly-owned sustainable enterprise.

A fundamental goal

A fundamental goal is to bring living wage jobs to the Phillips area, charecterised by concentrated poverty and unemployment. Because of this thrust, Phillips was included in the Federal Enterprise Community area designated for Minneapolis. The Green Institute has received federal funding as part of the program.

The Institute employs 40 staff members and has an annual budget of $1.8 million. Funding sources are diverse, including program revenue, local, state, and federal government grants, foundation support, and contributions from private corporations and individuals.

ReUse Center

In 1995, the Institute launched its first project, the ReUse Center, a 26,000-square-foot retail store selling salvaged building and construction material. The Center is located at the Hi-Lake Shopping Center at the intersection of Lake Street and Hiawatha Avenue in South Minneapolis. Its mission is to renew the economic and environmental vitality of the Phillips neighbourhood through the establishment of a community-based business enterprise that will provide a model of self-sufficiency by combining environmental and social concerns while simultaneously striving to reduce dependence on government.

The Center houses a retail store, an education center and de-construction services. The retail store focuses on harvesting valuable building material from the waste stream by way of donations, which then are sold at a low cost. Retail sales for 1998 are projected at $375,000. Proceeds from sales go towards paying living (not minimum) wages and benefits to staff, the majority of whom live in the surrounding communities. The education center offers a variety of classes from hands-on home improvement, to new environmental construction techniques and natural foods preparation.

Source www.greeninstitute.org

CLEAN DEVELOPMENT MECHANISM –THE PROCESS

Background:

In response to the threat of global warming, countries are getting together to devise a long-term strategy. Two facts form the basis of the emerging approach. First, developed countries are chiefly responsible for the current problem due to their energy intensive standards of living. A group of such countries now known as Annex I countries are committed to reducing their emissions to a fixed percentage of their 1990 emissions. Secondly, the cost of carrying out emissions reduction is generally much lower in developing countries (non- Annex I countries). As a result of this, new mechanisms are being devised to counter the global warming problem.

One such mechanism, called the clean development mechanism (CDM) is being put in place that will allow countries on both sides of the globe to work co-operatively. Under CDM, Annex I countries will benefit by being able to meet at least a part of their GHG reduction commitments at a much lower cost in developing countries. Non-Annex I countries will benefit by having access to financing for advanced energy efficient technologies. This mechanism was proposed at the Third Conference of parties (COP-3) at Kyoto and forms part of the Kyoto Protocol.

The CDM Process:

Projects falling under CDM would have to undergo a certain process in order to qualify for and be eligible for the benefits available under the CDM facility.

The following activities can be considered to make up the entire process :

1. **Project certification/registration**: Projects would be registered with an authorized entity that meets the criteria of a CDM project.

   A CDM project will have to meet certain criteria before it is certified and registered as a CDM project

   a. **Additional**: Reductions in GHG emissions arising from the project are additional to those that would occur in the absence of CDM. Determination of the baseline would be a critical element in determination of the reduction additionality. Projects should also be additional in the sense that financing under CDM is besides the financing available under all existing resource mechanisms.
   b. **Aid sustainable development objectives**: All countries would need to have sustainable development indicators and candidate projects would be required to meet the standard as set by these sustainability indicators.
   c. **Measurable benefits**: Benefits arising from the project should be real, measurable and long term.

   This is an ex-ante activity.

2. **Project monitoring**: The project would need to be monitored to ensure that it does not violate the qualitative

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and quantitative criteria that are the basis of its existence under CDM. This would ensure that the project maintains a minimum acceptable performance with regard to certain parameters. Secondly, to get credit for any specified reduction in GHG emissions, certain project performance related parameters would need to be monitored in order to verify the claimed reduction.

This is an ex-post activity.

3. **Verification**: This is required to verify that the claimed reduction has actually occurred.

This is also an ex-post activity.

4. **Certification:** Once the claimed reduction is verified, certified emission reduction (CERs) certificates will be issued for the verified reduction.

Institutional arrangement: The entire CDM process will have to be governed by an institutional arrangement to ensure that all aspects of project are efficiently handled.

1. **Conference of Parties serving as Meeting of Parties COP/MOP**: CDM will be subject to the authority and guidance of COP/MOP. This guidance will include: modalities and procedure governing the operation of CDM; providing guidance to the Executive Board; and periodically reviewing the operations of the Board, operational entities and auditing agencies
2. **Executive Board**: The Executive Board would supervise the CDM and could provide guidance on the operational and technical issues. The composition and size of the Board is yet to be decided, but for the sake of efficiency should be small and fairly representative of all parties.
3. **Operational entities**: Practical functions of the operational entities should include reviewing projects based on guidelines and criteria adopted by COP/MOP, and registering them as CDM projects. Once a project has begun, the operational entity would verify and certify a project's emission reduction or removal after it has occurred and also monitor whether the project continues to meet certain performance criteria which qualify it as a CDM project in the first place.

Desirable features of CDM operational framework

There is a general agreement among many parties and stakeholders in the CDM that it should have the following features :

Efficient project certification: The structure to certify CDM projects should ensure minimum transaction costs for participating parties without compromising on the basic goals.

Non-bureaucratic: With a minimum amount of regulation, yet standardised in terms of quality and project handling

Market driven: Yet ensuring sustainable development and providing all non-Annex I parties with equal opportunities, including the low emission countries

Cost efficient: With a fair cost-sharing mechanism between entities acquiring and transferring the emissions reduction administered by CDM

Compatible with any possible Emission Trading regimes: CERs should be tradable like any other emission reduction currency units such as ERUs without any discrimination.

Transparent and flexible: Responsive to the needs of the Parties and with a high credibility

CLEAN DEVELOPMENT MECHANISM-THE PROCESS

Activity	Authority*	Output	Functionality
[illegible]	[illegible]	[illegible]	[illegible]
Appoint operational entities	CDM/ EB	[illegible]	[illegible]
Monitor certification bodies	CDM/EB	[illegible]	[illegible]
[illegible] certification	[illegible]	Certificate of project [illegible]	[illegible]
Registration	CDM/EB	List of approved projects	Have records of all approved projects
Monitoring and verification	Monitoring & verification agency	Provide the basis for certification of emission reduction	Monitor and verify claims of emissions reduction periodically
Certification of emissions reduction	Certifying agency	Certificate for verified emission reduction	Issue certificate for verified emissions reduction

** Conference of Parties, *** Meeting of Parties, **** Executive Board

Among the wide variety of possible CDM structures, different countries will have varying preferences because of differences in their resources, experience and objectives That is reason enough why the Indian Government and industry should be a key stakeholder in the CDM and must actively help shape the CDM rather than passively accept any form and structure of CDM that its non-participation will entail. Indian industry must get involved in the development of CDM process by interacting with and providing inputs to the Indian Government which could form the basis of Indian representation at the forthcoming Conference of Parties (Fifth) later this year.

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GREENHOUSE GAS OFFSET REQUEST FOR PROPOSALS

TransAlta's Sustainable Development Department (SDD) provides leadership to the company on global climate change issues and is responsible for the overall administration of the request for proposals (RFP), the corresponding evaluation of project proposals, project selection, negotiation of project agreements, and overseeing of the project implementation process.

Corporate Objectives

Through RFP, the SDD is seeking to review a set of well-designed greenhouse gas (GHG) emission reduction projects that advance the goals of TransAlta and the SDD. It is important that projects also contribute to other corporate objectives such as promoting environmental stewardship, technology co-operation and advancing the state of knowledge regarding options for mitigating GHG emissions. Therefore, non-GHG benefits of a proposed project (both environmental and non-environmental) will be considered in the evaluation process. Such benefits might include employment effects, regional economic development, technology innovation, information transfer and the promotion of sustainable development.

The SDD recognizes that some projects may be very attractive on certain criteria, such as a low cost per tonne of CO_2 equivalent sequestered, while other projects may offer other benefits including technological advancement, technology demonstration and an attractive rate of return. By encouraging a wide range of potential, the SDD hopes to sponsor a diversified group of projects that collectively advance all its goals.

Guidelines in brief

Participants including but not limited to business, non-governmental organisations, business associations, government agencies as well as academic and research institutes are invited to submit proposals for TransAlta's 1998 GHG offset RFP in accordance with the guidelines in the proposal outline section.

Participants are requested to follow these guidelines to ensure an efficient technical review by TransAlta. Project submissions that do not contain the required documentation will not proceed through the technical review process until the necessary information is provided.

Each project brief and / or proposal submitted in response to this RFP will become the property of the SDD and will not be returned to the participant.

Proposals may be submitted at any time and will be reviewed on a quarterly basis.

Confidentiality

It is recommended that proposals include a minimum of confidential information regarding the participant's company, project, technology or processes. A certain amount of information is required before TransAlta will consider signing a confidentiality agreement. The project brief or proposal should indicate the following aspects of confidentiality agreements:

- under what circumstances confidentiality considerations apply;
- when confidentiality agreements are required before additional information would be made available;
- a draft confidentiality agreement should be provided as an appendix to the proposal.

Proposals must provide sufficient information to enable SDD to provide a reasonable description of the project within TransAlta without disclosing confidential information.

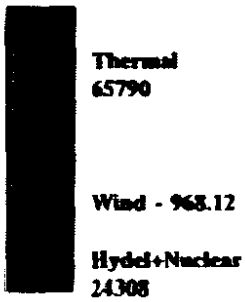
Source : www.transalta.com

Electricity Sector

Emission Reduction Possibilities

- **Clean Coal**
- **Efficiency Improvement**
- **Shift from Coal to Gas**
- **Renewables**
- **T&D improvement**

FUEL MIX (MW)



Source: Ministry of Power Oct. 99

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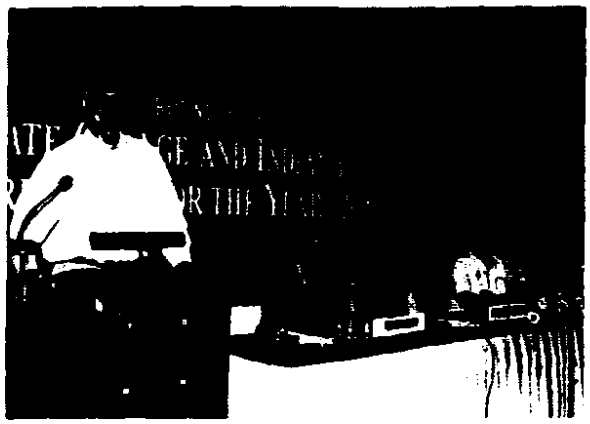
CII CLIMATE CHANGE OUTREACH AND AWARENESS CENTRE

HIGHLIGHTS

The beginning – Creating an awareness over climate change



The Roundtable on "Climate Change and Indian Industry: Preparing for the year 2000", April 1999 New Delhi

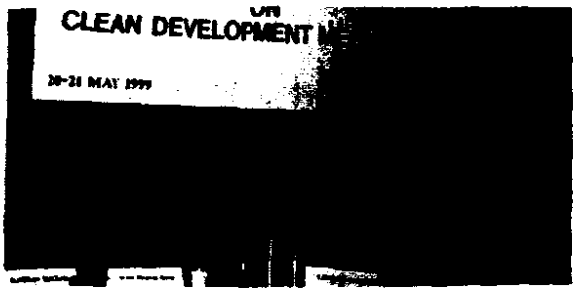
From negotiation to strategies

Global Climate Change - Operationalizing Projects and Partnership, July 1999, Mumbai

Commitment at the Government level

The Environment Summit, October 1999, New Delhi

Keeping the tempo – The Indo-US Business Dialogue



Indo-US Business Dialogue on clean development mechanism, May 1999, Washington

Strategies give way to action

Climate Friendly Project Development Workshop, September 1999, Chennai

GREEN BUSINESS CENTRE

Supported by :

USAID

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THE DEVELOPMENT ALTERNATIVES (DA) GROUP

The Development Alternatives Group (or the "DA Group") comprises Development Alternatives and its associate organizations in India: namely, TARA (Technology and Action for Rural Advancement) and People First. It also includes their respective subsidiaries, Tara Nirman Kendra, Tara Leasing and Finance and DESI Power.

The activities of the DA Group broadly cover the three primary areas that underlie any form of sustainable development process: the design and large-scale dissemination of appropriate technologies, environmental management systems and effective people-oriented institutions and policies.

Development Alternatives and its associate organizations operate on the philosophy that sustainable development benefits not only the economy, but also the environment - and above all the people. The DA Group is therefore dedicated to bringing about a better balance among the basic prerequisites of sustainable development: social equity, environmental quality and economic efficiency.

The key to achieving this, in the worldview of the DA Group, is the creation of sustainable livelihoods in large numbers. To do so, the DA Group seeks to develop commercially viable technologies and environmental management systems and to create financial, institutional and policy instruments that can deliver these on the scale needed.

Further, it has sought to carry out its own work in a manner that is largely self-financing. Apart from some purely research-oriented activities, mainly to develop the various rural technologies, which have been financed through project funding by a small number of donor agencies, all the work of the group is financed from its own earnings. Its ability to generate revenues depends, of course, to a large extent on its capital base.

To carry out its work effectively, the DA Group has pioneered in its own design and structure, the concept of a sustainable development enterprise. It is a new kind of not-for-profit corporation that combines social objectives with business-like methods.

The Evolution of the DA Group

Development Alternatives, the flagship of the DA Group, was set up in 1983. The vision that triggered its establishment was that sustainable development:

- Cannot be achieved by government action alone, and needs new kinds of independent initiatives, particularly ones that blend the strengths of the private, voluntary and research sectors
- Neither research nor action alone is enough; each needs the other and both must be conducted simultaneously and interactively to achieve the results needed

- Science and technology are crucial for raising the productivity of people and resources, to create sustainable livelihoods and to conserve the environment
- Small, local enterprises based on appropriate technology can be highly profitable provided they have access to necessary technical, financial and marketing support systems.

It describes a new, independent organization capable of innovation and large scale delivery of new, environmentally sound products for the poor. The plan concluded that to achieve impact on the scale needed, such an organization must use front-line innovation methods, as in successful corporate R&D, and modern production and marketing methods like franchising.

This primary vision still forms the basis of action for the DA Group, although it has, of course, been substantially enriched and filled out through more than a decade of operational experience and organizational learning.

EXPERIENCE (GENERAL)

The Achievements of the DA Group

The Group has established itself at the national and international levels as a premier organization in the independent sector, working at the front lines of sustainable development issues. Within the communities of research organizations, NGOs and think-tanks, the DA Group has been able to establish a unique position because of its capacity to undertake activities ranging from direct action on the ground, through analytical and field research and the development of conceptual and methodological frameworks, to policy formulation and advocacy synthesize sustainable development issues spanning the spectrum from community management systems, natural resource management, waste minimization and recycling, renewable energy systems to the creation of sustainable livelihoods on a large scale work at different scales, extending from the household and community, through the district and region, and to the national
and global.

The DA Group is widely known and extensively consulted by governments, international agencies, corporations and the voluntary sector. It is represented on numerous national level boards and committees, and also takes active part in a number of international bodies.

The DA Group has demonstrated significant convening power across the various sectors, and regularly organizes major conferences and workshops on specific issues relating to sustainable development. Through a strong communications program including a monthly journal, publications and weekly television programs and capsules, the DA Group has contributed to the awareness of sustainable development issues.

The DA Group has established a strong reputation for innovation and problem solving. It has been able to develop several ranges of commercially viable technologies for rural development, institutions for innovation and delivery, and methodologies for environmental resource management. Among its primary contributions, the organization has been able to demonstrate that not only are alternative development strategies needed and possible, but that many of them form the basis of a good business.

The DA Group is now active in most States of India. In addition to its headquarters and building center and factory Delhi, it has permanent units in Bangalore and Jhansi. An Appropriate Technology Center is being established at Orchha near Jhansi. Network links have been established with more than 3,000 institutions based in India and abroad. It also has active partner organizations in other countries, including Colombia (The Green College), Iran (CENESTA) and Canada (Development Alternatives Canada).

In its fourteen years of operation, the DA Group has been able to establish its credentials as a major actor in the fields of appropriate technology, environmental management and policies for sustainable development. The Group has achieved considerable output, but recognizes the long way that remains ahead to meet its overall goals.

GLOBAL ENVIRONMENT SYSTEMS GROUP

Green house induced global warming and the Ozone hole over Antarctica pose major threats to life on our planet. Studies indicate that these phenomena are caused by human induced activities resulting in emissions of carbon dioxide, methane, Chloro Fluoro Carbons etc.

The Global Environment Systems Group contributes to developing local and global solutions to these problems through three broad programs:

- Climate change Program
- Atmospheric ozone Program
- Conventions and protocols Program

1. Climate Change Program

This Program addresses various facets of climate change including problem identification, impact assessment and formulation of response strategies. The Group is actively engaged in assessing the impact of climate change on agriculture, health and hydrology. Research also focuses on sequestration of carbon dioxide by forests and other vegetation.

2. Atmospheric Ozone Program

The Atmospheric Ozone Program has two major components:

a. Stratospheric Ozone
b. Tropospheric Ozone

The focus in this component is on problems associated with increase in surface ozone due to vehicular and industrial pollution. The impacts of surface ozone on agricultural yield and human health are assessed. Besides, the response strategies for reducing surface ozone causal factors are also being formulated.

3. Conventions and Protocols Program

Under this program the group actively contributes towards national and international deliberations on climate change and ozone related issues. The Group is involved in the Montreal Protocol, Biodiversity Conservation, and FCCC activities, with emphasis on Activities Implemented Jointly (AIJ).

CLIMATE CHANGE RELATED RESEARCH WORK

The Environment Systems Branch at DA has been involved in the Climate Change research. The main focus of DA's activities is to study the building materials and renewable energy sources, which would lead to sustainable development. The Global Environment System Group manages the climate change program, which addresses to the facets including problem identification, import study and formulation of response strategies. The group is engaged in assessing impact on climate change on agriculture, health, hydrology carbon sequestration etc.

The Group also focuses on Ozone Program and activities related to Montreal Protocol, Biodiversity conservation, FCCC and AIJ activities.

SERVICES

The Global Environment Systems Group offers the following services:

- Commissioned research studies on global environmental issues
- Awareness generation through newsletter articles, journal papers, query-response, etc.
- Opinion building by organizing national and international conferences.

MAJOR CLIENTS

The activities of the Global Environment Systems Group cater to the following clients:

- The Government of India
  - Department of Science and Technology
  - Department for Non-Conventional Energy Sources
  - Department of Space
  - National Wastelands Development Board
  - Ministry of Environment and Forests

- Bilateral Agencies
  - International Development Research Center (IDRC)
  - Canadian International Development Agency (CIDA)
  - Swedish International Development Agency (SIDA)
  - United States Agency for International Development (USAID)
  - Swiss Development Corporation (SDC)

- Multilateral Agencies
  - United Nations Environment Program (UNEP)
  - United Nations Development Program (UNDP)
  - The World Bank (IBRD)
  - World Food Program (WFP)

- International Institutions
  - International Council for Scientific Union (ICSU)
  - World Conservation Union (IUCN)
  - Ford Foundation
  - International Institute of Environment and Development (IIED)

- Academic and Research Institutions
- Business Associations
- National and International NGO Community

TO CHOOSE A FUTURE

A STRATEGY FOR [illegible]ABLE DEVELOPMENT

★ Development Alternatives

TO CHOOSE A FUTURE

DEVELOPMENT ALTERNATIVES

a non-profit
corporate organisation
established in 1983 and
registered under the Societies Act
in the Union Territory of Delhi.

OUR OBJECTIVES

To design options and promote sustainable development through programmes of

* economic efficiency
* equity and social justice
* environmental harmony
* resource conservation
* self-reliance

OUR STRATEGY

Innovation and appropriate design of

* technologies
* institutions
* decision making systems
* knowledge structures
* societal paradigms

TECHNOLOGY FOR THE PEOPLE: TOWARDS AN ENDURING RELATIONSHIP

Technology is the answer to the inadequacies of the individual, the means to overcome human limitations.

Technology is the extension of our selves - our third arm. An instrument of our will to better our lot. With technology we can harvest nature's resources for our use and shape the world in our own image.

If it was mankind's vision which made us want to conquer distance, darkness, disease, and destitution, it is our technology which has made it possible for us to do so.

To eradicate poverty, inequality, injustice, for ourselves - and forever - is no longer a dream. To enable men and women to determine and fashion their future. To ensure that their children have the options from which to design their own lives and lifestyles.

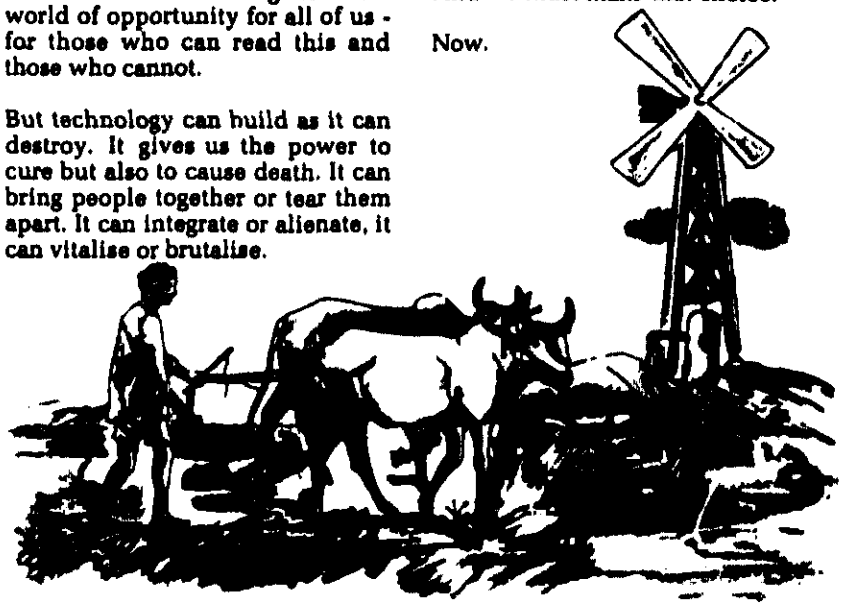
Technology must now be for the many what it has been for the few. It could then be the bridge to a new world of opportunity for all of us - for those who can read this and those who cannot.

But technology can build as it can destroy. It gives us the power to cure but also to cause death. It can bring people together or tear them apart. It can integrate or alienate, it can vitalise or brutalise.

The choice is ours.

And we must make that choice.

Now.



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INGENUITY AND APPROPRIATE TECHNOLOGY

In no country is economic growth the sole aim of development. Development must also satisfy the basic needs of the poorest; promote equitable income distribution and social justice; provide employment; encourage participation and involvement; and build institutions and infrastructures. And, of course, such development has to be sustainable: it must not destroy the resource base on which it depends.

The direction in which a country develops is determined by the technology it adopts. The technology chosen must ensure a balance among social, economic, ecological and technical factors, and must generate a perennial stream of products and services which reach and satisfy the needs of the majority, without exploiting them.

Technology which serves the goals of development by this definition, is "appropriate."

Appropriate technology is the creation of human ingenuity - and springs in response to local needs and possibilities. It is ready for use by the common people and aims directly at improving the quality of their lives. It draws upon the existing resources and skills available in an area, while maintaining man's harmony with nature.

Our national imperative is now to combine modern scientific concepts and tools with traditional knowledge, resulting in forms useful to man: a method, a process, a design, a device or a product which will open up a new path to development.

DEVELOPMENT ALTERNATIVES

The Organisation

Development Alternatives has been established to help foster the new relationship needed between man and technology.

Using modern organisational methods, it has the capacity

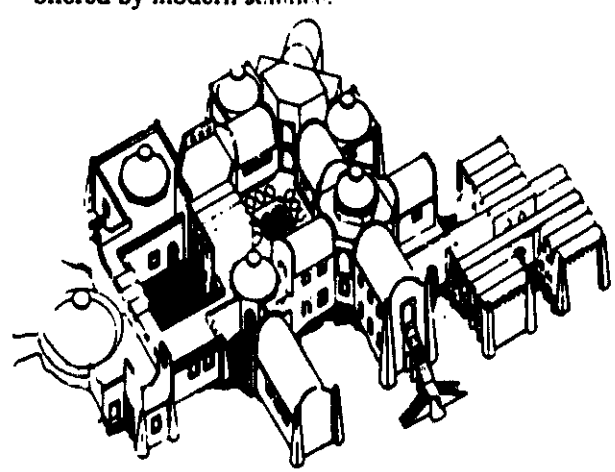
- to think globally and act locally
- to link R&D to the realities of production and marketing
- to close the gap between innovation and application

To realise this capacity, *Development Alternatives* synthesises the dialectical elements of three critical dimensions in its goals and structure:

*** The private and the public**
The organisational methods and motivation of the private sector drive the engine of *Development Alternatives*, and the social, developmental purposes enshrined in its mandate direct its efforts.

*** The big and the small**
Local, small-scale facilities for innovation, manufacturing and marketing linked together comprise the nation-wide *Development Alternatives* franchised network.

*** The old and the new**
By involving those who will benefit by its activities integrally in the innovation process, *Development Alternatives* derives maximum advantage from both traditional knowledge and the opportunities offered by modern science.



THE MISSION OF THE ORGANISATION

Development Alternatives has a mission: to promote environmentally sound development, and to achieve the mass deployment of appropriate technologies.

To fulfil this mission, *Development Alternatives* has clearly defined business objectives and developmental goals.

Business Objectives

Development Alternatives is a self-financing corporate entity whose activities are:

- to generate, select, improve, adapt and develop appropriate technologies, particularly for the poor
- to manufacture these in small scale franchised units or through job contracts
- to package, promote and sell the appropriate technologies on a mass scale, and provide after sales service
- to provide quality technical and management consultancy services on systems and other science and technology related activities

Development Goals

Development Alternatives shall select and carry out its activities so as to maximise their positive impact on development-related factors such as:

- basic needs, particularly of the poorest
- employment and well-being
- self-reliance and self-determination
- participation and involvement
- physical and social capital
- institutions and infrastructure
- energy and material resource use
- environmental quality

THE INSTITUTIONAL SYNTHESIS

	REACH	INVENTIVENESS	MOTIVATION	OBJECTIVES	PARTICIPATION
GOVERNMENT	•				
ACADEMIA		•			
PRIVATE SECTOR			•		
NGO's				•	
CONSUMER					•

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ORGANISATIONAL INNOVATION

It stands to reason that any organisation which hopes to achieve even a part of its large range of business and social objectives, many of them potentially conflicting, must be prepared to devise wholly new methods of programming and carrying out its work.

New technologies and techniques are certainly needed, and the research effort of *Development Alternatives* will continue to bring new and useful products into the market. However, the most fundamental and high impact innovations must lie in its own organisational design.

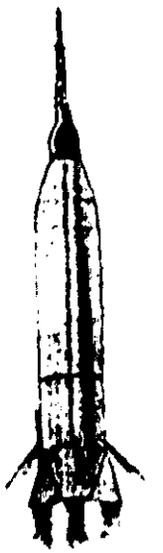
This is a field that is relatively unexplored in India, and academic studies in the field of organisational development relating to other countries, other contexts, and other clienteles are not relevant.

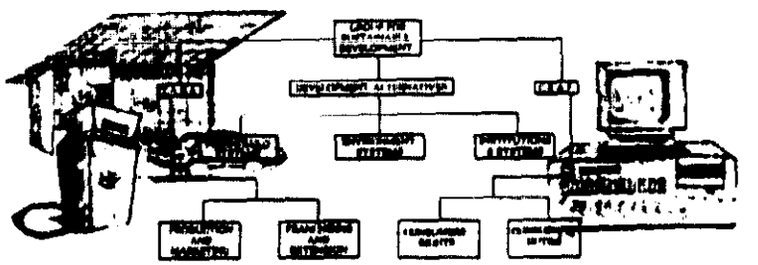
Yet development of sorts has taken place in some parts of the world, and management approaches that have succeeded can yield valuable ideas which, appropriately generalised and adapted, can also be made to work in the rural business environment. Among these, the most influential in the design of *Development Alternatives* are:

- the decentralization of production and marketing through franchising, such as petrol pumps, or the commune system.

- the decentralization of production and marketing through franchising, such petrol pumps, or the commune system

- management of complex systems and projects, such as space programmes





AN ADAPTIVE ORGANISATION

Development Alternatives is unique not only in its mix of business and social objectives, but also in its comprehensive thinking and open-ended strategy.

The Networks

A Network is a decentralised organisation of which each component unit shares common defined objectives with others.

Networks permit the big and the small to be brought together into a cooperative resonance, thus mutually reinforcing the strengths of each.

Development Alternatives is built around three primary networks:

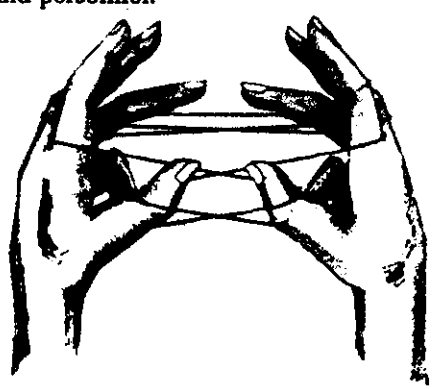
- The Innovation Network (I) identifies, generates, develops and designs environmentally sound and socially appropriate technologies, products, services and systems

- The Production Network (P) manufactures, assembles and packages the products

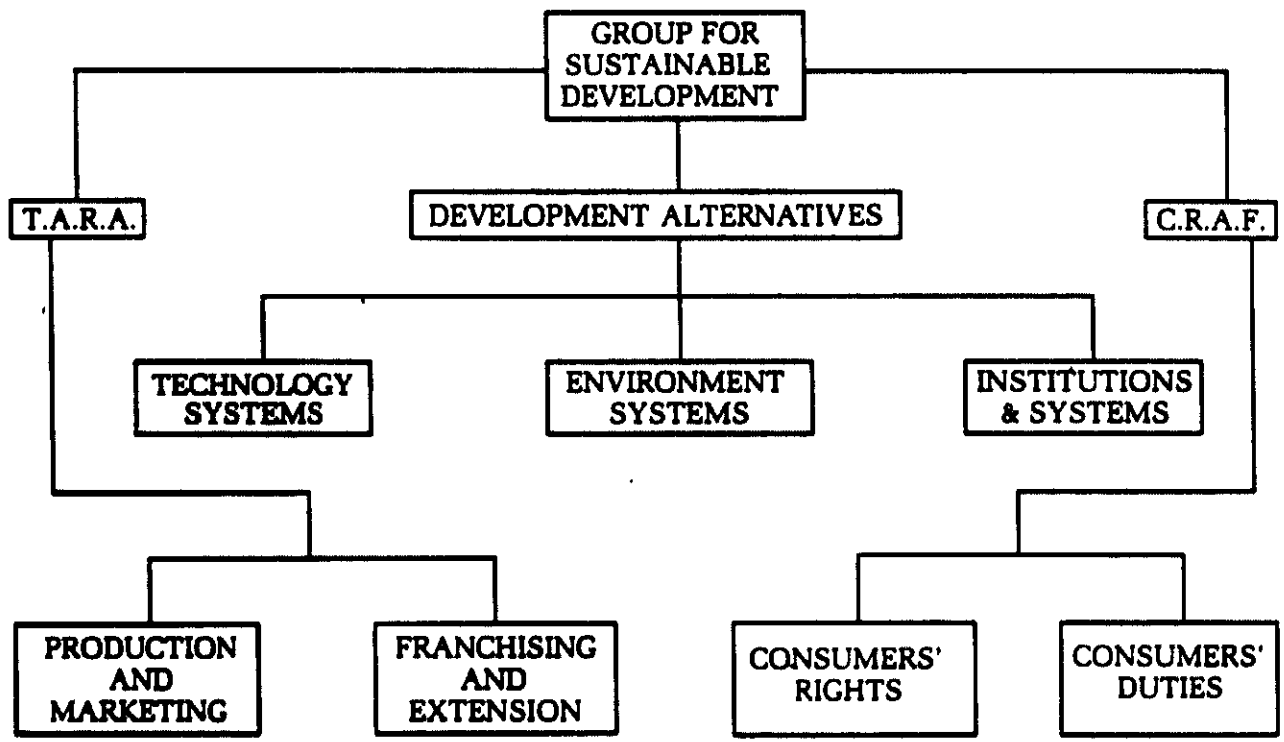
- The Marketing Network (M) sells the products, provides after-sales service and feeds back marketing information

Each network consists of small scale units able to respond sensitively and quickly to local needs and opportunities.

The three networks are intertwined, linked at all organisational levels through active and continuous exchange of ideas and information, financial payments, and personnel.



THE GROUP FOR SUSTAINABLE DEVELOPMENT



CLIENTS AND FUNDING ORGANISATIONS

International

* United Nations Environment Programme (UNEP)
* United Nations Centre for Human Settlements (HABITAT)
* United Nations University (UNU)
* World Commission on Environment and Development (WCED)
* International Development Research Centre (IDRC)
* Canadian International Development Agency (CIDA)
* Swedish International Development Agency (SIDA)
* The World Bank (IBRD)
* Overseas Development Administration (ODA)
* International Council for Scientific Unions (ICSU)
* International Union for the Conservation of Nature and Natural Resources (IUCN)
* Mac Arthur Foundation

The Government of India

* Department of Environment
* Department of Science and Technology
* Council for Advancement of People's Action and Rural Technology
* Department of Scientific and Industrial Research
* Department of Non-Conventional Energy Sources

State Government

* Andhra Pradesh
* Jammu & Kashmir
* Orissa
* Uttar Pradesh
* Karnataka
* Madhya Pradesh
* Assam
* Kerala
* Sikkim
* Bihar
* Haryana
* Rajasthan

Collaborating Institutions

Research, design, training or other collaborative projects have been undertaken in cooperation with some twenty reputed organisations in India and abroad including:

* Indian Institute of Technology, Delhi
* Indian Institute of Science, Bangalore
* Birla Institute of Technology and Science, Pilani
* Indian Institute of Management, Ahmedabad
* National Institute of Management, Calcutta
* MYRADA, Bangalore
* Systems Research Institute, Pune
* The Beijer Institute, Stockholm
* University of Regina, Saskatchewan

Other Organisations

* Housing and Urban Development Corporation (HUDCO)
* Society for Promotion of Wasteland Development (SPWD)
* Tata Iron and Steel Company (TISCO)
* Indian Oil Corporation Ltd.
* Tata Fertilizers Ltd.

THE COMMUNICATION RESEARCH AND ACTION FOUNDATION (C.R.A.F.)

The Communication Research and Action Foundation (CRAF) is an organisational member of the Group for Sustainable Development (GSD).

The function of CRAF is to raise the understanding of citizens, particularly those who are disadvantaged and peripheralised, of their rights and responsibilities as participants in the process of national development. More specifically, it is the aim of CRAF to ensure that the benefits of development reach all classes of people, and that the associated costs are no longer simply passed on to the weakest and most vulnerable members of society.

A primary thrust of the organisation is the design and development of communication approaches by which people throughout the country can acquire information on the day-to-day issues which most deeply affect the quality of their lives.

The mandate and structure of CRAF enable it to initiate action and direct intervention where and when it feels that the values of sustainable development are threatened. To maintain its independence and capacity to act, CRAF's work is largely supported by its own earnings.

CRAF's areas of concern include:

- improved communication methods
  - need identification
  - informed public participation
  - publications on sustainable development
- consumer protection
  - monitoring of specifications/standards
  - spurious products
  - fair business practices
- public interest litigation
- deep ecology/non-violent action
- environmental issues
- social/development issues
- forums for consensus building

TECHNOLOGY AND ACTION FOR RURAL ADVANCEMENT (T.A.R.A.)

The prime commercial partner of *Development Alternatives* is its sister organisation, T A R A. It is the responsibility (and the non-exclusive right) of T A R A to manufacture and market all the products of *Development Alternatives*. T A R A is also mandated to feedback relevant production engineering and market information to the designers of *Development Alternatives* to facilitate the continual adaptation and improvement of the technologies.

The operations of T A R A are self-financing and conducted through a decentralised network of franchised enterprises. An enterprise can be an individual entrepreneur, a cooperative, a voluntary organisation, an existing business, a government agency, or any other entity capable of manufacturing and marketing the products designed by *Development Alternatives*.

Under a contractual arrangement between the franchiser (T A R A) and the franchisee (the local enterprise), their respective duties are clearly defined. Broadly, T A R A is responsible for technology development, technology transfer and training, standardisation, networking, common procurement and bulk purchasing, quality control, and marketing. The franchise is responsible for manufacturing, selling and providing after sales service to the local market.

The franchise pays nominal royalty and fees to T A R A, which in turn pays royalty and service fees to *Development Alternatives*.

FRANCHISING

While the anatomy of *Development Alternatives* is represented by the networks, its physiology is determined by the franchising system.

Franchising is based on a well-defined allocation of responsibilities between the network partners, and brings individual, autonomous production and marketing units under the umbrella of a common purpose, strategy and brand image.

The franchiser provides - for an agreed fee and royalty - the technical and material know-how: standardisation, testing and quality control services; improved access to capital and money markets; common procurement of machines and raw materials; and customer goodwill such as brand names and trade marks.

The franchisee provides risk capital, production and/or marketing facilities, and is responsible for management of his unit at the operational level.

Franchised networks have particular relevance, so far unexploited, to the rural economies of developing countries. They are especially appropriate in this context because they:

- gain from many economies of scale, are a highly effective method for mobilising risk capital and local resources, and are an excellent means for building entrepreneurship.

- provide the small entrepreneur with a backup system for financing, management, research, design, quality control, common procurement, brand image creation.

- benefit from the best of both worlds: they combine the power, financial resources and economies of scale of the big corporation and the responsiveness of the small, local unit.

- Franchising network are particularly suited to the small scale manufacturer, large scale marketing and after sales service of appropriate technologies.

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THE ORGANISATION'S RESOURCES

Location and Facilities

Development Alternatives has its national headquarters in Delhi. However, in line with its decentralised philosophy, its innovation, production and marketing activities are carried out at autonomous units in different parts of the country.

Initially, the main technology development activities are to be located in Karnataka (in the Bangalore Mysore region) and in Gujarat (in the Ahmedabad Baroda region). The Environmental Systems and Institutional Systems Branches are at present based in Delhi.

The expansion of our activities is following a pragmatic tactical approach within a broader strategic plan, which allows rapid but balanced growth of the three networks for innovation, production and marketing.

The production and marketing operations of *Development Alternatives* are largely carried out through local franchised entrepreneurs.

Development Alternatives is establishing an in-house capacity for innovation, including its own

- staff and consultants
- education and training facilities
- transport and communication facilities
- office support systems
- laboratory and testing equipment
- machine shops
- computer facilities
- prototypes and demonstration units
- testing and quality control facilities
- journals and newsletters

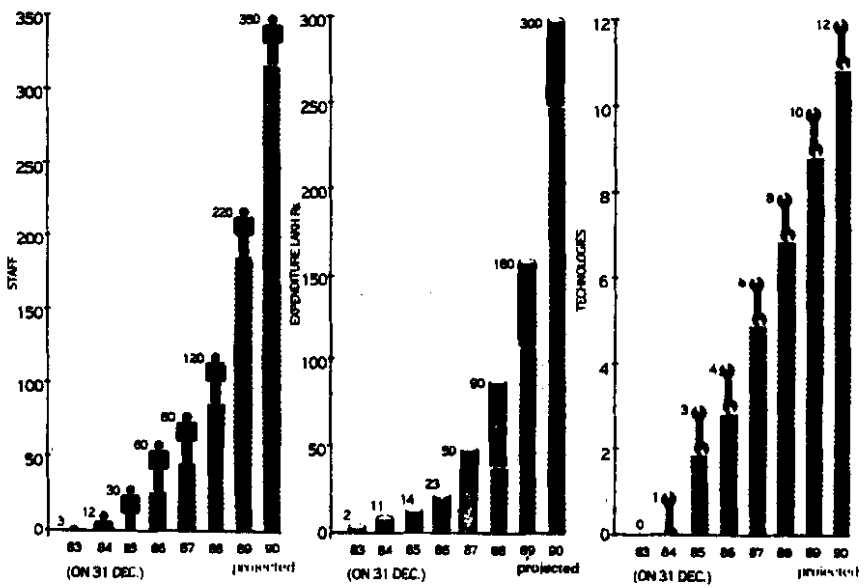
GROWTH

We have established cooperative arrangements with several institutions in the public and private sector which provide us with access to the best talent and expertise in the country. These include the Indian Institute of Technology, Delhi; Jawaharlal Nehru University; and several corporate enterprises in India.

Development Alternatives provides an institutional "umbrella" and organisational infrastructure for individuals with exceptional talent, making it possible for them to raise their own funds for research.

By 1990, we will have invested more than Rs.20 million in research and in the development of appropriate technologies. At the end of this period, we will have more than 200 scientists and specialists in technology, management and other disciplines on our staff.

By that time, *Development Alternatives* plans to be operating from a dozen centres and making and selling fifteen different products throughout the country.



INDICATORS OF OPERATION

PERSONNEL

Development Alternatives undertakes an unusually wide range of activities. The urgency for results is the urgency of the need to solve the problems of development. No item on the national agenda has higher priority.

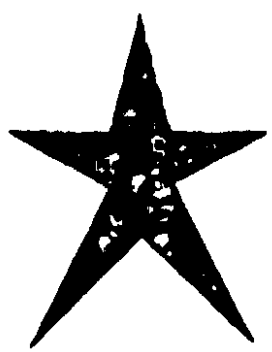
Unquestionably, our success will depend largely on the performance of our people.

Because of the imperatives of effective multi-disciplinary work, *Development Alternatives* is staffed by individuals with exceptional qualifications and, more important, qualities.

Development Alternatives staff are expected to maintain the highest intellectual standards, bringing an objective, open and flexible mind to bear in a scientific manner on the problems of development. They have therefore been chosen for their wide and balanced perspective, and trans-disciplinary skills and attitudes.

While every staff member has the capacity to work individually and with a minimum of supervision, all are able to cooperate in the type of team-work required for genuinely multi-disciplinary work.

To recruit and keep staff of this quality, *Development Alternatives* has a three pronged approach: an outstanding work environment, exciting career development programmes, and attractive terms of employment.



WORK ENVIRONMENT AND CAREER DEVELOPMENT

Development Alternatives is, and will always remain, a non- bureaucratic, non-hierarchical and highly participative organisation.

We employ a flexible, matrix structure of problem-solving task forces. These forces carry out research and development by establishing teams for each specific purpose. Each staff member serves simultaneously on one or more teams, sharing his expertise and knowledge with experts in other fields, gaining and giving.

We are establishing well equipped research centres, laboratories, workshops, and testing facilities. Our up-to-date information system provides expeditious access to the world's information resources. Our high standard journals and publications provide staff members with authoritative channels for the exchange of information with the world's scientific community.

Development Alternatives believes that its salaries and employment benefits must be adequate to attract and retain the best personnel. Within the constraints of our non-profit status, social objectives and Indian context, we therefore offer competitive financial rewards.

HOW ABOUT YOU ?

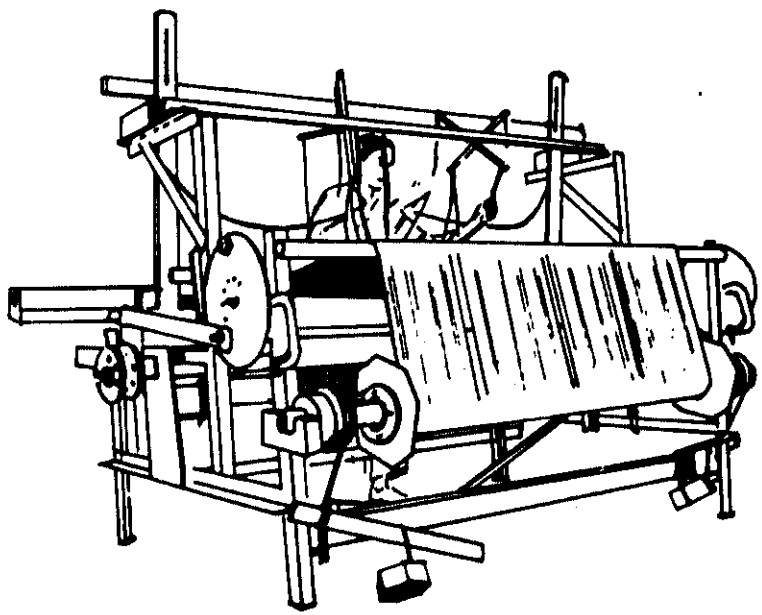
By establishing an exciting, challenging, socially-relevant yet free working environment, we at *Development Alternatives* believe that we have a significant advantage over other organisations.

We are even helping to reverse the brain drain.

Anyone who shares our beliefs and goals is welcome to advise us, cooperate with us, work with us.

Come and meet us, or call or write:

President
Development Alternatives
B 32, Institutional Area
New Mehrauli Road
Hauz Khas
New Delhi - 110 016
Tel. 66 5370
Tlx. 031 - 61735 VC IN



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TECHNOLOGY DESIGN

The Technology Systems Branch of *Development Alternatives* selects, develops and designs the products and the tooling needed for manufacturing them.

The products are chosen after detailed feasibility studies and market analysis, and in direct response to the needs of the target clienteles - the poor, the deprived and the under- privileged.

The design process integrates modern multi-disciplinary expertise and local traditional knowledge.

This ensures that each product does meet the needs of the people for whom it is intended. At the same time it serves societal objectives such as employment generation and resource conservation.

Additional considerations in product selection include the need to:

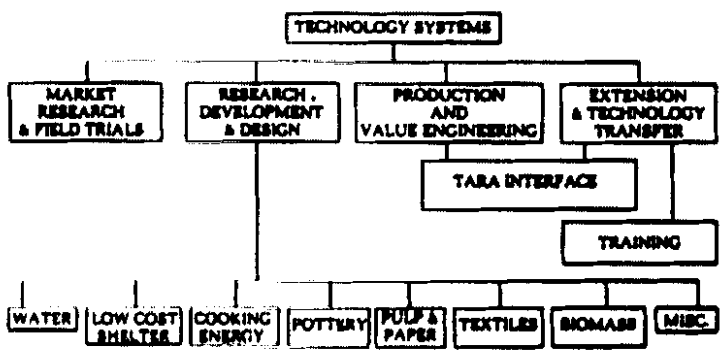
- develop clusters and packages of technologies, to take advantage of standardised modules and components for facilitating production, marketing, spare-part availability and maintenance

- raise the levels of "technicity", so as to provide continuity with existing methods while introducing new technological perceptions and possibilities in the village.

The product range of *Development Alternatives* includes devices for energy, water, agriculture, shelter, transport, employment-generation and other human needs.

Specific examples are:

* stabilised soil brick machines
* paper and board making equipment
* cooking stoves
* handlooms
* water pumps
* solar devices
* biogas generator kits
* food storage bins
* multi-purpose hand presses
* windmills
* Integrated Village Energy Systems



ENVIRONMENTAL SYSTEMS BRANCH

While fulfilling its purpose to better the lives of people today, development that is sustainable must also insure the right of the next generation to inherit the planet and its resources in a condition which does not foreclose its options to design its own future.

Design of sustainable development process and its translation into action depend upon a clear understanding of the need for rational utilisation of natural resources and continuous improvement in the quality of the environment.

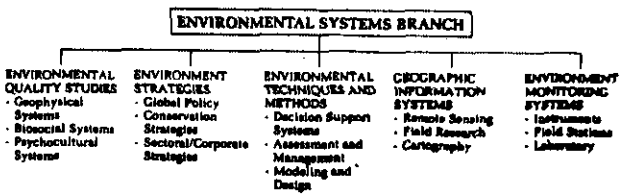
The environment is dynamic interdependent and if cared for, as resilient as it is vulnerable. The interactions between people and the environment are also highly complex. Planning and management of the development process must, therefore be adaptive and based on a well-informed assessment of each specific situation, so that the benefits do indeed reach the intended beneficiaries.

The *Environment Systems Branch* of *Development Alternatives* designs and implements policies, programmes and projects for sustainable development. These activities are undertaken at various scales of human intervention, such as:

- household
- community
- block
- state
- national
- village
- corporate
- district
- region
- international

Our services are available to government, international agencies, public and private institutions and grass-root voluntary organisations. These include:

- Sustainable development strategies
  - regional, sectoral
  - national, state, district
- State of Environment reports
- Impact assessment studies
- Management plans and programmes
  - basic needs, resources, rural economies
  - land use, command areas, watersheds
  - wildlife, protected areas, wastelands
  - rehabilitation, disasters
- Technology assessment and forecasting
- Guidelines for environmental management of projects



INSTITUTIONAL DEVELOPMENT

Design of appropriate technologies and environmentally sound projects needs syntheses of an unusually wide variety of multi-disciplinary inputs. *Development Alternatives* has therefore introduced innovative institutional approaches to facilitate the high level of cooperative team effort required.

In its own work, *Development Alternatives* incorporates new matrix and other organisational methods within a non- rigid, cybernetic framework, to help achieve its business and social objectives.

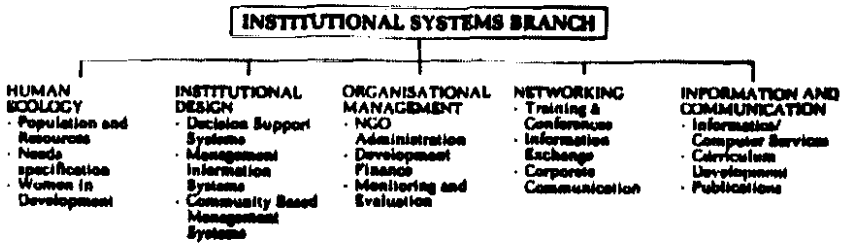
The wider institutional framework of *Development Alternatives* is based on a new cooperative model which brings the traditional trio of interests - owners, managers and workers - together to work for their mutual benefit. The end-client is the fourth - and equal - partner, fully participating in the selection, design and development of the products.

With its experience and capacity to apply the concepts of general systems to organisations, our Institutional Systems Branch also provides outside advisory services in the area of institutional design and development.

The primary aim of our effort in this area is to contribute concretely to the building up of national capacity to better utilise our human and natural resources, and to clear a path to sustainable development.

Specific projects of this type include design, implementation, monitoring and review of:

- Research institutions
- Information systems (national, local, organisational)
- Effective administrative structures and procedures
- Strategic planning units
- Urban transport systems
- Protected area management schemes



Stack monitoring

- ascertain possibilities of waste minimisation and pollution prevention
- assess compliance with regulatory requirements
- generate periodic environmental efficiency information for the general public
- provide regular feedback to the management for incorporating continuous improvements in the plant operations.

2. Corporate Environmental and Social Responsibility Programme

This programme enables corporations to fulfill their environmental and social obligations. The programme has three components:

a. Environmental and Social Policy and Procedure (ESPP)

The Industrial and Urban Environment Systems Group has pioneered the formulation of Corporate Environmental and Social Policies and Procedures in India.

At the outset, the probable environmental and social issues associated with the operations of a corporation are assessed. Simultaneously, the requirements of the regulatory agencies and other stakeholders like multilateral or bilateral agencies and financial institutions are identified. The environmental and social commitments of the corporation are then elucidated in the policy statement. A set of detailed operational procedures are customised for the corporation to ensure that environmental and social issues are either pre-empted or optimally managed. In the process, responsibilities are allocated and risk management mechanisms are specified.

Experience with corporations in large infrastructure, urban development and power transmission projects indicate that the process of developing ESPPs has enabled them to dovetail environmental and social concerns as an integral part of operations at nominal costs.

b. Environmental Impact Assessment/ Environmental Management Planning (EIA/EMP)

This programme also caters for undertaking Environmental Impact Assessment and Environmental Management Planning for specific projects. The EIA analyses, interprets and evaluates the impacts of development projects and their ancillary activities on the bio-geophysical and the socio-economic environment in a region. Based on the impacts identified by the EIA, an environmental management Plan (EMP) is prepared which suggests measures for mitigating or minimising adverse impacts.

Industry in harmony with environment

c. Corporate Neighbourhood Development

In close collaboration with the Rural Environment Systems Group, corporations are provided designs and support systems to catalyse development programmes in their neighbourhood. The programmes help to create livelihood options, improve infrastructure facilities and build congenial relationships between the corporations and the communities around them. Often, resettlement and rehabilitation of project affected persons are also taken up as an integral part of the Neighbourhood Development Programme.

SERVICES

The Industrial and Urban Environment Systems Group provides the following services:

- Cleaner production strategy formulation
- Waste minimisation and pollution prevention studies, training and demonstrations
- Environmental audits
- Environmental and social policies and procedures formulation
- Environmental impact assessment and environmental management planning
- Corporate neighbourhood planning and support services.

CLIENTS

The Industrial and Urban Environmental Systems Group focusses on the following clients :

- Large, medium and small scale enterprises
- Multi sector corporations
- Urban local bodies - development authorities municipalities, etc.
- Industry / business associations
- Regulatory agencies - Pollution Control Boards, Departments of Environment.

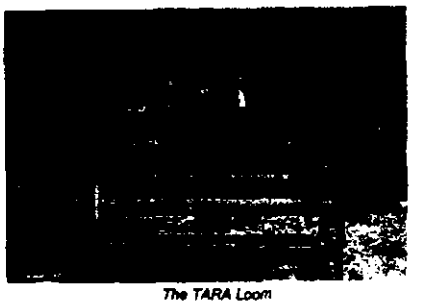
Pollution from conventional brick kiln

DEVELOPMENT ALTERNATIVES - A Brief Profile

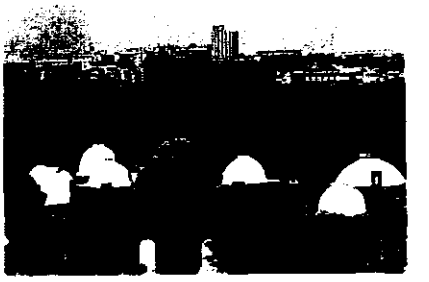
A global network of organisations with the objective of generating activities aimed at sustainable development.

Development Alternatives, India, is a non-profit research, development and consultancy organisation established in 1983. It fosters the new relationship in the people, technology and environment interactions needed to attain the goal of sustainable development.

The Technology Systems Branch focuses on designing and developing environmentally sound and appropriate technologies in close collaboration with the other branches. Several technology packages in Shelter, Domestic Energy, Handmade paper, Textiles, Pottery, etc. have already been disseminated and others are in various stages of development. The sister organisation, Technology and Action for Rural Advancement (TARA) undertakes production and dissemination of the technologies.



The TARA Loom



Development Alternatives Headquarters

The Environment Systems Branch designs environment and development management strategies at various geographic scales and levels of detail. Experimental cum demonstration projects are also undertaken in the field. The range of field studies and projects include Environmental Impact Assessment and Analysis, Environmental Management Plans, Environmental and Social Policies and Procedures for Corporate organisations, Community development, Food Security in tribal areas, Rehabiliatation and Resettlement, Pollution Prevention, Cleaner Production, Waste Management, Natural Resources Management using GIS & Remote sensing, Income Generation through Microenterprises, and Biodiversity Conservation.

A highly competent and motivated staff of more than 160 professional and support staff in diverse fields ranging from Anthropology, Sociology, Economics, Forestry, Ecology,

The Balram – compressed earth block press

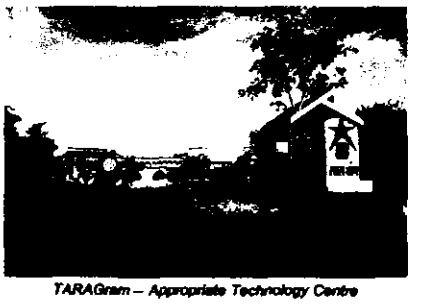
Geology, Engineering and Analytical Chemistry contribute to the assignments undertaken. Professionals for each assignment are carefully selected to provide trans-disciplinary inputs effectively.

Besides R & D workshops, support is also drawn from a well equipped Computer Unit, an accredited Information Unit and Geomatics Facility. The Environmental Monitoring Facility can undertake soil, water and air analyses.

The Regional Office in Bangalore in the past seven years of its operation has built up considerable expertise in the field of low-cost construction using appropriate technologies and local materials as well as in income generation activities. The Regional Office looks after the operations in Karnataka and other southern states.

The Regional Office in Jhansi looks after the operations in the Bundelkhand region. It has shown excellent results on ground during the past four years in wasteland development, natural regeneration, soil & moisture conservation, community irrigation systems and income-generation activities.

An Appropriate Technology Centre is being established in Orchha, Madhya Pradesh. This Centre is a unique experiment in design and dissemination of appropriate technologies in the Bundelkhand region.



TARAGram – Appropriate Technology Centre

A Field Station is now operational in Tumkur, Karnataka to take up wastelands regeneration and Watershed management in the region.

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Fax 91 [illegible] 6131
Email [illegible]

July 27, 2000

The Louis Berger Group Inc.
[illegible], Safdarjung Development Area
New Delhi - 110 016

Dear Sir :

Subject : GEF-CCS Project - CLIN 04: Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above subject. We are glad to confirm our in principle acceptance to host a forum for research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing technical papers would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

Thanking you.

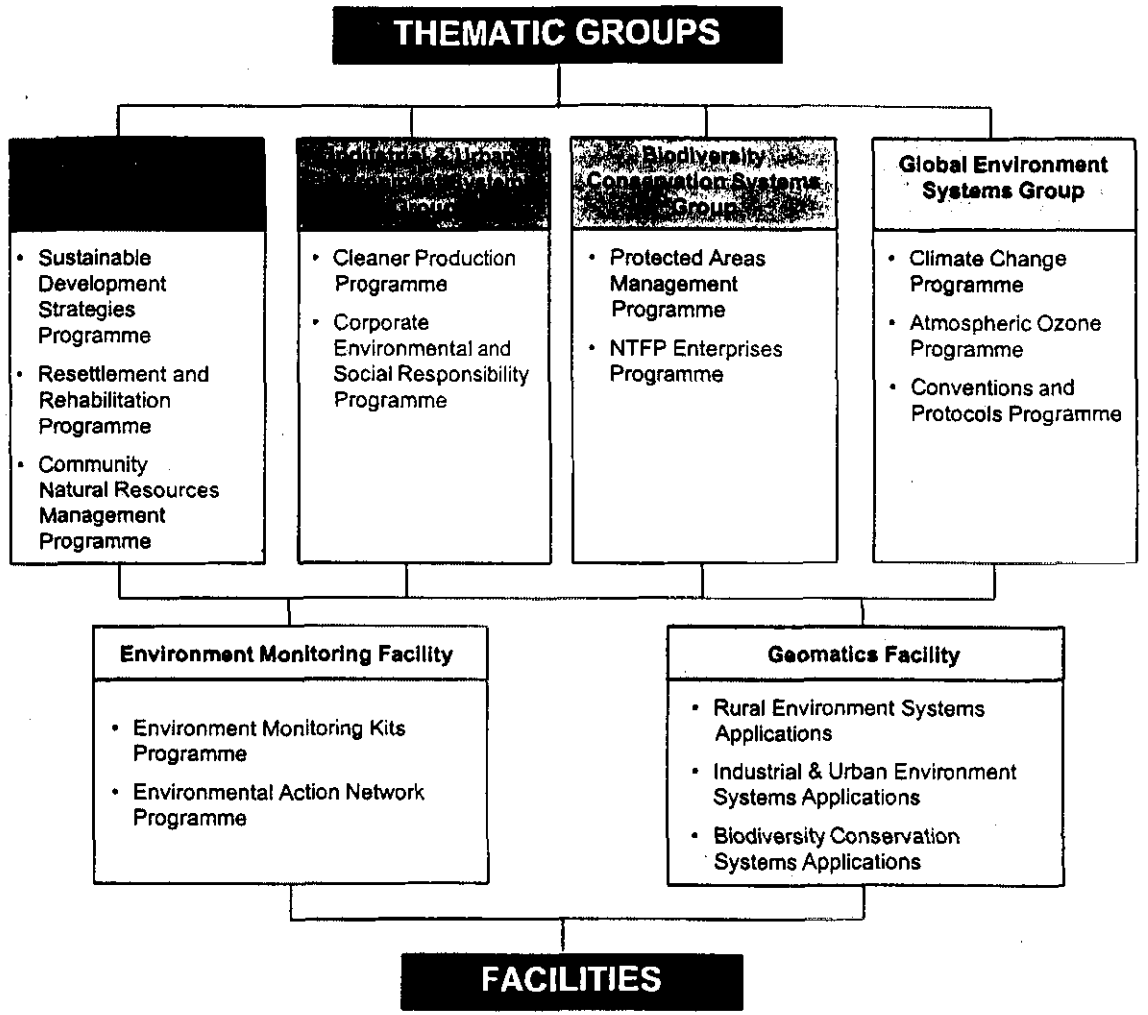
Yours faithfully,

George C. Varughese
Vice President

Environment Systems Branch

Environmental Management
- A Systems Approach

Development Alternatives

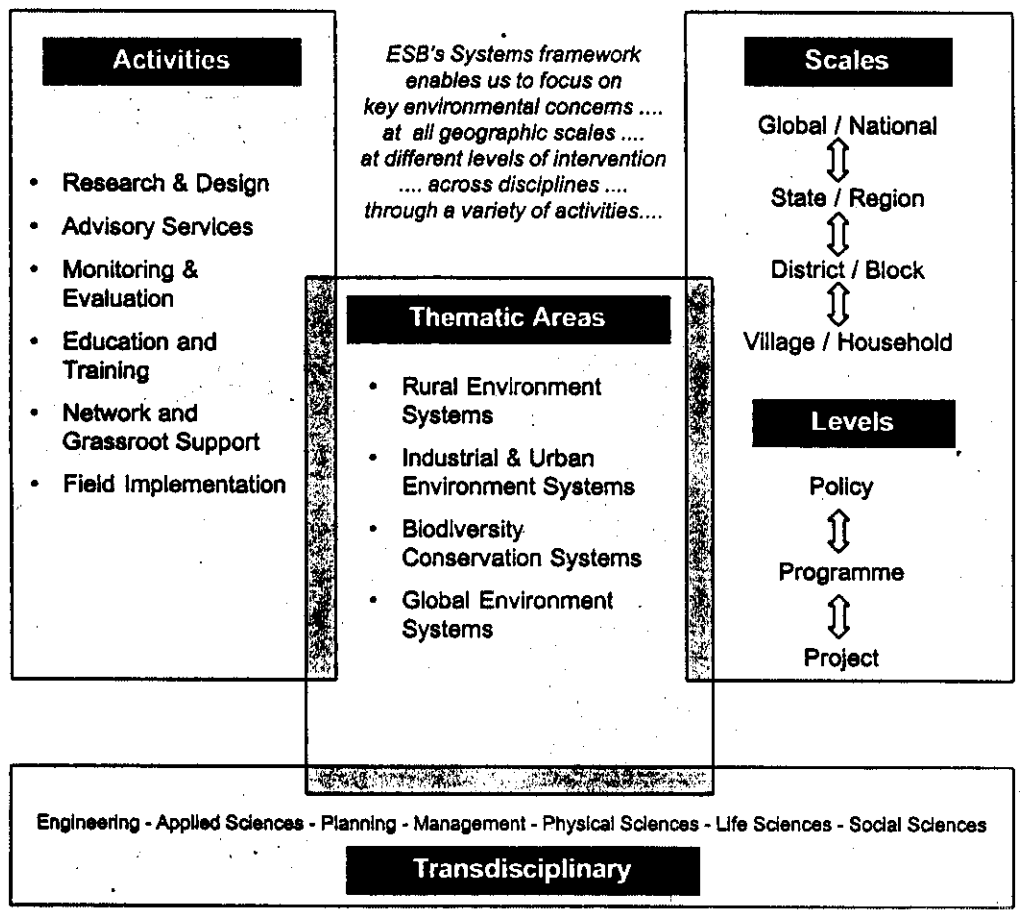

THEMATIC GROUPS
Sustainable Development Strategies Programme
Resettlement and Rehabilitation Programme
Community Natural Resources Management Programme
Cleaner Production Programme
Corporate Environmental and Social Responsibility Programme
Protected Areas Management Programme
NTFP Enterprises Programme
Global Environment Systems Group
Climate Change Programme
Atmospheric Ozone Programme
Conventions and Protocols Programme
Environment Monitoring Facility
Environment Monitoring Kits Programme
Environmental Action Network Programme
Geomatics Facility
Rural Environment Systems Applications
Industrial & Urban Environment Systems Applications
Biodiversity Conservation Systems Applications
FACILITIES

Groups, Facilities

and Programmes

2

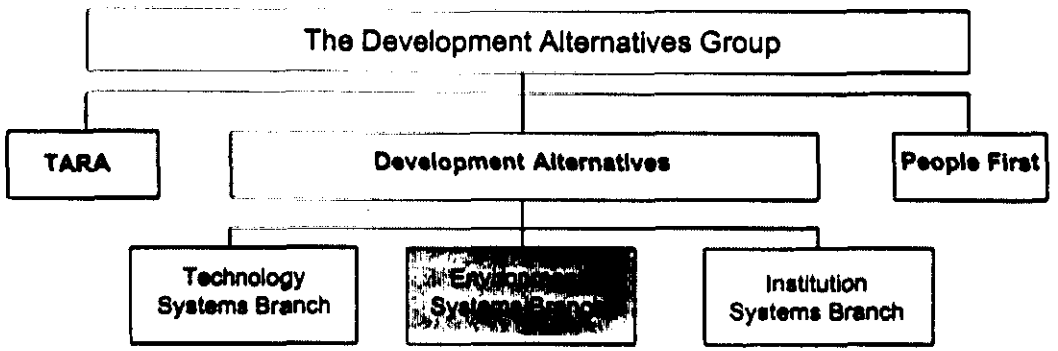
The Systems Approach



ESB and Development Alternatives

ESB is an integral part of Development Alternatives, a non-profit corporate organisation established in 1983 and registered under the Societies Act. Development Alternatives is a global network with headquarters at New Delhi. Its mission is to design and implement strategies for sustainable development, especially to improve the lives of the poor.

ESB works closely with the other branches of Development Alternatives which develop and disseminate appropriate technologies and institutional systems for sustainable development.



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GLOBAL ENVIRONMENT SYSTEMS GROUP

Green house induced global warming and the Ozone hole over Antarctica pose major threats to life on our planet. Studies indicate that these phenomena are caused by human induced activities resulting in emissions of carbon dioxide, methane, Chloro Fluoro Carbons etc.

The Global Environment Systems Group contributes to developing local and global solutions to these problems through three broad programmes:

- Climate change programme
- Atmospheric ozone programme
- Conventions and protocols programme

Evidence of Ozone depletion

1. Climate Change Programme

This programme addresses various facets of climate change including problem identification, impact assessment and formulation of response strategies. The Group is actively engaged in assessing the impact of climate change on agriculture, health and hydrology. Research also focusses on sequestration of carbon dioxide by forests and other vegetation.

2. Atmospheric Ozone Programme

The Atmospheric Ozone Programme has two major components:

a. Stratospheric Ozone

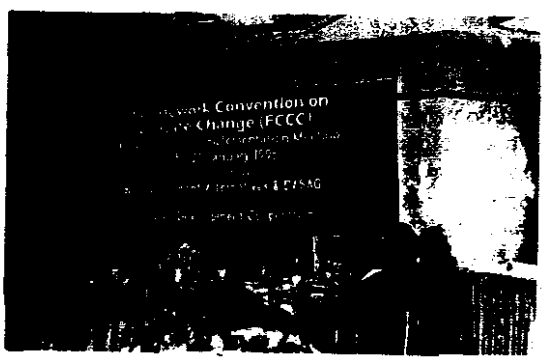
Studies have been undertaken to assess trends in atmospheric ozone and UV-B radiation over India. Implications of UV-B on vegetation and human health are also being assessed in order to formulate and advocate policies for phasing out Ozone Depleting Substances (ODSs).

b. Tropospheric Ozone

The focus in this component is on problems associated with increase in surface ozone due to vehicular and industrial pollution. The impacts of surface ozone on agricultural yield and human health are assessed. Besides, the response strategies for reducing surface ozone causal factors are also being formulated.

3. Conventions and Protocols Programme

Under this programme the group actively contributes towards national and international deliberations on climate change and ozone related issues. The Group is involved in the Montreal Protocol, Biodiversity Conservation, and FCCC activities, with emphasis on Activities Implemented Jointly (AIJ).



New Delhi Joint Implementation Meeting

SERVICES

The Global Environment Systems Group offers the following services:

- Commissioned research studies on global environmental issues
- Awareness generation through newsletter articles, journal papers, query-response, etc.
- Opinion building by organising national and international conferences.

CLIENTS

The activities of the Global Environment Systems Group cater to the following clients:

- Government of India
- National and International NGO Community
- Academic and Research Institutions
- Business Associations
- Multilateral and Bilateral Agencies

ESB - Illustrative List of Clients and Collaborators

Multilateral Agencies

- United Nations Environment Programme (UNEP)
- United Nations Development Programme (UNDP)
- World Commission on Environment and Development (WCED)
- World Food Programme (WFP)
- The World Bank (IBRD)

Bilateral Agencies

- International Development Research Centre (IDRC)
- Canadian International Development Agency (CIDA)
- Swedish International Development Agency (SIDA)
- Norwegian Agency for Development (NORAD)
- Overseas Development Administration (ODA)
- Swiss Development Cooperation (SDC)
- United States Agency for International Development (USAID)

International Institutions

- International Council for Scientific Unions (ICSU)
- World Conservation Union (IUCN)
- Swedish Society for Nature Conservation
- Ford Foundation
- International Institute of Environment and Development (IIED)

The Government of India

- Department of Science and Technology
- Council for Advancement and Promotion of Rural Technology
- Department of Non-Conventional Energy Sources
- Department of Space
- Ministry of Rural Development
- Ministry of Environment and Forests
- National Wastelands Development Board

State Governments

- Andhra Pradesh
- Assam
- Haryana
- Jammu & Kashmir
- Kerala
- Rajasthan
- Madhya Pradesh
- Sikkim
- Karnataka
- Uttar Pradesh
- Bihar
- Orissa

Business and Industry

- Confederation of Indian Industries (CII)
- Tata Chemicals Limited (TCL)
- Shriram Industrial Enterprises Limited (SIEL)
- VAM Organic Chemicals Limited (VOCL)
- Tata Iron and Steel Company Limited (TISCO)
- Infrastructure leasing and Financial Services Limited (IL&FS)
- Power Grid Corporation of India Limited (POWERGRID)
- Met-Chem Canada Inc., Montreal

Academic Institutions

- School of Planning and Architecture, New Delhi
- Indian Institute of Technology, New Delhi
- Erasmus University, The Netherlands
- Clark University, United States of America

National NGOs

- World Wide Fund for Nature (WWF), India
- Society for Promotion of Wastelands Development (SPWD)
- Tata Energy Research Institute (TERI)
- The Rajiv Gandhi Foundation (RGF)

Grassroot NGOs

- Tarun Bharat Sangh, Alwar, Rajasthan
- Pinakini Rural Development Society, Kolar, Karnataka
- Seba Sangh, South 24 Paraganas, West Bengal
- Gram Vikas Nav Yuvak Mandal, Jaipur, Rajasthan
- Centre for Rural Education, Research and Development Association, Anna, Tamilnadu
- Project Tharangini, Khammam, Andhra Pradesh

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Report Editors

Prof. Kirit S. Parikh

Dr. Sudhakar Yedla

Photographs by Saurabh Ghosh (IGIDR student) ...

Preface / Director's Report

The Indira Gandhi Institute of Development Research (IGIDR) has two main activities: research and teaching. During this financial year, IGIDR maintained the tempo of activities in research in diverse areas. The teaching programme has continued to attract bright students, many of whom obtained their degrees this year and were offered good jobs.

Research Activities

The broad objective of our research remains the same – to better understand development processes and policy options, through not only applied and empirical research, but also theoretical research. The topics studied depend largely on the interests of faculty members. Even sponsored projects, while they indicate customer interest in our research, also in a sense keep faculty interest in mind.

During the financial year – April '98 to March '99, the Institute published 2 books, 35 journal articles, 9 discussion papers and 2 project reports. In addition, 1 M.Phil. thesis and 12 Ph.D. theses were submitted in the year. IGIDR research spans many areas. For the purpose of this report, they are broadly grouped as follows: poverty, levels of living and development; food and agricultural policy; energy systems and policy; infrastructure, industry and labour; macro-policy, trade and capital flows; banking, finance and capital markets; and environment and sustainable development. Here we briefly describe the questions addressed by IGIDR research.

Poverty, Levels of Living and Development:

Elimination of poverty has been the goal of Indian planning much before we got our independence. Over the years, we have recognized that development is more than just increase in income. To understand development more fully we should consider various aspects of levels of living as well. Some key questions, which could serve as guidelines are: Has development increased welfare? What has been the impact of our development strategy on the poor and the levels of living? But how do we monitor and analyze these issues? A number of studies done by the institute have explored some aspects of these processes.

We have also examined what lessons we can learn from South-East Asian experience concerning growth and equity. Some East Asian countries too have been studied. It was found that economic growth, lower relative food prices, higher agricultural yields and higher real agricultural wages reduce poverty. Closer home we have also examined the progress in Maharashtra which has had an employment guarantee scheme for many years, on poverty and levels of living.

Child labour is persistent in India despite economic growth and it reflects a poor level of living. Why does it persist? Is it an outcome of poverty? How do we eliminate child labour? All these and more questions have been addressed by our researchers.

Food and Agricultural Policy:

Provision of food security has been a major element of our anti-poverty efforts. The Public Distribution System (PDS) has played an important role in it. The adequacy and efficiency of PDS as well as the targeted PDS are examined by the Institute researchers. One of the

papers questions how has PDS contributed to provision of food security in Kerala?

Issues related to pricing too were tackled. How important is price stabilization for food security? What is the impact of a sudden rise in food prices on the people marginally above the poverty line? What is the optimum strategy for price stabilization?

Apart from price variability, production variability can also have an impact on the poor. One study examined the yield fluctuation of crops across different districts.

Another factor affecting the poor is tenancy arrangements. The key question addressed here was: why tenancy arrangements are what they are and why do these arrangements persist? These issues are examined and explained by risk and supervision costs in one of the papers.

Energy Systems and Policy:

The demand for petroleum products is increasing rapidly and so are India's imports. The institute delved into questions like: what can one do to curtail this demand? How effective can price policy be here? What are the short run and long run price elasticities of demand of gasoline in India? The short run price elasticity is estimated to be – 1.18 and long run elasticity to be – 2.68.

Major consumers of petroleum products are state transport undertakings. How efficiently do they use fuel, their fleet and their staff? An analysis of the productivity of state transport undertakings reveals that the age of fleet and unevenness of terrain decrease their efficiency and increase fuel consumption.

Increase in prices of petroleum prices can have an economy wide impact. When, for example, the diesel price is hiked, transport costs increase leading to increase in consumer prices. On the other hand, if the additional revenue helps cut down fiscal deficit, the long term impact may be beneficial. The welfare impact of relative price changes would be different on different groups. An applied general equilibrium model was used to explore the welfare impact of hike in oil products' prices.

Apart from transport energy, the household energy problem is a major problem in both rural as well as urban areas in the country. In rural areas, the inter-linkages between energy, agriculture and environment involve trade offs between food, feeds, fodder, fuel and fertilizer. These inter-linkages can have surprising effects. For example, if price of fertilizer is increased, more dung would be burnt, which may reduce soil fertility. These linkages are examined in the framework of an integrated model.

In urban areas, the choice of fuel use by different households depends on their income levels as well as on the discount rate. In a sense, one could use the choice of fuel to indirectly estimate the subjective discount rate of households belonging to different classes.

Industry, Infrastructure and Labour:

With private participation in infrastructure, regulation has become critical. How should regulators function? Regulators need to know the possible welfare impact of their actions. A study at the Institute has assessed the welfare impact of telecom tariff reforms.

Economic reforms are expected to increase industrial growth and exports. The study of textile sector can provide useful guidance on how successful the reforms have been. Textile is a major industrial and export sector. The impact of reforms on textile sector in Tamil Nadu was examined in one study and another looked at the textile exports in the country.

Rigidities in India's labour markets affect corporate behaviour. How job security and wage bargaining affect duopoly outcomes was examined in a study. The entering firm which requires skilled labour employed by an incumbent monopolist, would have to offer higher wages to draw away workers from the incumbent or invest in workers' training. The optimal strategy depends on the strength of the labour union in the existing monopoly.

The literature on industrial organization uses game theory extensively. Even non-specialists need to understand the basic concepts involved to appreciate the results of this literature. The notions of Nash equilibrium, repeated games, social norms, informational cascades and common knowledge are explained with illustrations in a series of articles in a journal addressed to young science students.

Macro-policy, Trade and Capital Flows:

In a liberalized economy, export competitiveness becomes critical. The researchers have examined several issues related to exports. How do financial factors affect export competitiveness? Does availability of credit permit firms to export more? Or does an exporting firm, by the fact of exporting, signal competitiveness and attract more credit?

What determines foreign inflows? Are they affected by expectations of the future or by historical experience? Some of the macro puzzles in this area were examined in one study.

An important source of funds for India is the IMF quota. IMF quotas are allocated to different countries and these quotas are periodically revised. In a detailed study, the IMF quotas are examined and alternative mechanism for quotas is suggested. The IMF quotas do not seem to be consistent with the stated objective. Quotas are determined based on various variables to which some weightages are given. Depending on the weightage scheme, the quotas change significantly. For India, India's GDP is the main factor that determines our quota. Since there are many reasons to believe that India's GDP is under-estimated, we may be losing some IMF quota. Obviously, if instead of using nominal GDP parity, purchasing power parity adjusted GDP is used, India's IMF quota would go up. Under the proposed 11th quota revision, India's quota is going down and so are our quota rights. We should explore ways by which we can form coalitions with others to have greater impact on the IMF decision-making.

Foreign capital inflows affect the economy in various ways. They boost expectations regarding future output and thus increase investment. How do these affect the macro dynamics of growth? Can we explain cycles and how do we adapt policies to maximize benefit of foreign inflows?

When asset markets are integrated with well-developed equity and foreign exchange markets, how do they affect the impact of money supply on interest rates?

Why was India immune when East Asia went into a crisis? Was it because we had a more rigid system that insulated us from external shocks? Or was it because we had the right kind of flexibility to absorb the shocks?

With a large population at subsistence level, the price of food and wages are major determinants of inflation. With liberalization of agricultural trade, agricultural prices would not respond as much to supply shocks, and the exchange rate becomes important. How do these interact to determine inflation, exchange rate and interest rates?

issues. What is the projected demand, and how best to meet it? How to moderate its impact on the environment? What policies can help in this? What are the gaps in our policies? Can we develop an index for air quality?

To balance the need for environmental quality and economic growth, we need to account for environment. We should value natural assets and resources and subtract their depreciation from net domestic product (NDP) to obtain a truer measure of NDP – which is environmentally adjusted. IGIDR has worked for years in developing a framework, methods and case studies for such accounting in India. A case study for Brunei was also carried out and a survey was carried out to assess green perceptions of Bruneians by an IGIDR faculty member who was a visiting faculty in Brunei.

Deforestation and land degradation are serious environmental concerns. IGIDR has assessed plantation programmes that try to restore wasteland through peoples participation. How cost effective are they? They showed high benefit/cost ratios. Also a comparison of approaches shows the critical ingredients of such a programme are its management structure and participation rules. Performance indicators for such programmes were also developed to help in monitoring them.

Sustainable development calls for a prudent use of exhaustible resources. Exploitation rules of exhaustible resources assume that the stock size of the resource is known. In reality, it is an unknown. How do we ensure intergenerational equity when there is asymmetry in the information that different generations have?

Environmental issues are coming up in World Trade Organization (WTO) negotiations. We need to explore how strategic trade affects environment under alternative tariff regimes.

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Teaching Programme

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These students and the human capital they represent are an important output of the Institute. The range of their theses is listed in this report. It shows the diverse areas in which these students, and thereby the institute, would contribute to the society, when they are employed in well-known research and academic institutions, corporate, quasi-government and public institutions.

Apart from teaching our own students, some faculty give lectures at other institutions as well. Moreover, they develop teaching material, text books and research papers which also contribute to the economic teaching and skill formation in the country.

Banking, Finance and Capital Markets:

Banking sector efficiency is critical for an efficient capital market. One of the studies explores many related questions. Has deregulation increased banking sector efficiency? Can entry by other private firms and branch location deregulation by themselves improve efficiency even when the power of the entrenched bank is very high?

The banking regulation has put a lot of emphasis on prudential norms and capital adequacy ratio (car). The car is the ratio of bank's liquid capital to the risk weighted loans lent. A theoretically more attractive measure would be the amount of liquidity required to meet possible demand with a given confidence level, say, 99.5%. Such a measure called value at risk can be applied towards prudential regulation in securities market such as of traders on the stock market and this should be calculated in real time so that one can prevent a trader from putting others at risk by his behaviour. How can such calculations be done in real time? An institute project found ways to do this.

The stock markets have provided an important source of investible funds from savers and they also provide important signals to investors and to firms themselves. To what extent are the various stock markets in India integrated and how does the process to price discovery work in the Indian stock market? These important indicators of efficiency of the Indian stock market were examined in a study.

The Indian debt market is not yet well developed. Thus, the investors do not know the rate of return obtained on loans of different maturity periods, what is known as the yield curve. An Institute's researcher tried to estimate the yield curve in India. It runs into data problems of missing liquidity for many maturities and of wide daily fluctuations.

Social security has become a major issue in many countries. Most people do not have a social security coverage in India. The need to provide some form of social security is increasingly felt. The notion of pension funds in which individuals invest their savings periodically and which grow over time and provide old age security is quite popular in many countries. What kind of multi-horizon investment strategies should a pension fund follow? Over multi-decade horizons, Indian data shows that equity premium is large enough to compensate for risk and that an equity portfolio would out-perform government bonds, with probability exceeding 95%.

One of the expected outcomes of financial reforms in the 1990s was an improvement in the allocational efficiency of investment by channelising funds towards profitable firms. What has been the empirical evidence? In early years of reforms, a study did not find evidence for increase in allocation efficiency of corporate investment. FDI is not always welcome by domestic firms. Under what circumstances the incumbent domestic firm cooperates with the foreign entrants?

Environmental and Sustainable Development:

Environmental problems have become so visible and all pervasive that they can no longer be neglected. Air pollution in our cities, polluted water in most rivers and land degradation requires some action. At the same time, we need economic development. We need to find policies that lead to sustainable development, policies, which often can be win-win policies as they lead to growth and increase in welfare. Our institute research has addressed a number of related issues.

Transport sector is a major polluter of urban air and transport demand is rapidly growing. Institute researchers have examined several

Other Academic Activities

A research Institute must keep abreast of the latest development in the field. Seminars by visitors at the Institute, giving seminars at other institutions and participation in conferences are the means by which peer feedback is obtained and fresh ideas are generated. The Institute organized 21 visitors' seminars and 8 conferences/workshops during the year. And of course, Institute faculty and students attended many national and international workshops and conferences.

Dissemination and Policy Impact

For a research institute peer reviewed publications are a major indicator of success. However, if the findings of our research are to have any impact on the society, it requires special effort to communicate them effectively. Faculty members of the Institute regularly write in newspapers. This is important to create a consensus in the country or generate a debate on policy issues. This could have an impact on policy in time.

The Institute however is also able to have an immediate impact on policy in the country through participation of the faculty in many committees at state and national levels.

Taking up of sponsored projects is another way through which the Institute can affect policy thinking in a relatively short time.

In all these, IGIDR has been active and, I think, effective.

This then, was another year of IGIDR's march of progress to be a leading centre of excellence for teaching and research in development policy.

Kirit Parikh

Kirit Parikh
Director

IGIDR at a Glance as of 1998-99

Established in	1987
Affiliated with Mumbai University	1990
Granted Deemed University status by the Govt. of India	1995
Faculty staff strength	37
Current number of students including part-time	58
Ph.D. completed	9
P.G. Diploma obtained (from 1990 batch – 1995 batch)	61
M.Phil. awarded	5
M.Phil. thesis under examination	3
Ph.D. thesis under examination	5
Continuing thesis work	42
No. of students pursuing course work (i.e., 1998-99 batch)	12
No. of projects completed till now and ongoing	
Completed	39
Ongoing	13
No. of research publications (1986 to March 1999)	
Books	30
Reprints (journals and chapter in books)	350
Discussion papers	161
Project reports	39
No. of international conferences participated in 1998 - 99	47

issues. What is the projected demand, and how best to meet it? How to moderate its impact on the environment? What policies can help in this? What are the gaps in our policies? Can we develop an index for air quality?

To balance the need for environmental quality and economic growth, we need to account for environment. We should value natural assets and resources and subtract their depreciation from net domestic product (NDP) to obtain a truer measure of NDP – which is environmentally adjusted. IGIDR has worked for years in developing a framework, methods and case studies for such accounting in India. A case study for Brunei was also carried out and a survey was carried out to assess green perceptions of Bruneians by an IGIDR faculty member who was a visiting faculty in Brunei.

Deforestation and land degradation are serious environmental concerns. IGIDR has assessed plantation programmes that try to restore wasteland through peoples participation. How cost effective are they? They showed high benefit/cost ratios. Also a comparison of approaches shows the critical ingredients of such a programme are its management structure and participation rules. Performance indicators for such programmes were also developed to help in monitoring them.

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1. Outline of IGIDR

Background, Aims and Objectives

The Indira Gandhi Institute of Development Research (IGIDR) is an advanced research institute established in 1987 in Mumbai by the Reserve Bank of India for the study of national and global issues relating to economic development. The Institute is recognized as a Deemed University under Section 3 of the UGC Act. The primary objectives of the Institute are:

- to promote and conduct research on development from a broad inter-disciplinary perspective
- to serve as a centre for promoting cooperative endeavour and interaction between research scholars and institutions in India and abroad
- to undertake any other project or activity which may be usefully carried out by the Institute for the furtherance of development and social welfare.

Board of Management

The present composition of the Board of Management is as follows:

1. Dr. Bimal Jalan — Chairman
   Governor
   Reserve Bank of India, Mumbai
2. Dr. Kirit S. Parikh — Member
   Director
   IGIDR, Mumbai
3. Dr. Suhas Sukhatme — Member
   Director
   Indian Institute of Technology, Mumbai
4. Dr. Mrinal Datta Chaudhuri — Member
   Delhi School of Economics, New Delhi
5. Prof. Amaresh Bagchi — Member
   National Institute of Public Finance and Policy, New Delhi
6. Dr. Raghbendra Jha — Member
   Professor
   IGIDR, Mumbai
7. Dr. K.V. Ramaswamy — Member
   Assistant Professor
   IGIDR, Mumbai
8. Dr. Y. V. Reddy — Member
   Dy.Governor
   Reserve Bank of India, Mumbai
9. Dr. I. G. Patel — Member
   Former Governor
   Reserve Bank of India, Vadodara
10. Dr. L. K. Deshpande — Member
    Economic Consultant
    Mumbai
11. Mr. T. V. Subramanian — Secretary
    Registrar
    IGIDR, Mumbai

Past Members of the Board of Management

Mr. R. N. Malhotra (Chairman)
From inception to December 22, 1990

Mr. S. Venkitaramanan (Chairman)
From December 1990 to December 1992

Prof. Sukhamoy Chakravarty
From inception to August 22, 1990

Prof. D. T. Lakdawala
From inception to April 15, 1992

Prof. V. M. Dandekar
From March 1993 to July 1995

Dr. P. K. Iyengar
From inception to December 1994

Dr. M. S. Gore
From inception to January 1996

Dr. J. K. Ghosh
From September 1991 to January 1996

Dr. Kirit S. Yagnik
From September 1991 to January 1996

Prof. M. Gadgil
From March 1993 to July 1994

Mr. S. S. Tarapore
From March 1993 to September 1996

Dr. C. Rangarajan
Member from inception to March 1993
Chairman from March 1993 to November 1997

Prof. Jyoti Parikh
From January 1996 to September 20, 1998

Dr. M.H. Suryanarayana
From January 1996 to January 30, 1998

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Sunsets at IGIDR ...

It is a great pleasure watching the sun set on the horizon from our institute. Our institute is nestled on a hillock near Borivali National Park. Like any other

high altitude place it provides a bird's eye view of the surroundings. Also, being flanked by the Film city with all its rich natural landscape, the institute is amidst green cover. The nearby hutments and cow sheds lend a rustic touch. Yet being close to the city, all modern amenities are conveniently accessible. The institute no doubt, has an enviable location.

Unlike most cityfolk in Mumbai, I am fortunate to be able to watch the sunset from this vantage setting. I make it a point to watch it every evening. I eagerly wait for that moment to arrive. The experience is captivating. On days when I have to miss the event because of unavoidable work, my mind wanders outside imagining the event. Sometimes during the rainy season when the sun doesn't show up and the sky remains overcast, my mind as if sifting through the dark curtain starts visualizing how it must really be setting behind the curtain.

Though unique each time, I still find some regularity in sunset timings and uniformity in its patterns within seasons. Sometimes one doesn't get to see the sun setting when it gets eclipsed by clouds. But even then watching the changing hues and abstract patterns of the clouds at that time is pure fun. Many a times just a few white layers scatter over the sky. These layers turn bright crimson after the sun sets, and starts fading from the opposite direction before turning white again. That part of the sky where the sun sets, begins to get darker in colour but remains lit until complete darkness overwhelms.

To a trained eye, the sky does not appear to be plain blue. Blue colour, like numerous shades of natural green, has several shades if only one observes them carefully. And these shades change every moment.

Sometime the glare of the halo around the Sun continues to remain extremely bright till it completely disappears causing much discomfort to the observing eyes. Sometimes its brightness fades much before it sets. It then appears to be a big ball suspended in the air. Its colour varies markedly from off- white on some days to dark orange on the other. As I walk in the institute, I see the big ball moving along with me, playing hide and seek behind the walls of eucalyptus trees, behind coconut fronds, behind glistening, dancing pipal leaves. I feel as if left alone when it gradually disappears into the blue unknown.

As the brightness pales off, smoke from the hutments trapped under green canopies makes the view hazier. Intermittently, in the abrupt gush of wind, dry coconut leaves make a shrilling sound. During twilight, mysterious sounds of myraid creatures come alive. Listening to countless sparrows, crows, and parrots that gather on big trees during this time is a real music to ears.

In the daily grind of city-life this big celestial event, a real bonanza of colours, goes unnoticed. Any break from the humdrum existence is greatly looked forward to. And when the break comes after much waiting, one rushes to either a hill station or a tourist spot. There, becoming conscious of the event one scrambles to reach a higher point to watch sunset. In fact with a bit of an effort one can observe and enjoy this glorious event daily from the city itself. It may just require going up to the window, or climbing a few stairs or walking some distance. There are many little joys like this present in city life. All one needs to do is to keep one's eyes and ears open and the senses tuned to such events. Rediscovering these hidden joys makes one's life not just bearable but much livelier and happier.

Rajeev Ahuja

2. Research Activities at IGIDR

IGIDR established as an advanced research institute has kept its pace in producing quality research published in various national and international journals. The research often multidisciplinary, covered a wide range of subjects including agriculture, economics, finance, human development, international trade, energy & transport systems, global & local environmental issues and sustainable development issues. The research objectives are grouped under the following broad themes:

1. Poverty, Levels of Living and Development
2. Food and Agricultural Policy
3. Energy Systems and Policy
4. Industry, Infrastructure and Labour
5. Macro-policy, Trade and Capital Flows
6. Banking, Finance and Capital Markets
7. Environmental Issues and Sustainable Development
8. Miscellaneous

Research in these areas is described in turn below.

2.1 Poverty, Levels of Living and Development

In a paper, *Growth With Equity: Policy Lessons from Experience of India* prepared for the UN-ESCAP[1], Manoj Panda investigated the nature of interrelations among growth, poverty and inequality in recent decades in India and examines the impact of important policies on growth and equity. He finds that when overall growth is small, the gains to the poor also turn out to be small. While growth is generally regarded as the most important factor for poverty reduction, the Indian experience clearly points towards the important role of a *critical minimum* growth level (say, of above 3 per cent per capita) in poverty reduction. Creation of employment opportunities for the poor through self-employment or wage employment programmes has been the most important policy adopted in India to make growth process broad based. Over the years, such programmes have grown in size creating about one billion person-days of employment in recent years and uses about 15 per cent of government's plan expenditure. While there is a lot to be desired for more effective implementation, there is no doubt that these have helped the poor a great deal. Among the major factors that determine the year-to-year movement of poverty in India, he finds that rise in per capita income and per capita development expenditure have poverty reducing effects, while rise in relative food price and money supply (in excess of that needed to meet growing transaction demand) have poverty increasing effects.

M. H. Suryanarayana, in his paper titled *Poverty, Food Security and Levels of Living: Maharashtra*[2], explores the magnitude of poverty, inequality and food security in rural and urban Maharashtra and the changes in them since the 1960s. Rural and urban poverty, as measured by different measures, increased in Maharashtra till the mid-60s and declined thereafter; similar to the findings at the national level. But the frequency and range of fluctuations in poverty were higher for Maharashtra than for the case of all-India. The limited growth that took place since the 1970s

[1] United Nations Economic and Social Commission for Asia and the Pacific

[2] *Journal of Indian School of Political Economy*, Vol. XI, No. 1, pp. 77-100 (1999).

was found iniquitous. With improvement in economic entitlement, the poor have diversified their consumption basket without impairing their nutritional security. Data for 1972-73 and 1983 shows an improvement in calorie, protein and fat intakes for all the decile groups in rural Maharashtra and only in calorie intake for the bottom nine decile groups in urban Maharashtra. Yet a majority (exceeding 80 per cent) suffer from shortfall of calorie intake in both rural and urban areas, calling for appropriate public policies towards nutrition security.

The socio-economic dimensions of the development of industrial projects have been discussed by Ramanathan, R. and Geetha, T. in their paper *Use of private land for industrial purposes: Need for amendments in legislations*[3]. The plight of the project-affected people due to land acquisition and other industry-related activities has been brought out. When land is acquired for the sake of industries, it is necessary to properly compensate the people affected by the acquisition, and arrange alternative accommodation and employment for them. It has been pointed out that the present practice in this regard is not satisfactory, and that modifications in the relevant legislation are necessary for sustainable development. The modifications suggested in the paper includes: market price should be properly defined as the money required to acquire the land in practice so as to ensure proper compensation for those losing their land for the sake of industries; provision may also be made in the legislation to ensure that local project-affected people get preferential employment in the upcoming industries, wherever feasible; and proper alternative accommodation should be made mandatory for the project-affected people. During the construction and operational phases, it is necessary that the industries provide the required incremental infrastructure and arrange for transport of personnel and materials without straining the existing facilities at the locality. Especially, in the operational phase industries must take active role in improving the infrastructure facilities in their vicinity. These, among others, include protection of environment, creation of additional infrastructure facilities like roads, drinking water facility, hospitals and schools for the benefit of the local people. Authors have concluded that these steps taken by the industries will help a lot in achieving the purpose of development.

Basudeb Guha-Khasnobis examined the issue of child labour in developing countries, which is a complex socio-economic phenomenon. It also displays a prominent spot on the world trade proscenium. The emotional reaction towards this problem shown in the west, by adopting boycott of goods, has in fact exacerbated the problem rather than helped in finding solutions. The complex problem of child labour cannot be resolved easily by domestic and international sanctions. For instance, in India, there is a ban (restated by the Supreme Court in 1997) on child labour in hazardous occupations, but some children continue to work and cannot be weaned away for several reasons. Therefore, sanctions can backfire. From the study[4] conducted in the Rajasthan carpet industry, Basudeb Guha-Khasnobis finds that poverty is the main cause behind the working of children. Most of the child workers come from farmer-households with household size more than five, and with practically no land

[3] *Seminar, 474, pp: 52-54 (February 1999).*

[4] *Consumer Policy Review, U.K. (1999).*

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holdings of their own. The reported incomes of the heads of families (both parents included) range from Rs 1000 to Rs 2000 per month, or approximately, between three to four hundred dollars per year. These families are clearly a long way below the poverty line, by any standard. The decision to send their children to work (in other words, the *supply* of child labour) is driven by hunger, which is a physical need. Moral or ethical considerations are completely irrelevant to them. An abridged version of the study *Seen but not heard? Dealing with Child Labour* by the author has been accepted for publication.

In a paper, *Economic Growth and the Persistence of Child Labour: Evidence from an Indian City*[5], Swaminathan, M. examined the features of child labour in an area of high economic growth in western India. Growth was associated with an increase in the number of child workers over the last 15 years. The analysis shows that children work at simple repetitive manual tasks that do not require long years of training or experience. The work is low-paying, involves drudgery and is hazardous. Work forecloses the option of school education for most children. In this context, the author argued that economic growth alone is not sufficient to eradicate child labour. In the continuing efforts, author is focussing on the issues of child labour, specifically on estimating the costs of programmes to end child labour and make schooling universal.

Agarwal, P. along with Srinivasan, P. V., analyzes India's performance in social development, i.e., in poverty alleviation and in the provision of education and health facilities to its people using indicators such as, poverty rates, literacy and infant mortality rates, access to safe drinking water and sanitation facilities. Evidence from the previous three decades suggests that India's progress on these fronts has been rather slow, especially when compared to that of East Asia. Further attempts were made by the authors to understand the causes of this slow progress by examining the various factors that affect poverty alleviation and the provision of education and health amenities to the people. In a book *Social Development in Asia: Strategies, Problems and Prospects*[6] authors concluded that economic growth appears to be the main source of poverty reduction in India. It reduced poverty by increasing income per capita and by creating more employment in an environment where the income distribution has remained largely unchanged. Expenditure on anti-poverty programs, lower relative food prices, higher growth rates of employment, higher agricultural yields and higher real agricultural wages also help to reduce poverty.

The slow progress in indicators of education and health could also be related largely to the slow growth of GDP as this lowered the government's ability to incur expenditure on these areas. India's public expenditure on health as a proportion of the GDP is comparable to most East Asian countries, but the per capita expenditure is much lower. In the case of education, even the public expenditure as a proportion of the GDP is lower. This is an unfortunate trend as better levels of education, especially of women, also help to improve the health-related indicators by increasing awareness. The poor institutional structure and the prevalence of corruption, due to which even the limited funds available for social development are not utilized effectively to provide health and

[5] *World Development, 26 (8) (August 1998).*

[6] *Kluwer Academic Publishers (forthcoming).*

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education services to the poor, further compound the problem.

2.2 Food and Agricultural Policy

In a paper, *Spatial Variability in Crop Yields: The Case of Cereals Across Districts of Andhra Pradesh*[7], Ganesh-Kumar, A., studied the variation in crop yields across different regions during a given time period for five major cereal crops across the districts of Andhra Pradesh.

Swaminathan, M. studied, in her research for last couple of years, the working of Public Distribution System (PDS) and ways of improving the PDS to make it an effective tool of food security. In a work[8] motivated by the current state of food consumption and nutrition among the Indian population, she addressed various aspects of PDS. The average consumption of cereals, major source of energy, has fallen over time. In 1993-94, 80 per cent of households, on average, did not get the recommended intake of calories a day. Food expenditure was the major component of the family budget for the large majority of households and accounted for more than 50 per cent of household expenditure among 95 per cent of rural households and 80 per cent of urban households. Author concludes that if the criterion used in the United States for identifying the poor for food stamps – that is, a household that spends more than one-third of its income on food – were used in India, more than 95 per cent of households in India would be identified as poor.

An important observation that emerged from the review of the PDS in different states was that access by the poor to the PDS was closely tied to the nature of access and coverage for the entire population. In states with high coverage and an effective distribution network (such as Kerala and, to some extent, Andhra Pradesh), the poor utilised the PDS more than the rich. In states with an inefficient and ineffective distribution network (such as Uttar Pradesh and Bihar), PDS reached neither the poor nor the rich. The author argues that the central government is responsible for the overall policy of price support, procurement, storage and distribution and state governments are responsible for implementation of the PDS and can set some key parameters of the system, such as entitlements, prices and coverage. Effect of inflation of food grain prices on the PDS also has been given light. Contrary to popular perceptions, targeting has costs attached to it, particularly in terms of a fall in welfare for the poor. The specific scheme for targeting introduced in India has attempted to classify households into "poor" and "non-poor" categories on the basis of the official poverty line. Swaminathan, M. and Ramachandran have argued that targeting based on an income criterion is extremely difficult to administer in a country like ours, and is likely to result in large targeting errors. And further, authors have thrown some light on TPDS and its advantages[9].

The state of Kerala in the Indian Union has received considerable acclaim for high levels of human development through conscious choice of public policies. With high levels of poverty and inadequate domestic food grain production, Kerala is one of the most food insecure states

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[7] *Indian Journal of Agricultural Economics, 54(1), pp.53-78 (1999).*

[8] *Asia Research Centre, Working Paper 2, London (1999).*

[9] *Frontline, March 12, (1999).*

in India. Its adverse implications, however, have been mitigated through active government intervention and public distribution system (PDS). As a result, per capita cereal consumption has increased in spite of a decline in domestic cereal production. Yet, about 80 per cent of the population suffers from inadequate calorie intake. The scale of PDS is substantial; but its effective utilisation is less than 50 per cent of the potential due to inadequate economic access and poor quality of food grains. Instead of focusing on these fundamental causes, the Government of India opted for a policy of targeting and scaling down the PDS benefits solely to reduce the budgetary costs. In a paper, *Food Security and PDS in Kerala: Form and Scope for Reform*[10], Suryanarayana, M.H. examined the implications of Government of India policies of targeting and scaling down the PDS benefits solely to reduce the budgetary costs for Kerala.

The governments' policy intervention for food grain price stabilization concentrating on the two principal food grains, rice and wheat have been reviewed by Srinivasan, P.V. and Jha, S. In a paper, *Food Grain Price Stabilisation in India: Lessons from Past Experiences and Emerging Issues*[11], the historical evolution of policies and their effectiveness in meeting price stabilization and other interrelated objectives such as protecting consumers, providing incentives to producers and achieving self-sufficiency in food grains has been analyzed. The issues that arise from liberalizing external trade and the role that private storage and foreign trade can play in containing the rising costs of government intervention were examined. Given high costs of direct targeting, implicit targeting mechanisms can provide the poor with more effective protection. Substitution of agricultural subsidies with investment in agriculture was found better for long term agricultural growth. The authors opined that encouraging private storage and liberalizing private external trade can reduce the high cost of public storage. Variable levies/ subsidies on trade can stabilize prices at lower costs than buffer stocks. The removal of restrictions on trade needs to be complemented by better ports and other infrastructure.

Agarwal, P., in a paper, *Contractual Structure in Agriculture*[12], developed a generalized double-sided moral hazard model of contract choice in agricultural production, with mutual monitoring of each other by the landlord and the tiller who generally have different levels of farming efficiency and are risk averse. Using this model it has been formally proved that the optimal contract maximizes the output net of the risk-bearing and agency costs (of both the parties). A simulation exercise is carried out which helps explain many of the tenancy related issues. The difference in the farming efficiency of the two sides, often ignored in previous analysis, turns out to be the principal determinant of the contract offered to a tiller.

2.3 Energy Systems and Policy

A paper by Ganesh-Kumar, A., Darbha, G. and Parikh, K.S.[13], has described the impacts of a hike in the administered prices of petroleum

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[10] *Oomen, M.A. (ed.): Rethinking Development: Kerala's Development Experience, Vol.2, Concept Publishing Company, New Delhi, pp. 325-369 (1999).*

[11] *Asia-Pacific Development Journal (December 1998).*

[12] *Journal of Economic Behavior and Organization, Forthcoming*

[13] *Discussion Paper No. 150, Indira Gandhi Institute of Development Research, Mumbai, India (1998).*

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products in India using an applied general equilibrium model for analysis. The quantitative implications of a hike in the administered prices of three petroleum products (liquefied petroleum gas, petrol and high speed diesel oil), which are vital inputs to most of the activities in the economy, are studied using a static multi-sector multi-agent applied general equilibrium model for India that explicitly allows for different types of quantity-price adjustment mechanisms across sectors. The results suggest that there would be an increase in the cost of transportation following the hike in the price of these petroleum products. This in turn would push up production costs and also the end-user prices of various goods, resulting in a contraction in the demand by households. All this would result in an increase in the prices and a decline in the outputs of non-agricultural commodities and services. On the other hand, those commodities / sectors such as agriculture that face a fixed level of world market price are likely to witness an erosion in their producer prices and incomes due to the increase in the trade and transportation margins between the border and domestic markets. At the end-user level, the price rise is likely to be largest in the case of investment goods, imports and inputs in that order, while consumer prices is likely to witness the smallest increase. The erosion in agricultural incomes would result in a sharp deterioration in the welfare of all rural households while urban households might enjoy welfare gains due to increase in the nominal non-agricultural incomes. The paper also finds that attempts at providing domestic price supports to agriculture can protect only the nominal incomes of rural households but not their welfare which would be adversely affected by the much steeper increase in the prices of consumer goods than when domestic price supports were absent.

In developing countries like India, consumption of petroleum products has implications on its balance of payments, economic growth and fiscal deficit. In a paper, *Short and long-run elasticities of gasoline demand in India: An empirical analysis using cointegration techniques*[14], the relationship between demand for gasoline, one of the prime petroleum products, national income and price of gasoline was examined empirically by Ramanathan, R., using cointegration and error correction techniques. From the analysis with the time frame of 1972-73 to 1993-94, it has been found that gasoline demand is likely to increase significantly for a given increase in the gross domestic product. The increase will be larger in the long-run (2.682) than in the short-run (1.178). Gasoline demand was found relatively inelastic to price changes, both in the long and short terms. The error correction model has shown that gasoline demand adjusts to their respective long-run equilibrium at a relatively slow rate, with about 28% of adjustment taking place in the first year.

Integration of different aspects is the key process in solving a complex problems involving many aspects. A paper by Parikh, J.K. and Ramanathan, R., *Linkages among Energy, Agriculture and Environment in Rural India*[15] explains and analyses the interconnections among energy, agriculture and environment in rural India. Rural areas of developing countries use bio-mass for fuel, fodder, fertilizer and other purposes, and it is necessary to understand the fuel-fodder-fertilizer relationships for optimal bio-mass allocation. Authors have used linear programming model to explore the allocation. The model was first validated by simulating it

[14] *Energy Economics, 21, 321-330 (1999).*

[15] *Energy Economics (forthcoming).*

using data for the year 1990-91. Then it was applied for the year 2000, and several scenarios have been generated to obtain answers to various policy questions. The authors have shown in the paper that it is necessary to increase fertilizer consumption, to increase efficiencies of cooking stoves, to improve livestock feed, and/or to decrease population growth for maximizing the revenue generated in the rural system of India. The study has shown that when the prices of fertilizers increase, a large increase in kerosene requirements could be expected. The study has highlighted the necessity to increase kerosene consumption to reduce emissions (due to non-commercial fuels) and soil fertility loss. Correspondingly, kerosene consumption ranges from 0.18 million tons to 15 million tons.

Energy consumption in urban areas, especially modern urban areas, has been changing and its impacts on forests, environment, transportation and economy as well are increasing rapidly. In a study carried out by Reddy, B.S.[16], these effects have been assessed through fuel cycle approach involving the source of energy, the mode of transportation and the pattern of energy use for a city in India - Bangalore, for a period of eight years (1979-87). To study the technological competition in the context of long-term energy planning, two models were developed to study the process of energy carrier substitution in the residential sector. The empirical data on energy carrier consumption showed that with increasing household income there was a shift in carriers from firewood to kerosene, kerosene to LPG, etc. Looking at the carrier shifts in terms of devices competing for adoption by households, a competition model was developed according to which ln (X_2/X_1) (where X_1 is the number of households using device D_1 and X_2 is the number of households using device D_2) was predicted to vary quadratically with income. This income dependence was in conformity with observations. A multilogit model was used here to explain the probability of selection of the fuel for cooking/water-heating by the household.

Another model was also formulated to explain the switching of a household from one device (D_1) to another (D_2). Each such device shift corresponds to a certain rate of return but a household decides to make the shift only if the discount rate that it uses for its investment decisions is less than the internal rate of return. The observed device shifts indicate rapidly decreasing consumer discount rate with income. The energy carrier substitution model developed in this study provides insights into the decision making nature of the household. It is from this perspective that the policy makers should think in terms of increasing the pace of diffusion of energy efficient fuel wood stoves for those who can not afford to purchase LPG or electric stoves. The rural afforestation programmes and the energy conservation measures through efficient wood stoves will certainly decrease the stress on rural resources. Thus, this study serves as a guide to policy formulation and intervention.

Performance of public bus operators plays a key role in efficient traffic management. Various techniques have been applied to map the performance in the past. In a study undertaken by Ramanathan, R., data envelopment analysis has been applied to evaluate relative performances of the public bus operators in India during the year 1993-94. Data on three inputs and one output are used for the purpose. In a paper, *Using Data Envelopment Analysis*

[16] *Urban Energy Systems, Concept Publishing House, New Delhi (1998).*

for assessing the productivity of the State Transport Undertakings[17] only two out of the twenty-nine operators are identified to be relatively productive with a unit efficiency score. For the inefficient operators, the amounts by which inputs have to be reduced or the amount by which the output has to be improved are calculated. It was found in this analysis that most of the operators are using their fuel efficiently, while large inefficiencies are observed in the usage of fleet (a measure of capital stock) and staff. This result is, in general, representative of the behaviour of any firm in the public sector. The efficiency scores are then decomposed, using regression, to identify the effects of certain factors beyond the managerial control of individual bus operators. Factors such as age of fleet, nature of terrain, average number of passengers per bus per day and the proportion of urban services are identified to be significant factors affecting the productivity of Indian bus operators. The first two factors have a negative effect on the efficiency score, while the other two have a positive effect.

2.4 Industry, Infrastructure and Labour

Srinivasan, P.V. along with Das, P., in his paper titled *Welfare Implications of Telecom Tariff Reform*[18], argued that the current level of cross subsidy is sub optimal and raising government resources through an increase in the price-cost markup on long distance traffic can be highly inefficient. This argument is based on the estimates of own price elasticities of local and long distance calls, obtained from Public Call Office data. This tends to justify the current restructuring of telecom tariffs in India by the Telecom Regulatory Authority of India. It is also argued that the opposition to tariff changes on equity grounds is unreasonable since there is no firm evidence to show that long distance usage is predominantly by the rich and local call usage by the poor. Also, subsidization of rental charges (access) may not serve the objective of universal service since, the demand for access is known to be extremely insensitive to price and much more responsive to income levels. Moreover, field surveys have shown that the mere provision of a Village Public Telephone, for example, does not ensure telephone usage among the rural people. Thus, authors feel that it is essential to tackle the demand side problem- overcoming economic and educational barriers- in order to attain the universal service objective.

Economic reforms have shown a noticeable impacts on industrial sector. One of such industries is Powerloom industry. A study was carried out by Roy, T., on the powerloom industry in Tamilnadu, as part of a series of studies on changes in the textile industry after the economic reforms. In his paper, *Development or distortion? The powerlooms in India, 1950-97*[19], Roy argued that the powerloom industry has done exceptionally well in India, in the long run and especially during an export boom after trade liberalization in the late 1980s. Their growth illustrates several intuitions of a recent international literature on small firm dynamics.

An export recession in 1996-98, however, showed that the growth has happened without basic changes in the technological and organizational capability of the industry. Using the example of an export-oriented weaving

[17] *Indian Journal of Transport Management, 23(5), 301-312 (1999).*

[18] *Economic and Political Weekly, (March 20, 1999).*

[19] *Economic and Political Weekly, (April 1998).*

region, the study describes the origin and present conditions of the industry, its major handicaps, how it tries to address its handicaps, and what kind of policy initiatives may be needed to deal with them. The paper, *Economic reforms and the textile industry in India*[20] also suggests that some recent changes in organization and technology in the industry can be seen as attempts to deal with these weaknesses.

In an invited series of articles on game theory[21], Babu, P.G. had outlined the game theory and dealt with Nash equilibrium with various illustrations. In another series of articles[22] , the concepts of repeated games, social norms, informational cascades, and common knowledge have been explored.

Financial reforms in India during 1990s had two major objectives. First, they were aimed at improving the efficiency in allocation of investments by channeling funds towards profitable firms. Second, they were meant to create access for the corporate sector to more sources of funds. Basudeb Guha-Khasnobis along with Saumitra Bhaduri in their paper, *A Critical Appraisal of the Effects of Financial Liberalization on Corporate Investment: India 1990-1995*[23] examined the actual outcomes in the Indian Corporate sector. Their empirical analysis shows that during the early years of financial liberalization the share of investment going to the more efficient firms did not rise, resulting in no perceptible rise in the overall efficiency of investment allocation for the economy. From their analysis of the sources and uses of funds they infer that in the period immediately following the announcement of liberalization in 1991, there was a tendency in the Indian corporate sector towards a myopic use of funds. The surge in the availability of funds in the stock market, coming mainly from small and medium savers, failed to translate itself into any noticeable rise in gross fixed assets. They were generally diverted towards speculative financial portfolios. Thus, the lack of an improvement in the index of efficiency of investment allocation can perhaps be partly ascribed to bad investments to begin with. Authors are further working on extending the analysis to more recent data, as they become available, to have a more robust picture of the same effect.

Various constraints for labour supply influences the performance of an industry as well as market significantly. In a paper, *Job Security, Wage Bargaining and Duopoly Outcomes*[24], Majumdar, S. and Saha, B. have developed a model where labour supply is constrained because training new workers is costly and redundant workers cannot be fired. An entrant draws labour from an incumbent firm through a wage contest while wages in the latter are bargained with its unionized workers. In a Cournot equilibrium, the union's bargaining power has a positive effect on the incumbent's output, but a negative effect on the industry's output. Social welfare under duopoly may fall short of the monopoly level. Authors, in this paper, concluded that the distribution of bargaining gains within the incumbent firm is

[20] *Economic and Political Weekly, (August 1998).*

[21] *Resonance: Journal of Science Education, Indian Academy of Sciences, 3 (7) (1998).*

[22] *Resonance: Journal of Science Education, Indian Academy of Sciences, 3 (8) (1998).*

[23] *International Journal for Development Banking, 17(1) (January 1999).*

[24] *The Journal of International Trade & Economic Development, 7(4), pp. 389-403 (December 1998).*

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sensitive to whether wage and output choices are made sequentially or simultaneously.

2.5 Macro-policy, Trade and Capital Flows

In an effort to assess the role of financial factors in determining the export competitiveness of various sectors in development countries, Ganesh-Kumar, A, Vaidya, R. and Sen K. undertook a cross-country project "International Trade, Competitiveness and Finance: The Developing Countries Experience – Case Study for India" sponsored by The International Development Research Centre (IDRC), Canada[25]. The countries in the study includes Argentina, Uruguay, Brazil, South Africa, Tunisia, India, Indonesia and Philippines. Trade theories cite real factors such as productivity, unit labour costs, technological complexity of the commodities, economies of scale, etc., as the driving force for the export performance. The evolution of these real factors over time however, depends on investments. In this context, modern theories of investments that stress the role of finance in determining investments become relevant. In this study, the link between finance and export performance is postulated to be via investments.

The empirical analysis begins with an examination of the importance of real exchange rate in explaining India's competitiveness at an aggregate level for both total and manufacturing exports. Movements in the real exchange rate is found to have a significant role in influencing India's export competitiveness at an aggregate level. Further, it is the movements in the nominal exchange rate and not the inflation differential between India and the US that matters more for aggregate competitiveness. The role of each of the various real factors stressed in theory such as productivity, unit labour costs, quality, technological sophistication, etc., in influencing export competitiveness was assessed at the sectoral level. Towards this, industries are first categorised into "winner" and "loser" sectors based on their export performance. The relationship between various real factors and export performance are assessed for winner and loser industries separately. No significant link is found between export competitiveness and unit labour costs indicating that non-price factors may play a more important role in explaining India's export performance.

Next, the relationship between finance and investments have been assessed by estimating investment functions at the firm level. Firms are categorised into "exporters" and "domestic firms" based on the importance of exports in their total sales, and the relative importance of finance in affecting investments is tested for these categories of firms. Investments in fixed capital are found to be constrained by the availability of internal resources of the firm and that such finance constraints are less binding for exporting firms than for the domestic firms. This suggests that the financial sector reforms undertaken so far have had the desired impact of creating an enabling environment for Indian exporting firms.

In a paper, *Do Foreign Inflows Let Expectations Dominate History?*[26], Goyal, A., examined how foreign inflow can influence

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[25] *Finance and Changing Trade Patterns in Developing Countries: Case Study of India", Report submitted to the International Development Research Centre (IDRC), Canada, PP-38, Indira Gandhi Institute of Development Research, Mumbai, India (1998).*

[26] *Journal of Foreign Exchange and International Finance, 10(3) (Oct.-Dec. 1998).*

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expectations. In her framework investment is a function of the present value of expected future output. A change in the regime of foreign inflows can boost these expectations, so that investment propensities exceed savings. A pricing rule exists that ensures stability and maximises expected profits. A macro dynamic system results in which there are two classes of equilibria, with high (low) capacity utilization associated with lower (higher) mark-ups. There are unique classes of adjustment paths approaching these equilibria, and medium-run growth cycles occur due to switches between these. Expectations can jump to either equilibria, causing an endogenous amplification of shocks. Growth cycles have been explained by the interaction of history and expectations. The model gives an explanation for macro puzzles such as the reconciliation of excess volatility in quantities, pro-cyclical real wages, and excess capacity, with maximization of expected profits. It provides a justification for stimulatory fiscal policy. Author concludes that the mark-up rule allows only small counter-cyclical variations in the medium-run mark-up but makes large quantity adjustments possible without instability. In the case of a shock to foreign inflows supportive macroeconomic policies that tie the domestic to the world interest rate are required to achieve the highest feasible growth path.

Developing countries today want to attract and cooperate with foreign firms. But an entering firm can be aggressive or accommodating. Goyal, A., in her paper, *Signaling and the Acceptability of Foreign Direct Investment*[27], argues that potential conflict can cause a prisoner's dilemma structure to the payoffs. Even so, cooperation can become the equilibrium outcome because the accommodating firm can design credible signals to reveal its type, based on differing discount rates. Cooperation, once established, tends to continue in the future. But the game differs from standard models in that signaling also changes the payoffs that determine firm's profits. This, together with cultural attributes that influence out of equilibrium beliefs, and expectations of high growth, leads to a unique pooling equilibrium with determinate signaling expenditures.

An extensive work has been carried out on the present quota structure of IMF and its impacts on the developing countries and also the possible restructuring. This study of Jha, R. along with Mridul K. Saggar[28] has as one of its focal points, the articulation of a rationale for revamping the structure of quotas within the IMF. It has been argued that the quota structures as used by the IMF are not entirely consistent with its stated objectives. Several levels of problems viz. omission of variables that should be included in the formula; inclusion of variables that need not be included; not taking sufficient cognizance of problems relating to measurement of variables; using inappropriate and arbitrary weighting structures; and paying insufficient attention to strategic considerations in translating quotas into voting were delineated.

Further, the authors focussed their attention to quota changes that were affected as part of the 11th quota revisions. It is argued that institutions (such as the IMF) governing global economic issues need revamping. In particular,

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[27] *Presented at the India and South Asia Chapter of the Econometric Society, ISI New Delhi (December, 1998).*

[28] *IMF Quota structure and the Developing Countries, report submitted to Reserve Bank of India (1998-99).*

in the case of the IMF, attention needs to be paid to IMF's own financial strength and the emergent needs for international liquidity in the aftermath of the recent Mexican and on-going East Asian crises. These planned changes in liquidity would have to be dovetailed with policies better designed to deal with the problems of moral hazard. Countries that are assured of IMF help in case something goes "wrong" will fail to undertake those measures that would have prevented "something from going wrong". It was also shown that the 11th Quota Review has failed to accord a common set of principles on the basis of which the quotas for different member countries get determined. Different variables get different weights under different schemes of formulas and these weights become different for different members even within the same scheme of formulas. The inter-country disparities are huge and the weight determination has become a matter of accident rather than a policy choice for the Fund or its member. Authors also shows through quantification of weights and elasticities that for India, GDP is the driving force in determination of quotas through the Reduced Bretton Woods formula. If GDP were indeed underestimated it would affect our quota and voting share position in the Fund adversely. However, quantification of underestimation, if any, is essentially a matter which is best left for CSO to resolve.

The authors further focussed on articulating alternative quota structures as illustration of the direction in which the Fund need to begin thinking. The analysis focuses its attention primarily on India – but is, clearly, general. It is evident that under a wide variety of formula structures, India's relative quota position improves substantially. This includes three broad varieties of cases: (a) those in which we do not take capital account and stabilization arguments into account; (b) those in which stabilization arguments are important and (c) those in which capital account considerations are also important. In several of these cases India's relative quota ranking improves to 8th and 5th position. A key factor that affects this transition is the use of Purchasing Power Parity (PPP) values of GNP rather than the actual GDP figures. However, although the use of PPP magnitudes is important, they are by no means the only determinants of the improvement in relative quota position for India. Some of the alternatives considered shows that India's quota position can be improved even without giving very much higher weight to PPP figures. It should be possible to build an argument about revision of quota formulae structures along these lines. In particular, the Indian position appears to be sound even when we incorporate capital account and macro stabilization considerations into the quota formulae.

Empirical characteristics of IMF programs were also discussed with two levels of analyses. First, the authors modeled in a panel data framework the determinants of loans from the IMF. These determinants include the quota position of the concerned country, the various macroeconomic factors that the IMF emphasizes and so on. Estimates were done for several groups of countries and it was discovered that there is very little uniformity in the determinants of the IMF loans across various groups of countries. A second level analysis modeled the macroeconomic impacts of IMF loans in the Indian economy using a VAR framework. Important inferences about the exogeneity of IMF loans to various macroeconomic magnitudes in the economy were made. The problems arising from the fact

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that within the IMF voting rules, effective coalition formation is a tool that can be used over and above the quota positions of countries was discussed. It was argued that the power of a country within the IMF voting rules depends partly on its quota position and partly on the effectiveness of coalitions that the country can form. In this context a Banzhaf index of power was computed for different quota formulae structures – including, for illustrative purposes, one formula that has been suggested in this study. The results show that India's voting power was reduced as a result of the 11th quota revision under the simple majority rule, though not under the special majority rule requiring 85 per cent majority. The results also show that alternative PPP-based formulas can considerably enhance our voting power.

A short-run model developed by Goyal, A. and Dash, S., incorporates instantaneous portfolio equilibrium with macroeconomic flows to clarify the structure of real-financial sector interactions. If equity and foreign exchange markets are introduced in structuralist theories of asset markets in developing countries, the key result that a fall in money supply raises the rate of inflation now holds only under special conditions on partial derivatives. But there is a tendency for interest rates to rise and for fluctuations in asset prices. Fuller integration of asset markets moderates these fluctuations. Outcomes are stable in spite of the generalized complementarity distinguishing equity markets from loan markets. Authors concludes that expectations play a major role. Implications for policy are to link domestic interest rates to foreign rates, remove artificial barriers to market integration, and stimulate demand as well as supply.

Goyal's paper along with Dash, S., *Arbitrage: An Explanation for Southeast Asian Crisis and Indian Immunity*[29] explained the financial crisis in the Southeast Asian markets and the immunity of Indian markets. In many southeast Asian countries, the short-term bank lending interest rate significantly exceeded the US rate through the nineties. This interest differential exceeded the change in nominal exchange rates over the period. Country risk was low because growth was high. Governments committed to stimulate exports would not allow an appreciation of the exchange rate, and the large foreign inflows ruled out an immediate depreciation. Therefore, private corporations and banks had a large incentive to borrow abroad in the short-term without hedging. But because medium-run expectations of depreciation had to be positive, to satisfy arbitrage, and equilibrate domestic to foreign returns, the economies were susceptible to shocks. This together with financial market weaknesses explains the rapid collapse after mild external shocks. Before the onset of the Southeast Asian crisis the Indian monetary stance had been relaxed. Authors expressed their opinion that this was one of the factors that that helped India escape the crisis.

In a country with a very large population at subsistence levels, the interactions between the price of food and wages are major determinants of inflation. But, with liberalisation, as agricultural prices approach border prices, the exchange rate influences the inflationary process. Inflation is determined from the supply side, from the gap between the actual exchange rate and the exchange rate that satisfies a wage target. Then monetary policy acts upon interest, and equilibrium exchange rates, thus influencing expected depreciation.

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[29] *Economic and Political Weekly, 33(31), pp 2098-2104 (1st August, 1998).*

The key findings of Goyal, A., in a paper, *The Impact of Structure and Openness on the Causal Ordering of Inflation, Exchange and Interest Rates in India*[30], are that monetary tightening, in the face of a supply shock, can lead to an expected depreciation of the real exchange rate. This is the reverse of the predictions of monetary theories of the exchange rate. Agricultural productivity now determines the feasible non-inflationary nominal exchange rate. Real wages can rise if agricultural productivity rises. The analysis of the interaction between agriculture and industry changes since, agricultural markets now adjust to equilibrium through quantities rather than prices. The framework developed makes possible a narrative history of recent macroeconomic trends in India, which supports the hypotheses made here.

2.6 Banking, Finance and Capital Markets

Policy makers around the world have emphasised the virtues of deregulation since the eighties. In financial markets, deregulation has taken the form of removal of barriers to entry and licensing policies, as well as the dismantling of regulated interest rate regimes. These measures have been widely acclaimed as the harbingers of competition, competition being the stepping stone to higher levels of efficiency. Using theoretical caveats from the industrial organisation literature and empirical evidence from the Indian banking industry, Sarkar, J. and Bhaumik, S., in their paper titled *Deregulation and the limits to Banking Market Competition: Some Insights from India*[31] argue that entry and branching deregulation and interest rate liberalisation might not be the panacea that many policy makers make them out to be. Specifically, Sarkar and Bhaumik argue that competition might not naturally follow such deregulation if the incumbents are well entrenched in their market segments by virtue of sheer size and greater accessibility to customers. Further, given the inherent structure of the Indian banking industry, there is very little potential for a 'critical level' of competitive pressure to be generated in the aftermath of deregulation that should, in principle, motivate incumbent banks to improve their efficiency levels.

The analysis of trends in concentration ratios in the total and savings deposit market, and trends in inter-bank mobility among the top ten banks and among all banks suggests that at best competition has emerged at the fringe. This, in turn, is presumably because the entry of banks has been at the lower end, with the position of the dominant public sector banks not under any threat either from the private sector entrants or the incumbents. Regression analysis of changes in market shares in the Northern, Southern, Eastern and Western regions, revealed that some pockets of competition, have indeed appeared in the last five years, but that the oligopolistic dominance of public sector banks in the deposit market and branch network continues.

Given the findings of a marginal impact of belated deregulation on competition, this paper argued that the onus on the policy makers, is to supplement banking sector deregulation with other policy measures. One logical alternative

[30] *Invited paper at the NCAER-Ford Foundation workshop on New Directions for the Indian Economy, Gokhale Institute of Politics and Economics, Pune, (December, 1996).*

[31] *International Journal of Development Banking, 16(2) (July 1996).*

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could be the privatization of public banks in order to both "jump-start" efficiency improvements in these banks and infuse fresh capital into the weaker banks. The other, less controversial, alternative is to increase competition for the banking sector as a whole from non-banks and local banks, a policy move that has been adopted in India in recent years.

Shah, A. and Thomas, S., have been working on the real time evaluation of value at risk of portfolios of future and options using parallel computing[32]. Any futures market transaction involves a significant amount of counterparty credit risk – once a market transaction has been done, there is a non-zero probability that trade will not get settled because one party in the trade reneges on the contract. Future markets all over the world have solved the counterparty credit risk problem through the institution of clearing corporations, which acts as a principal to every trade. The counterparty risk of the clearing corporation is therefore the cumulative counterparty risk across the entire country.

This risk is calculated as the Value at Risk (VaR) of a given portfolio of futures and options. The VaR of a portfolio of futures is calculated easily, but that of options is not a problem that has a closed form solution. This is estimated in a MonteCarlo procedure, which involves drawing a large number of possible observable returns (5000 in the present work) based on the probability distribution of the returns of the underlying instrument. This VaR is measured against the margin capital that the individual has with the clearing corporation. If the VaR of the portfolio becomes larger than the margins, the clearing corporation disallows the individual from further trading until fresh margins are brought in.

In India, the cumulated counterparty risk is exacerbated in an anonymous, nation-wide market with computerised trading, since the probability of transaction volumes increasing within a very short interval of time is very high. Thus, the problem becomes one of being able to calculate the cumulative counterparty risk at very high frequencies. India's traded volumes seen today in the equity markets are on average 30 trades per second. The futures and options markets are expected to have double the number of trades. There are a large number of optimisation issues that arise to be able to calculate portfolio VaRs accurately in the shortest possible time.

We find that the system with the best accuracy-time-cost performance is designed as a parallel processing system which runs over a network of computers, with one central computer acting as a majordomo over a database of individual portfolios, which parcels the job of individual portfolio VaRs to other machines on the network. This system has been currently tested for a performance of 50 trades a second, and will be the system used to calculate portfolio VaRs at the NSCCL when the index futures and options starts trading at the NSE in the near future.

Jha, R. along with Hari Nagarajan in their paper *Market Integration and Price Discovery in Indian Stock Markets*[33] explain the role of capital market and the possibilities of improving it. They argue that capital markets are essential

[32] *"Parallel Risk Management (PRISM): Real-time evaluation of value at risk of portfolios of futures and options using parallel computation" funded by NSCC (December 1998).*

[33] *International Journal of Commerce and Management – Forthcoming (1999).*

to prevent the under-utilization and waste of resources in an economy faced with declining real value of its currency. Capital markets afford the opportunity to millions of savers in an underdeveloped economy to invest their savings in various productive assets that act as a hedge to erosion of purchasing power. The ability to buy (a claim) on a fraction of a real asset and the concomitant diversification possibilities for an investor with limited resources is valuable to the individual and to the society as a whole. The individual gains insurance through risk reduction and hence saves more, while the economy achieves a higher rate of growth due to the channelisation of savings into real assets. Thus capital market development can act as a catalyst for economic activity.

The authors opine that a prerequisite for sound capital market development is the robust functioning of the primary and secondary capital markets. Stock exchanges are secondary markets, which facilitate the price setting and trading process of securities, which are issued in the primary markets. The primary and secondary markets perform complementary roles and the healthy development of secondary markets engenders vigorous growth in primary markets as well. Price discovery is the principal function of the stock exchange. If price discovery is absent, then stock exchanges do not have any meaningful role. One might as well distribute shares through banks and post offices. Improper or inefficient price discovery impedes the functioning of capital markets. If asset prices bear no relationship to their fundamental value, then under or over-investment may occur in the capital market. A properly functioning stock market can facilitate a transfer of domestic savings into the corporate sector. Under-investment in real assets is one of the major reasons of poverty in developing countries. This can at least be partially remedied by the establishment of a well-functioning secondary market. In this paper authors have explained the reasons why the understanding of the price discovery process is important and useful in the context of emerging markets such as India. Further, authors have addressed the various aspects of functioning of Indian stock exchanges viz. are the markets integrated, is there a concept of a Central market that produces prices, which are then fed to the other markets, are the regional exchanges important for the national exchanges and so on.

It has been concluded that fragmentation in trading caused by multiplicity of exchanges does not impede the long run process of price formation in the Indian stock markets. All markets are integrated in the long run. However there is some degree of asymmetry in the long run price movements across markets. Price was discovered in all markets. The data set generated by changing the order of the markets also has been used but the results are not significantly altered.

The authors argue that specific conclusions on causality cannot be made as there is no such evidence of a central market. This is especially the case given that markets for the most part are mutually endogenous. If markets are endogenous then, it was observed that the others influence each market. That is, both lagged prices from the local market and price information from other markets control prices in the local market. The prices in stock markets are quite volatile in the short run. It was observed that in any given market, some of the stocks are stable while the others are not. It was further opined that the presence of a larger number of markets will provide a stabilizing

influence on the overall trading system. Arbitrage seems to occur more between NSE and the regional markets than between BSE and the same regional markets. This seems to be an unintended outcome of the NSE.

Thomas, S., addressed the investment strategies for multi-horizons. This was a project to investigate alternative investment strategies for long term investment of pension funds[34]. Pension fund returns and the reform of pension fund management has recently been in prominence in public policy debates. One of the most serious points under debate has been the asset class mix that is currently permitted for pension fund management. In this work, the performance of two broad categories of assets are considered from the point of view of answering questions about the impact of the equity premium under pension fund management horizons. The work has been carried out using data on Indian interest rates, inflation rates, stock market returns and risk. The answer, very clearly, was that over multi-decade horizons, the equity premium was found to be large enough to compensate for the risk levels of the equity investment.

The work simulates out the returns that would accrue to a person who can save Rs. 10 a day (including inflation rates) over 35 year work horizons, in a cumulative portfolio of assets. The simulation was done by bootstrap of past observed Indian stock market returns, and this was run 10,000 times to give 10,000 different possible outcomes. The interesting observation is that 95% of the simulations end with the individual having accumulated more in the portfolio with equity than that which contains only government bonds.

The same simulation has also been worked out for scenarios of higher savings rates. In every case, the result is that a portfolio with a higher fraction invested in equity will outperform investment purely in the risk-free rate with a 95% probability. As the savings rate increases, the amount of the outperformance also increases.

In another research project, Thomas, S., as a principal investigator addressed the estimation of yield curve in India. Yield curve estimation is a problem of finding the term structure of interest rates from prices of government bonds traded on the secondary market. If there are sufficient number of "zero-coupon" instruments at a sufficient set of maturities, then the "zero-coupon yield curve" where the prices of bonds at a given maturity form yield the interest rate at that maturity, the problem of estimating the term structure is a simple one.

In the face of (a) a lack of bonds with a sufficient set of maturities (as is the case almost everywhere in the world) and (b) a sufficient number of traded prices for instruments at all these maturities, the problem of yield curve estimation becomes a two-pronged process:

1) The choice of the functional form to represent the term structure. There is no one functional form that seems to represent the term structure; it is a choice of estimation. The literature suggest three main forms - polynomials, cubic splines and the Nelson-Siegel formulation - which is variously applicable depending upon the availability of data

[34] *Investment strategies for multi-decade horizons", funded by Project OASIS (November 1998).*

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2) The estimation of the chosen functional form based on the traded data for any given day to yield the zero-coupon yield curve for that day. The liquidity of bonds at different maturities vary widely, which becomes a problem when estimating a daily yield curve. Liquidity of bonds in India (and several countries in the world) vary widely in different periods. The estimation technology has to be robust to shifts in maturity patterns, and in the liquidity patterns within maturities.

Yield curve estimation in India has long been a problem, initially because of (a) a rigidly controlled government debt market (prior to 1996) and (b) a lack of liquidity in the debt market since then. From the preliminary stages of this project[35], Thomas, S. claims that they could reliably estimate a daily term structure for Indian using the Nelson-Siegel functional form.

2.7 Environmental and Sustainable Development

Ramanathan, R. along with Parikh, J.K., in his paper, *Transport Sector In India: An Analysis In The Context Of Sustainable Development*[36], presented a brief review of the Indian transport sector in the past few decades. It was shown that the period has witnessed a gradual transformation from rail-dominated transport to road-dominated transport with infrastructure bottlenecks such as lack of roads and railways network and aircraft as limiting factors. Emission of local pollutants and carbon dioxide due to fuel consumption in transport have also been estimated. Future, the author projected the transport performance using cointegrating econometric models. The models project that passenger traffic in India is likely to grow at more than 8 % per year and freight traffic at more than 5 % per year during the period 1990-2021. This will increase the energy consumption and CO_2 emissions at equivalent rates. Further, the effects of various policy options aimed at reducing energy consumption and CO_2 emission have been analysed using a scenario approach. The scenario analysis shows that efficiency improvements can reduce future energy consumption and CO_2 emissions by 26%. If the modal split is promoted in favour of public transport modes (rail and public road transport), the author mentioned that about 45% reduction in energy requirements and CO_2 emissions is expected.

In a paper *CO_2 Emissions Reduction Strategies and Economic Development of India*, Murthy, N.S., Panda, M. and Parikh, K.S. have examined the consequences of alternative CO_2 emission reduction strategies on economic development and, in particular, the implications for the poor by empirically implementing an economy-wide model for India over a 35-year time horizon. A multi-sectoral, inter-temporal model in the activity analysis framework is used for this purpose. The model with specific technological alternatives, endogenous income distribution, truly dynamic behavior and covering the whole economy is an integrated top-down bottom-up model. The results showed that CO_2 emission reduction imposes costs in terms of lower GDP and higher poverty. Cumulative emission reduction targets are, however, preferable to annual reduction targets and that a dynamically optimum strategy can help reduce the burden of emission reductions. The scenarios involving compensation for the loss in welfare are not very encouraging as they require large capital inflows. Contrasted with these, scenarios involving tradable emission

[35] *"Yield curve estimation in India", funded by NSE WDM (Wholesale Debt Market) (February 1999).*

[36] *Transport Policy, 6(1), 35-45 (1999).*

quota gives India an incentive to be carbon efficient. It becomes a net seller for the first 25 years and because of reduction in carbon intensity it would demand less in later years when it becomes a net buyer. The results suggest that for India, and other developing countries, the window of opportunity to sell carbon quotas lie in the next two decades or so.

There are three main factors linking environmental policies and international trade. First, international trade affects both the extent and the pattern of production and consumption of goods in different countries. Thus, if these activities have detrimental effects on the environment of these countries where consumption and production take place, trade will affect the environment. Second, production and consumption activities in one country could affect the environment of other countries - as in the acid rain problems of Europe and North America. Such transboundry pollution problems could arise in the absence of any trade between countries. But if there is trade between the affected countries, then trade policy may be used as a weapon to reduce a country's exposure to transboundry pollution. This is related to the third factor: international trade policies may be used to enforce international environmental agreements, not necessarily with a view to directly affecting the pollution generated by that country but simply as part of a package of sanctions for failing to join or comply with an international agreement. The main debate on environmental policy making centers on the use of instruments of environmental policy for achieving trade-related objectives. In this paper, *Strategic Trade and its Impacts on Environment under Different Tariff Regimes*, Basudeb Guha-Khasnobis and Chiranjib Gupta showed that trade policies can also be used to achieve environmental objectives such as choice of greener technology. It is also showed that the Preferential Tariff Regime (PTR) has got an endogenous advantage in taking care of environmental externalities than the Most Favored Nation (MFN) regime although the debate about tradeoff with world welfare remains. In a strategic trade framework, with cost asymmetry (arising solely due to differences in technological cost or abatement cost), global pollution is reduced more under PTR than under MFN. This paper concludes that the low cost country faces a higher tariff rate than the high cost country under PTR and the tariff rate under MFN is the mean of the two PTR tariff rates. The low cost country always imposes a lower environmental tax than the high cost country under all regimes but under PTR, the low cost firm imposes a higher environmental tax rate than under MFN and vice versa for high cost firm. The absolute levels of global pollution as well as the total damage caused by the pollution are less under PTR than under MFN.

In a paper titled *Some Issues in Climate Change Decision Making*[37], Babu, P.G. had critically analyzed various issues related to the Climate Change decision problem. The paper was focused on ex-ante preventive measures such as hedging strategies, as well as ex post remedies such as liability and insurance. In addition, it explored the importance of economic concepts such as free riding and value of information, to the climate change debate.

Selection of greenhouse gas mitigation options, for consideration by a national government or by a funding agency, has to incorporate multiple criteria as they have

[37] *International Journal of Environment and Pollution, 9 (2-3) (1998).*

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different characteristics. In a paper, *Selection of appropriate greenhouse gas mitigation options*[38], Ramanathan, R. discussed some important criteria relevant to the selection of these options, and a multi-criteria methodology is suggested for making appropriate selection. The methodology, called the Analytic Hierarchy Process, is described using two illustrations.

Global negotiations on environmental issues are essentially multi-dimensional: there is no single factor that governs the concerns of all parties involved. In a paper titled *A Multi-Criteria Methodology to the Global Negotiations on Climate Change*[39] Ramanathan, R., had reviewed some of the studies in the literature that analyses the outcomes of these negotiations and estimate the costs and benefits for different parties in adopting any particular position in the process. In this paper, the author brought out the multi-dimensional nature of these negotiations. A multi-criteria methodology has been suggested to support these negotiations, and the author illustrated how it can be used to allocate the greenhouse gas reduction targets for a future year. The suggested methodology, which makes special reference to the multiplicative version of the Analytic Hierarchy Process, is shown to aid group decisions in negotiations.

Concern over environment is growing day by day all around the world. As a result every development activity is tested for its environmental sustainability. When the environmental degradation has already triggered, it is for sure a hard task to attain environmental sustainability. But countries like Brunie Darussalam are in a favourable position to promote sustainable development, since to date Brunei Darussalam has no major environmental pollution problem. However, it is essential that proper management of the quality of the environment is needed in view of population growth, urbanisation and economic development. Geetha, S., in her paper, *Green perception of Bruneians:evidence from a survey*[40], tried to explain the green perception of Brunie Population. The structure, pattern and distribution of environmental problems are influenced by complex inter-relationships among the factors - population, resources, development and environment. Development should be approached with due consideration of the other three factors. In the case of Brunei, population is not a significant factor. But it has very limited resources. Hence, careful and thorough analysis must be done to integrate all the three factors in the development planning of the country.

The attitude of more preference for economic growth over environmental conservation, if allowed to persist and develop, could endanger the environment in the short term and economy in the long term. There is a need for continued and directed action on improving the environmental awareness of the population. Geetha, S., found that even though the population is more inclined towards economic growth than environmental protection, when confronted with an obvious problem and a clear solution they demonstrated a willingness to pay for that measure. At least one significant matter is, environmental concern

[38] *Global Environmental Change: Human and Policy Dimensions, 9(3), 203-210 (1999).*

[39] *IEEE Transactions on Systems, Man and Cybernetics - Part C: Applications and Reviews, 28(4), pp: 541-548 (November 1998).*

[40] *Policy and Management review 2, 1-14 (1998).*

does exist and it is also up to the market to capitalise on that.

An interesting tool to incorporate the environmental concern in the system is environmental accounting. Environmental accounting is becoming increasingly popular across the world as a way of explicitly demonstrating the economy-environment nexus. With the poor green perception, Brunei was lacking in this type of study and Geetha, S. concentrated on arguing a case for such an exercise[41], indicating the data requirements and demonstrating the techniques for converting the environmental impacts into economic values.

From her study, *Accounting for the environment: Brunei case study,* it is evident there is little realisation in the system about the interdependency of economic activity and environmental impacts. Ministries set targets of growth and work in cubicles without realising how projects to maximise food production would cause deforestation. The author attempted, with her work, to prompt thinking in the direction of environmental realisation in growth process. The author's attempt in explaining venting/flaring could be used as a good starting point for the best use of the money ear-marked for environmental projects.

Wide spread pollution problems in various parts of the biosphere viz. air, waste and soil has caused severe concern in recent times. Gaps in various policies causes the pollution to aggravate and become a major problem for the mankind both at local as well as global level. In a paper, *GAPS IN ENVIRONMENTAL POLICY: A Focus on General and Air Pollution Problems*[42], Sharma, V.K. observed that environmentally unplanned economic development has resulted in various kinds of ecological damages in India. The state of country's environment is grim and it will deteriorate further if proper measures are not taken immediately. Although India is one of the countries having well defined environmental laws and regulations but there are several gaps in their implementation and enforcement. Most of the problems are due to lack of coordination among various authorities responsible for environmental management and poor public response. In his paper, he discussed some of the technical gaps in environmental policies related to general and air pollution problems in India and suggested some measures to narrow down these gaps so as to improve the environmental quality in the country.

Monitoring pollution is important for controlling it in relative term of intensity. Development of indices for various pollutant would help in comparing different clusters of localities in terms of pollution intensity. Sharma, V.K. in his paper titled *An Approach for Development of Air Quality Indices for Mumbai, India*[43] suggested a simple approach for developing air quality indices for different sites in an urban region of India. The database used for calculating these indices included various physical and chemical characteristics of suspended particulate matter such as particle size distribution, chemical (elemental) properties and parameters governing the acidity of precipitation. The indices were used for ranking of various sites in terms of air pollution and higher indices

[41] *Mimeo submitted to Universiti Brunei Darussalam (1998).*

[42] *Environmental Policy and Law, 28(2), 90-96 (1998).*

[43] *International Journal of Environment and Pollution, 11(2), 141-146 (1999).*

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indicated the more polluted site. The analysis showed that complex and large amount of data could be converted into easily understandable simple numbers. The indices thus, could serve as a ready reckoner for comparing different sites. The information could be used to design efficient air quality management programmes and frame appropriate abatement policies.

Environmental Problems of Coastal Areas in India[44], a book edited by Sharma, V.K. explains various environmental aspects of coastal areas covering all of the nine coastal states of India. This book was focussed on some important environmental and socio-economic issues emerging due to the activities resulting form socio-economic development of the region and suggested measures to tackle them.

A paper, *Plantation programmes through peoples participation: A case study from India*[45], by Reddy, B.S., Parikh, J.K. and Srinivasan, P.V., provides a framework for analysing land regeneration programmes combining financial, economic and environmental aspects as applied to a wood plantation programme undertaken by a Tree Grower's Cooperative Society (TGCS) established by the National Tree Growers's Cooperative Federation (NTGCF), Anand, India. A survey carried out in a place called Mallanahally TGCS, situated in the southern part of Karnataka state and benefit-cost ratios and internal rate of return worked out for various situations elicited information on the villagers' perceptions regarding benefits from and barriers to implementation of plantation programmes. The major costs of the plantation programme are incurred during the initial years. There are direct monetary benefits obtained through the sale of products such as fuelwood, grass, poles, etc. Intangible benefits such as cooperative education and empowerment of the rural poor were also visible. It has been observed in the case of Mallanahally TGCS that land regeneration on a cooperative basis by village households can be financially viable. Lack of awareness and initiative on the part of the village population might have prevented them previously from exploiting this financial opportunity. The NTGCF provided the initial support needed to start the process of land regeneration on a cooperative basis and developed awareness among the rural communities about the potential benefits they can reap through cooperation.

The benefit-cost ratios are high from the perspectives of both TGCS as well as the society as a whole. Thus, according to the authors, an important policy conclusion is that the economic and social benefits of plantation programmes can be significant as exemplified by the case of Mallanahally TGCS. However, this need not necessarily hold good in general. Finally, authors expressed an opinion that success of such programmes depends on the characteristics of the plantation, including soil quality as well as the social and cultural factors influencing the villagers.

Usually the plantation programmes are evaluated on the basis of economic feasibility, sustainability by long-run viability of the program and stakeholder participation in terms of their active interest in the program. In a paper, *Performance indicators of an afforestation programme in India*[46], Reddy, B.S. evaluated

[44] *Bookwell Publishers, Delhi, India (1999).*

[45] *Biomass and Bioenergy, Vol 35 (1999).*

[46] *Ellisson, B, Riemer P, Wokaun A (eds), Greenhouse gas control Technologies, Pergamon, NewYork, (1999).*

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the tree plantation programs run by Tree Growers Cooperative Societies (TGCS) which provide fuelwood for household use, fodder for livestock, various products such as timber, poles, gum, etc. and habitat for a multitude of animals and plant life. Economic feasibility was measured in terms of internal rate of return (IRR) on investment, sustainability by long- data obtained from six TGCS in India, two each from the states of Andhra Pradesh, Karnataka and Orissa, have been analysed to calculate costs and benefits. It is important to understand the initial conditions that lead to the success of the programs and the categorisation of their success. Field surveys were conducted to obtain data on the participatory role of the stakeholders which shows the level of people's participation in decision-making.

Given an exhaustible resource, whose stock size is unknown, a major normative resource management problem is to distribute this stock over different generations using a sound ethical rule which could be labeled as informal approach to intergenerational resource sharing. Babu, in his paper, *Informational Approach to Intergenerational Resources Sharing*[47], formulated the complex relationship between different generations in the framework of the classical optimization problem in agency theory. The model brings out the important role played by informational asymmetry in the intergenerational resource-sharing problem.

In light of declining trend in exhaustible resources, the importance for renewable source of energy is increasing day by day. Especially, in urban areas where the energy usage is significantly high in comparison to the rural, generation of energy out of waste, which is other wise a severe threat to the environment, is gaining importance. In his paper, *Energy for Urban Poor in Developing Countries - Potential Solutions from Waste Materials*[48], Reddy, B.S., studied the nature of the energy flows within Bangalore, the fastest growing metropolis in India, with reference to the potential for the use of waste. The poor uses biomass fuels such as fuelwood, charcoal and agriculture wastes (with efficiencies as low as 10%) and the rich uses Liquefied Petroleum Gas (LPG) and electricity (with efficiencies greater than 60%). Further, the author noticed a significant difference in fraction of income spent on energy by different income groups. Low-income households who use biomass spend as much as 17% while those with high income only spend 0.4%.

It is estimated that Bangalore produces 690 tons of garbage every day. Conversion of waste in to energy would not only reduce the load on the environment but also would augment the energy supply. The author estimated that using the fermentable matter there is a potential for 512 MWh of thermal energy or 114MWh of electrical energy and 340 tons of fertiliser. The author argues that customer, government and society as a whole could get benefited by the adoption of waste energy technologies.

Waste Paper Trade and Recycling in India[49], edited by Sharma, V.K., which was an outcome of a comprehensive case study of Mumbai (Bombay), India that was undertaken to investigate the economic, social and environmental impact of international trade of waste paper for recycling purposes between industrialized and developing countries

[47] *Energy Sources, 20 (4-5) (1998).*

[48] *Presented at workshop on "Urban Waste and Energy in Developing Countries", Intermediate Technology Group, Rugby, U.K. (February, 1999).*

[49] *Scientific Publishers, Jodhpur, India (1998).*

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attempted to throw some light on trading aspects of waste paper in India. Analysis of a Western approach vis-a-vis informal policy for waste paper recovery concluded that employment is maximum under informal policy measure and public response plays an important role in maintaining environmental quality.

The study further showed that income inequality is more under informal policy and without policy, public cost will increase continuously in the future. The net present value of the informal policy is found to be higher than that for the formal policy. Econometric study on input substitution in Indian paper industry suggests limited substitution possibilities between domestic and imported waste paper. Results from a static material balance flow model indicate that environmental impacts are less with increased trade and economically, paper sector in India benefits from free trade. Based upon the results of the study authors have suggested some policy recommendations that may enhance the efficiency of waste paper recycling in India.

3. Research Projects at IGIDR

IGIDR encourages faculty members to take up projects funded by sponsors as long as they are consistent with IGIDR's objectives. Such projects provide a market test, make our research more relevant and often provide an opportunity to collaborate with other researchers and institutions.

The list of projects is given below:

Project Name	Funding Organization
Policies for Industrial Competitiveness: What India can Learn from Asian Experience	International Development Research Centre, Singapore.
Structural Adjustment and Policy Reforms: Perspectives from International Experiences	International Centre for Economic Growth, USA.
International Trade of Non-Hazardous, Recyclable Waste between Industrialized and Developing Countries (India).	CREED, Netherlands and UK.
Environmental Externalities in Energy Investments: Developing Local Responses	Stockholm Environment Institute / SIDA, Sweden.
"India: Environmental Management Capacity Building Technical Assistance Project"	Ministry of Environment and Forests and World Bank.
Capacity 21: Capacity Building for Introduction of Environmental Economics into Decision Making for Sustainable Development	United Nations Development Programme, New York and New Delhi
Asia Region Perspective on Global Environmental Management: Trade/Economic Issues and Institutional Mechanisms	ESCAP, Bangkok
Financial Performance of State Electricity Boards	Finance Commission, New Delhi.
International Trade Competitiveness and Finance	International Development Research Centre.
Opportunities for Greenhouse Gas Mitigation in India	UNDP, New Delhi.
Online Position Monitoring System for Value at Risk System	National Stock Exchange , Mumbai.
Trade-Environment Linkages and the Design of Global Environmental Institutions	MacArthur Foundation, Chicago, USA
Reduction of Greenhouse Gases through Transportation Sector	Asian Institute of Technology / SIDA, Bangkok.

Of these, two projects are described in detail as they are major projects having involved substantial networking and provided us an opportunity to promote relevant research in the country.

Capacity 21 Project

Consensus building through capacity building - grassroot level approach for natural resource management

India's Capacity 21 Project initiated in December 1995, aims to build capacity for introduction of environmental economics into decision making at various levels viz. policy planners, decision makers, user ministries, regulators, national institutions, NGOs, and grassroot level stakeholders. The project targeted four areas of the environment viz. air quality, water quality, common property land resources and biodiversity (wetlands). Prof. Jyoti Parikh and Prof. Kirit Parikh are the national project coordinators for this project.

The project aimed at a comprehensive approach, which included all steps from grassroot level survey, analytical case studies to identify policy options, to consensus building exercises at regional, national and ministerial levels. To adequately capture the grassroot level concerns, IGIDR, the implementing agency for Capacity 21 project in India, networked with 11 collaborating institutions in four focal areas, mentioned above, which did micro level case studies. IGIDR played a coordinating role for these studies beginning from designing them and later monitoring them to ensure a coherent outcome. These studies provided a common framework so that their conclusions can be built into a comprehensive strategy.

The institutions involved were Bombay Natural History Society; Centre for Water Resource Development and Management; Institute of Economic Growth; Madras Institute of Development Studies; National Environmental Engineering Research Institute; National Law School of India University; Pragati Prathisthan; Kalyani University; North-Eastern Hill University; Sri Ramachandra Medical College; and AC Nielsen.

Salient findings from some of the case studies are given below.

Air Quality:

(1) The study on economic valuation of air quality degradation in National Capital Territory, Delhi estimated that the bulk of carbon monoxide and hydrocarbon emissions come from the transport sector. Power generation and industrial sectors contribute significantly to suspended particulate matter, oxides of sulphur and oxides of nitrogen emissions. Through economic valuation techniques, the study estimated that for 1995:

- Human health damage costs due to air pollution were Rs.1168 million per year
- Vegetation production losses were Rs.321 million per year
- Total avoidance cost to reduce these damages was Rs.1699 million per year
- One time willingness to pay for good air quality by residents of NCT, Delhi was significant at Rs.5090 million.

(2) Gender specific local studies on impact of indoor air pollution on health in the states of Maharashtra, West Bengal and Arunachal Pradesh reemphasized the fact that adult females, children below 5 years of age and senior citizens are the silent sufferers due to indoor air pollution.

- 0.41 to .57 million premature deaths per year are caused due to indoor air pollution
- For each death, there are about 6 cumulative person years of illness in various segments of the population

Water Quality:

(1) A study for economic valuation of water quality degradation in National Capital Territory, Delhi found that in NCT, Delhi water availability has decreased from 1847 million cubic meters (mcm) in 1992 to 1442 mcm in 1995. It is found that the city of New Delhi is drawing an annual economic benefit of Rs.21100 million from future generations through unsustainable ground water extraction. Through contingent valuation the study found that local people are willing to pay Rs.3456 million per year for pollution prevention and Rs.1700 million for improved water supply. The study suggested the construction of a dam upstream of Delhi and piped water supply as an alternative to ground water extraction. It is argued that this alternative water supply would be economically feasible and environmentally sustainable unlike the existing practices.

(2) The study on conflict resolution mechanisms in Bhavani river basin in Tamil Nadu found that inter and intra sectoral conflicts are growing in the basin due to increasing demand for the limited water resources. The main conflicts are among

- Old canal system farmers Vs New canal system farmers
- Farmers and domestic users Vs polluting industries
- Water diversion to neighboring water deficit Noyyal basin Vs native users

After extensive interactions with all stakeholders (farmers, industrialists, residents, water resource managers, pollution control authorities, NGOs, scientists) during regional workshops the study found that

- the local stakeholders prefer negotiated conflict resolutions to lengthy legal settlements
- There is a need felt for new institutional mechanisms for conflict resolution at river basin level.

The major mechanisms suggested for solving intra-sectoral conflicts are:

- administrative solutions; conflict resolution through user organizations and local government; and finally judicial solutions

For inter-sectoral conflict resolution

- institutions like river basin authority or negotiated solutions are suggested

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Land and Forest Resources:

Economic analysis of land and forest regeneration programmes and studies were carried out for different scenarios of ownership. One valuation study was also carried out by IGIDR.

(1) Regeneration of common property land resources (CPLRs) through Tree Growers' Cooperatives (TGCs): Six case studies in 3 different states, revealed that regeneration of CPLRs through tree growers' cooperatives are *financially viable, economically feasible, environmentally sound and socially acceptable* as benefit cost ratios are more than 2 for all the six case studies. Carbon sequestration for 60 years life cycle ranges from 48 tonnes per ha to 108 tonnes per ha on the basis of type of species mix, age distribution, soil, and climatic factors and surface level biomass. The distributions of benefits of plantation products were such that it contributes towards social equity. The increase in the income of landless and poor was 22 per cent as against 2 per cent for high-income group people.

(2) Regeneration of commonly pooled private wastelands, panchayat land and degraded forest lands through Chakriya Vikas Pranali (CVP): It is based on Sukhomajri experiment in Haryana where profits from one investment cycle are ploughed back as capital in the next cycle. Well-planned agro-forestry programmes, based on the capability of the land, were carried out by village societies formed. The study reveals that these societies are able to bring socio-economic and environmental prosperity in the region.

(3) Valuation of forests in Maharashtra State: 14.3 per cent of Maharashtra State is covered by forests of varying quality. The 43,859 sq km of land classified as forests by Forest Survey of India contain a growing stock of 225,554 thousand cubic meters. In 1983, the value of timber, fuel wood, and non timber forest produce was approximately Rs.35,000 million, against an estimate of Rs.14,000 million reported in the conventional System of National Accounts (SNA). According to IGIDR estimates forests contribute more to the Net State Domestic Product (NSDP) than previously expected. They contribute some 3.56 percent as against earlier estimates of 1.46 per cent NSDP.

Biodiversity (Wetlands)

(1) Economic valuation of Keoladeo National Park (a Ramsar site located at Bharatpur, Rajasthan) shows the following:

- Wetlands are complex ecosystems and perform multiple functions
- The park generates a revenue of Rs.2.4 million per year, mostly from tourism
- Still, the government spends Rs:3.7 million per year on maintenance
- Most stakeholders recognize the ecological and livelihood functions of the park
- Stakeholders who do not have a direct interest in the park are willing to make a onetime payment of Rs.250 to Rs.400 for the conservation of the park

The study recommends substantial increase in the entry fee to generate more revenue, and visitors - both Indian and foreign - are willing.

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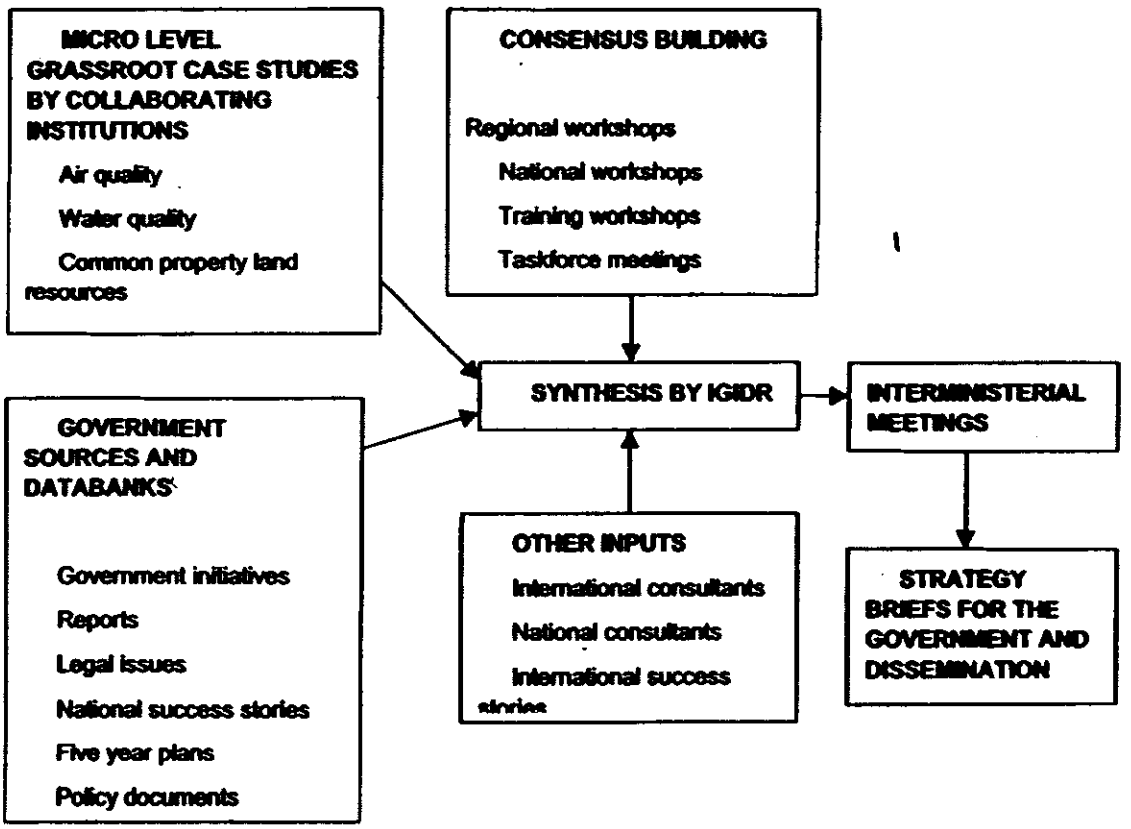
The collaborating institutions incorporated the local community's perceptions into their reports. These reports are synthesized by IGIDR with inputs from national and international experiences, existing government policies, focal area specific task forces, steering committee of the project, national and international experts and other inputs. At each level of synthesis the various stakeholder groups are involved through regional and national workshops, consultative meetings, brainstorming sessions, international workshops and interministerial meetings. All the meetings attracted senior level government officials and participants from other stakeholder groups. Twelve consensus and capacity building activities were conducted during 1998 and early 1999, as follows:

- Five regional workshops
- Two national workshops
- One consultative meeting
- One international workshop on ***environmental governance for sustainable development*** held at IGIDR, attracted participants from 13 countries. Union minister for environment and forests inaugurated the workshop. Participants from environment ministry and Planning Commission actively contributed to the proceedings.
- **Two interministerial meetings** were held to discuss water and wetland strategy briefs. The Ministry of Environment and Forests, Government of India actively promoted these meetings. The interministerial meeting on water quality management strategy attracted 31 participants from 16 stakeholder ministries and institutions. The interministerial meeting on wetland strategy management was participated by 27 representatives from stakeholder ministries and institutions. This synthesis phase coordinated by IGIDR garnered support for the ideas (policy/strategy recommendations) generated during the project. Synthesis of the case studies with the consensus building activities resulted in documentation of ideas and policies in the form of focal area specific strategy briefs for further dissemination. Linkages for strategy brief are graphically illustrated in Figure 1.

Efforts are underway to develop nation wide strategies for these four focal areas, which would be completed by the end of 1999.

Figure 1. LINKAGES FOR STRATEGY BRIEF DEVELOPMENT



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India: Environmental Management Capacity Building-Technical Assistance Project

IGIDR is selected by the Ministry of Environment and Forests, to be a core unit for the World Bank Aided "India: Environmental Management Capacity Building-Technical Assistance Project". This project aims to develop capacity for environmental economics in India. Four committees are set up for that purpose viz., to support research, training, curriculum development and fellowships. Professor Jyoti K. Parikh is the chairperson of the Environmental Economics Research Committee. This committee has $1.5 million to distribute for the research projects in the country over 1998-2002.

Ensuring Quality Research

In order to ensure quality, the submitted projects went through two reviews, one internal and one external expert selected proposals. A project development workshop is arranged where the project investigators (PI) present their proposals so as to receive feed-back from EERC members, experts and other PI. Subsequently, project review workshops are held to discuss after six months. International experts also comment on these. After awarding the projects, several reviews take place to ensure quality and for mid-course conventions where necessary "cluster manager" concept is introduced to get synergy from the cluster of projects.

Setting the priorities for research in Environmental Economics and co-ordinating with other core institutions

To develop a coherent research programme, the EERC identified the following priority themes

- Environmental and Natural Resource Management
- Environmental Pollution and Policy Design for Control
- Economics of Green Initiatives
- Role of Institutions in Environmental Management
- Methodology for Accounting, Valuation and Impact Assessment
- Linkages between Poverty, Development and Environment
- International Issues
- Macroeconomic Policies and Structural Adjustments
- Indigenous Technical Knowledge (ITK) and Stakeholders Participation in Environmental Management.

Status of funding

Upto March 1999, 197 project proposals were received through advertisement. In order to develop a coherent programme and develop network among researchers by project development workshop were organised. EERC approved 24 proposals for sanction and funding. These 24 proposals belong to the

area of land resources (3), natural resources management (1), bio-diversity (3), technologies (2), water pollution (3), wetlands (3), environmental policy (3), fisheries (2), forestry (2) and health (2).

The universities such as Jadavpur University, Bharadhidasan University, Purvanchal University, Rajendra Agricultural University, S.R.T.M. University, Himachal Pradesh University, University of Agricultural Sciences, Mangalore Fisheries College, Saurashtra University, Andhra University, Bengal Engineering College (Deemed University) as well as the research organisations such as ISI, NITTIE, MIDS, ISDEC, Ramchandra Medical College and Research Institute and IIFM were the recipients of the first cohort of 24 proposals.

Monitoring the progress of sponsored projects and recommend norms for publication of reports (books) are also the responsibility of Environmental Economic Research Committee.

4. Teaching Programme

Training of future analysts with a multi-disciplinary perspective is one way of multiplying the effectiveness of the Institute in meeting its objectives. The Institute had therefore initiated a P.G. Diploma/Ph.D. programme in 1990. Since then, around 20 students are selected every year through national advertisement and an aptitude test followed by an interview. The Institute was recognized as a deemed university in 1995. The P.G. Diploma programme was upgraded to an M.Phil. programme since 1996-97. The total number of students both for M.Phil and Ph.D. was 58 as on March 31, 1999.

Both the M.Phil. and Ph.D. programs include extensive course work for two years followed by a dissertation.

The Ph.D. programme is designed to create professionals who are capable of conducting policy analysis relating to national and global developmental issues in a quantitative and inter-disciplinary manner. While a multi-disciplinary approach is encouraged, the programme lays emphasis on economics to provide an integrating framework within which various development issues can be addressed. The students at the Institute are offered courses shown in the table.

Courses	Instructors
1st Year - Semester 1 – Compulsory Courses	
Microeconomics I	Shikha Jha
Macroeconomics I	Veena Mishra
Econometrics I	Ajay Shah
Optimization Theory	S. Geetha R.Ramanathan
Issues in Development Policies	Kirit Parikh R. Nagaraj
1st Year – Semester II – Compulsory Courses	
Microeconomics II	Ajit Ranade P.G. Babu
Macroeconomics II	Raghbendra Jha
Development Theory	V.K. Ramachandra Ashima Goyal
Econometrics II	Subrata Sarkar
Energy and Environment	Jyoti K. Parikh Anjana Das Manoj Panda
2nd Year - Optional Courses	
Monetary Economics	Veena Mishra
Time Series Analysis	R. Krishnan
Public Economics	Raghbendra Jha
Games and Information	P.G. Babu
Applied General Equilibrium Models	Manoj Panda A.Ganesh-Kumar
Theory of Institutions	Jayati Sarkar
Industrial Organisation	Sougata Poddar
Transport and Energy Economics	R. Ramanathan

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5. Conferences / Workshops

5.1 Seminars/Workshops Held at IGIDR

A summer workshop on "India: The Evolving Financial System – 1998", June 25-30, 1998.

The Second National Conference on Mathematical Modelling and Computer Simulation, August 6-7, 1998.

A workshop on "The Structure of Indian Industry", November 20-21, 1998.

A conference on "Money and Finance in the Indian Economy", December 2-4, 1998.

An International workshop on "Capacity Building in Environmental Governance for Sustainable Development" under the auspices of Capacity 21 Project, December 8-10, 1998.

A seminar on "Environmental Management" for students from SNDT College", under the auspices of Capacity 21 Project, January 18, 1999.

Technical Advisory Committee Meeting for Rural Pollution and Health Impact, March 4, 1999.

A workshop for project development at EERC on "India: Environmental Management Capacity Building" under the auspices of the EMCaB project, March 11-13, 1999.

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5.2 Seminars/Workshops Attended by Faculty and Students

Parikh Kirit S.

Panelist for the discussion on "Higher Education and Sustainable Human Development" at the UNESCO World Conference on Higher Education: Higher Education in the 21st Century – Vision and Action, Paris, October 5-9, 1998.

Chaired a session at the 5th Biennial Conference on Ecological Economics, organised by the International Society for Ecological Economics, and hosted by the University of Chile in Santiago, November 15-19, 1998.

Participated in the United Nations Framework Convention on Climate Change (UNFCC) – Conference of Parties (COP) 4 meeting held in Buenos Aires, November 8 and 15, 1998.

Presented a paper on the "Second Generation Reforms in a Changing World" at the conference on "Growth, Governance and Empowerment: The Future of India's Economy", organised by the University of California at Santa Cruz, California, November 19-21, 1998.

Participated in the Scientific Advisory Panel meeting of the UNEP Collaborating Centre on Energy and Environment, Copenhagen, December 14, 1998.

Participated in the Panel Discussion as a speaker on the theme *Current Economic Scenario*, at the Council of Chartered Financial Analysts - Convention 1998, at Hyderabad, December 18, 1998.

Delivered the M.H. Gopal Memorial Lecture "Infrastructure, Public Goods and Markets", at the Indian Economic Association's 81st Annual Conference, Bangalore, December 26-28, 1998.

Participated in the debate on *Current Economic Scene: What should we do?* at the Indian Merchant's Chamber, Mumbai, February 3, 1999.

Delivered the Third Tirath Gupta Memorial Lecture "Agriculture Policy at the Turn of the Millennium" at the Indian Institute of Management, Ahmedabad, February 11, 1999.

Delivered the lecture on "Indian Economy: Challenges of the 21st Century" under the auspices of Maharashtra Economic Development Council at the Y.B. Chavan Centre, Nariman Point, Mumbai, February 13, 1999.

Participated as a panelist in the international conference on "Sustainable Future of the Global System" at the Institute of Advanced Studies, United Nations University, Tokyo, February 23-24, 1999.

Participated in a workshop on "Environmental Governance" organized by IGES in Tokyo, March 16-20, 1999.

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Das Anjana

Attended a workshop on "Analysis of selected technical options for mitigating environmental emissions from the urban transport system in selected Asian countries" at the Asian Institute of Technology, Bangkok, October 15-17, 1998.

Attended a workshop on "Integrated Assessment Models (IAMS) and climate change policy analysis for Asia" at the Indian Institute of Management, Ahmedabad, February 1-4, 1999.

Ganesh-Kumar A.

Presented a paper "Impact of a hike in the administered prices of petroleum products: analysis using an applied general equilibrium model for India" (with Gangadha Darbha and Kirit S. Parikh) at the second national conference on "Mathematical modelling and computer simulation" at the Indira Gandhi Institute of Development Research, Mumbai, August 6-7, 1998.

Goyal Ashima

Presented a paper, "Modelling inflation, exchange and interest rates" at the CIDA-ICICI workshop on "Financial sector modelling" at NCAER, New Delhi, August 24, 1998.

Presented a paper, "Real and financial sector interaction under liberalization in an open developing economy" (with Shridhar Dash) at the IGIDR conference on Money and Finance, December 2-4, 1998.

Presented a paper, "The impact of structure and openness on the causal ordering of inflation, exchange and interest rates in India" at the NCAER-Ford Foundation workshop on "New Directions for the Indian Economy", at the Gokhale Institute of Politics and Economics, Pune, December 4-6, 1998.

Presented a paper, "Signaling and the acceptability of foreign direct investment" at the India and South Asia Chapter of the Econometric Society, Indian Statistical Institute, New Delhi, December 15-17, 1998.

Jha Raghbendra

Delivered a talk at MacArthur Project Conference and Conference on 50th Anniversary of GATT, University of Warwick, UK., July 1998.

Attended and delivered a talk ESRC meeting at the University of Reading, U.K., September 1998.

Organized the First conference on money and finance in the Indian economy, December 2-4, 1998.

Presented two papers at the Money and Finance Conference, IGIDR, 1998.

Delivered lectures at the University of Mumbai and the Gokhale Institute of Economics, Pune, 1998-99.

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Jha Shikha

Presented a paper "On reforming the public distribution system" (with P.V. Srinivasan) at the Symposium on Reforming India's Social Sectors: Strategies and Prospects, organized by the University of Bombay, UN and NABARD and held at the IMC, Mumbai, April 16-17, 1998.

Presented a paper "Food inventory policies under liberalised trade" (with P.V. Srinivasan) at the Tenth International Symposium on Inventories, Budapest, Hungary, August 23–28, 1998.

Delivered lectures on "Tax evasion and black income" at the Refresher Course in "Microeconomic Issues in Industrial Economics and Public Finance" for teachers from Universities and Colleges in Maharashtra, held at the University of Bombay, December 12, 1998.

Presented a paper, "Liberalized trade and food price stability: the case of rice and wheat in India" (with P.V. Srinivasan) at the 1998 India and Southeast Asia Meeting of the Econometric Society, New Delhi, December 15-17, 1998.

Presented a paper, "Fiscal effects of foreign aid: a case sutdy of India" (with Vinaya Swaroop) at the 1998 India and Southeast Asia Meeting of the Econometric society, New Delhi, December 15-17, 1998.

Attended a workshop on Technical assistance project for economic reform, organized by the World Bank and Ministry of Finance, Government of India, New Delhi, February 15, 1999.

Mishra Veena

Presented a paper at the Asian exports: past trends, furture prospects, organized by the ADB at its headquarters in Manila, July 30 - August 2, 1998.

Attended a conference on The new trade agenda, the WTO and India', organized jointly by the Economic Development Institute, World Bank and ICRIER, at Delhi, December 7 - 11, 1998.

Panda Manoj

Attended a seminar on "Growth with Equity: Experience of Asian Countries" at UN-ESCAP, Bangkok, June 1998.

Parikh Jyoti K.

Presented a paper "Linking Technology Transfer with Clean Development Mechanism (CDM) A Developing Country Perspective" at a conference "From Kyoto to Buenos Aires: Technology Transfer and Emissions Trading", Columbia University, New York, USA, April 24-26, 1998.

Presented wetland strategy for India at a consultative workshop on "Wetland Strategy and Action Plan" at the WWF, Delhi, May 7, 1998.

Inaugurated the regional workshop on "Water quality management" organized by CWRDM at Kozhikode, Kerala, May 19-20, 1998.

Presented Air pollution strategy at a national workshop on "Sustainable air quality management – economic considerations" at the National Environmental Engineering Research Institute (NEERI), Nagpur, June 1-2, 1998.

Gave a talk on "Global Environment and Kyoto Convention on Climate Change: Implications for Industrial Development" at the Indian Merchants' Chambers, Economic Research and Training Foundation, Mumbai, July 10, 1998.

Participated in a conference on "2nd Power Pooling '98" at the Marriott Hotel, Singapore, September 8-9, 1998.

Given a special lecture on "Biodiversity and Environmental Economics" at the workshop to produce a draft strategy to improve and formalise BNHS working relations with regional and local bird conservation organizations held at the BNHS Conservation Education Centre, Mumbai September 16, 1998.

Attended the first meeting of the Expert Advisory Committee (EAC), State Government Action Programme, Gujarat Ecology Commission, September 18-19, 1998.

Participated in a workshop for formulating a proposal on the 2nd phase of the Asian Regional Research Programme in Energy, Environment and Climate (ARRPEEC II) at the AIT, Thailand, October 15-17, 1998.

Participated in a two-day seminar on "macroeconomic change, poverty and the environment" by WWF's Macroeconomics Program Office at Copenhagen hosted by the Danish Ministry of Foreign Affairs, October 26-27, 1998.

Participated in the ASC Training programme on teaching environmental law in Universities on the topic "Role of Science, Technology and Economic Approaches in Teaching Environmental Law" at the National Law School of India University, Bangalore, October 30, 1998.

Attended the COP4 (Conference of Parties) on climate change in Buenos Aires November 2-13, 1998.

Presented two papers "Performance Evaluation and Sustainability of Afforestation Programmes in India" (along with S., Reddy) and "Socio-economic Development and Demand for Timber Products: A Panel Data Analysis" (along with Haripriya, G.S.) at the ISEE meeting at Chile, 1998.

Attended a meeting of the principal collaborators of research project "Implementation of the Climate Change Convention: Case studies from Asia (Woodshole Research Centre), Bangkok, Thailand, January 11-12, 1999.

Attended the advisory committee meeting at the Gujarat Ecology Commission, Baroda, Gujarat, January 16, 1999.

Attended the advisory committee meeting of the Central Electricity Regulatory Commission (CERC), Delhi, January 21-22, 1999.

Chaired a session at a workshop on "Evaluating the environmental laws and proposals for reforms" at the National Law School of India, Bangalore, January 30-31, 1999.

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Attended the international senior executive seminar on "Renewable energy: education and training", at Asian Institute of Technology, Thailand, February 25-26, 1999.

Delivered a talk on "Climate change negotiations and India's concerns" at a training course in environmental economics at the Institute of Economic Growth, New Delhi, March 8, 1999.

Delivered a talk on "Environmental Governance in India", at the international workshop on environmental governance in Asia, Japan, March 18-19, 1999.

Delivered a talk on "Climate change" at a training course organized by the National Law School, Mangalore, March 26-28, 1999.

Ramanathan R.

Presented a paper "Urban transport in India: some issues and suggestions", at the First Asia pacific conference on transportation and the environment, Singapore, May 13-15, 1998.

Presented a paper "Gasoline consumption in India: an econometric analysis", (with S. Geetha) at the first Asia pacific conference on transportation and the environment, Singapore, May 13-15, 1998.

Presented a paper "Biofuels scenarios for rural India and their greenhouse gas implications", (with Jyoti K. Parikh) at the Second all-India conference on mathematical modelling and computer simulation at the Indira Gandhi Institute of Development Research, Mumbai, August 6-7, 1998.

Organized a conference on "Second all-India conference on mathematical modelling and computer simulation" at the Indira Gandhi Institute of Development Research, Mumbai, August 6-7, 1998.

Reddy Sudhakara B.

Presented a paper "Optimal Carbon balances through Afforestation Programmes: Case studies from India", at the Fourth International Conference on GHG Technologies, Interlaken, Switzerland, August 30 – September 2, 1998.

Presented a paper "Evolution of Rural Institutions for Land Regeneration", International Conference on Environmental Governance", IGIDR, India, November 8-10, 1998.

Chaired a session on "Environmental Impact Assessment", at the Third International Conference on Ecobalance, Tsukuba University, Tokyo, Japan, November 25-27, 1998.

Presented a paper "Sustainable Tree Plantation Programmes through Rural Cooperatives", (along with Jyoti K. Parikh) at the Third Conference on Ecobalance, Tsukuba University, Japan, November 25-27, 1998.

Presented a paper "Energy for Urban Poor in Developing Countries - Potential Solutions from Waste Materials", at a Workshop on "Urban Waste and Energy in Developing Countries", Intermediate Technology Group, Rugby, U.K, February 24, 1999.

Roy Tirthankar

Chaired a session on 'Markets and the Development Process in South Asia' (jointly with Dr. J. Banaji) at the 12th International Economic History Congress, Madrid, August 1998.

Delivered a talk on "Growth and recession in small-scale industry in India: The Tamil Nadu powerlooms", at the Indian Institutes of Management, Ahmedabad and Calcutta, January-February 1999.

Sarkar Subrata

Attended a conference on India and South-East Asia Meeting of the Econometric Society, ISI, New Delhi, December 1998.

Shah Ajay

Gave a talk on "The impact of convertibility upon India's fund industry" at Invest India's "Fund Management in India" conference, Bombay, April 1998.

Participated in the UNDP roundtable discussion of "Responses to Discussion Paper 12: "International financial liberalization: Implications for development" by John Eatwell", Delhi, April 1998.

Chaired the session on Securities Lending in India for the Invest India's "Securities Industry Summit", Bombay, May 1998.

Participated in the IGIDR roundtable discussion of "Budget 1998", Bombay, June 1998.

Organised the 5-day IGIDR workshop on "India's emerging financial system" and gave a talk on "Introduction to India's Financial System", "Securities Markets", "Principles of Market Design", "Asset Pricing", "Introduction to derivatives", "Hedging using Futures", "Value at Risk", at IGIDR, Mumbai, July 1998.

Gave a talk on "Hedging using index derivatives" at a conference on "Derivatives for mutual funds" at the UTI Institute of Capital Markets, Bombay, July 1998.

Delivered a talk on NSE "Index futures and options", Bombay, July 1998.

Gave talks on "The idea of risk management", "Value at Risk" and "Derivatives in India: The State of the Art" at the ICM Worldwide's "Workshop on Risk Management", Bombay, Delhi and Bangalore in July, October, December 1998, respectively.

Gave a talk on "Index Futures" at the Institute of Company Secretaries of India, Delhi, August 1998.

Gave a talk on "Improved methods for obtaining information from distributed dealer markets" at the Reserve Bank of India presentation, Bombay, August 1998.

Gave a talk on "Derivatives in India: The State of the Art" at a seminar on "Currency Derivatives", Narsee Monjee Institute of Management Studies, Bombay, August 1998.

Gave a talk on "Interplay of IT and Finance" at the Department of Computer Science and Engineering, IIT-Bombay, August 1998.

Gave a talk "Value at Risk" at HDFC Bank, Bombay, September 1998.

Gave a talk on "The transformation of India's equity market", at Indian Institute of Administration, Mussorie, September 1998.

Gave a talk on "Reference rates for government debt", "Repurchase agreements" at the workshop on Invest India's The future of debt markets in India, Bombay, September 1998.

Chaired all sessions at the Invest India's 2nd Annual conference on Derivatives, Bombay, November 1998.

Gave a talk at "Project OASIS (Old Age Social and Income Security) seminar" at the Ministry of Social Justice and Empowerment, GOI, Goa, November 1998.

Taught Equity Derivatives at ICICI Training Institute, Pune, August 1998 and December 1998.

Gave a talk "Improved methods for obtaining information from distributed dealer markets" at IGIDR "Money and Finance Conference", Bombay, December 1998.

Gave a talk "Information processing by the Indian stock market about the real economy" at a Conference on Money and Finance at the Gokhale Institute, Pune, December 1998.

Invited to speak on "derivatives markets in India" in a conference at the Society for Capital Market Research and Development "Financial Markets and Institutions: Development and Reforms", Bombay, January 1999.

Gave a talk "Designing interest rate derivatives in India" at the NSE Debt Committee seminar, Bombay, February 1999.

Chaired a session on Repos in a conference on "Invest India's "Debt market", Bombay, February 1999.

Gave a talk "Issues in pension system design" at the Indian Merchants Chamber "Seminar on Pension Reforms", Bombay, February 1999.

Gave a talk "Limit orders and market orders: when and why" in a seminar on "Advances in Indian Capital Markets", at the Goa University, Goa, March 1999.

Participated in IGIDR "Seminar on Budget", Bombay, March 1999.

Gave a talk "Derivatives in India: The State of the Art" at a "Seminar on Currency Derivatives" at Narsee Monjee Institute of Management Studies, Bombay, March 1999.

Invited as a speaker for a "Seminar on Budget" at the IIT Bombay Alumni Association, Bombay, March 1999.

Gave a talk "The index futures market" at the Stock Holding Corporation of India, May 1998.

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Sharma Vinod K.

Presented a paper in the International Symposium on LCA in the Asia-Pacific region, Sponsored by UNEP, NEDO and MITI, organised by the National Institute for Resources and Environment, Tsukuba, Nov. 24-27, 1998.

Presented a paper in a Refresher Course on Topics of Environment, Ergonomics, Consumer Services and Computer Aided Design, for University Teachers from all over India, sponsored by the University Grants Commission, December 1-24, 1998.

Participated in the Fourth International Workshop on Asian-Pacific Integrated Model, Tsukuba, March 16-22, 1999.

Organised a Three Week's Refresher Course on Topics of Environment, Ergonomics, Consumer Services and Computer Aided Design, for University Teachers from all over India, sponsored by the University Grants Commission, December 1-24, 1998.

Organised a Workshop on "Integrated Solid Waste Management", sponsored by the International Development Research Centre, Canada, SNDT Women's University, August 7-8, 1998.

Srinivasan P.V.

Delivered lectures on "Issues in pricing of telecommunication services" at the Refresher course in "Microeconomic issues in industrial economics and public finance" for teachers from universities and colleges in Maharashtra, held at the University of Bombay, December 11, 1998.

Presented a paper "Liberalized trade and food price stability: the case of rice and wheat in India" (with Shikha Jha) at the 1998 India and Southeast Asia Meeting of the Econometric Society, New Delhi, December 15-17, 1998.

Suryanarayana M.H.

Presented a paper "Food security in India: issues and policy options", at the workshop on sustainable agriculture and food security under liberalisation in Gujarat, ACTIONAID and Unnati, Gandhi Labour Institute, Ahmedabad, April 6, 1998.

Attended a symposium on "Reforming India's social sectors: strategies and prospects", Department of Economics, University of Mumbai jointly with Office of the UN Resident Coordinator in India, New Delhi and National Bank for Agriculture and Rural Development, Mumbai, April 16-17, 1998.

Presented reports on "Poverty reduction in India: estimates and hard facts" and "Macro policies for poverty reduction" at the International symposium on good governance for poverty reduction during China's transition sponsored by UNDP and China Institute for Reform and Development, Haikou, China, May 6-7, 1998.

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Presented a keynote lecture on "Food security in India: problems, prospects and policies" to the session "Food security and entitlement" at the VIII national conference of women studies: survival and sovereignty: challenges to women's studies, May 31, 1998.

Chaired a session on "Food security and entitlement" at the VIII national conference of women studies: survival and sovereignty: challenges to women's studies, May 31, 1998.

Participated in a panel discussion and spoke on "Environment and economic issues" at the workshop on Integrated solid waste management, SNDT University, Juhu Campus, Mumbai, August 7, 1998.

Delivered a lecture course on `Growth and human development', and conducted a session on "Social security: concepts and issues" at St. Xavier's College, Mumbai, September 10, 1998.

Presented a paper "Government subsidies in Maharastra: size, pattern and trend", at the National seminar on "State Government Subsidies", organised by the Indian Council of Social Science Research and Institute for Social and Economic Change at Institute for Social and Economic Change, Bangalore, November 9 - 11, 1998.

Member, Panel of judges, Convention at the VI Annual Economic Conevention on `Development and Environment', Jain Hind College, Basantsingh Institute of Science & J. T. Lalvani College of Commerce, Mumbai, November 27-28, 1998.

Swaminathan Madhura

Gave seminar presentations at the Asia Research Centre, London School of Economics, May 1998.

Gave seminar presentations at the Institute for Social Studies at The Hague, June 1998.

Attended a workshop on "Women workers in the informal sector", Colombo, January 27-31, 1999.

Thomas Susan

Gave the dinner speech introducing Leo Melamed at the Invest India's "Fund Management in India", April 1998.

Attended the UNDP roundtable discussion of "Responses to Discussion Paper 12: International financial liberalization: Implications for development" by John Eatwell", Delhi, April 1998.

Gave talks on "Futures and options" at the Jawaharlal Nehru Institute of Development Banking, June 1998.

Delivered a talk at UTI-ICM "Statistics for volatility forecasting", June 1998, July 1998, September 1998.

Delivered a talk at NSE "Index Futures and options in India", July 1998.

Gave a talks "Volatility forecasting for three Indian markets", "Hedging using index derivatives", "Value at Risk" at ICM Worldwide's "Workshop on Risk Management", Bombay July 1998, Delhi October 1998, Bangalore December 1998.

Gave a talk on "Probability and Statistics in Finance", "Volatility forecasting in Indian stock markets" at a "Seminar on Currency Derivatives" at the Narsee Monjee Institute of Management Studies, Bombay, July 1998.

Delivered a talk on Equity Derivatives at ICICI Training Institute, Poona, Aug 1998, Dec 1998.

Delivered a talk "Volatility forecasting for Indian financial markets", at HDFC Bank September 1998.

Organised the 5-day IGIDR workshop on "India's emerging financial system" and gave talks on "Introduction to Statistics", "Introduction to Time-Series Analysis", "Market Efficiency", "Fixed Income Analytics", "The cost of Transacting", "Futures pricing and arbitrage", "Introduction to Options".

Presented a paper on "Investment strategies for multi–decade horizons" at the "Project OASIS (Old Age Social and Income Security) seminar" for the Ministry of Social Justice and Empowerment, GOI, Goa, November 1998.

Presented a paper "Natural experiments with price limits" at "Money and Finance Conference", IGIDR, Mumbai, December 1998.

Delivered a talk on talks "Volatility forecasting for three Indian markets", "Value at Risk" at A. V. Rajwade & Co. "Executive Development Program on Forex Market, International Finance and Risk Management", November 1998, December 1998.

Attended a Conference on Money and Finance at the Gokhale Institute Pune, December 1998.

Delivered a talk on "Financial markets and their progress in India" at Indian Institute of Technology, Bombay, TechFest '99, January 1999.

Gave a talk on "Volatility in three Indian financial markets" at "Advances in Indian Capital Markets", Goa University, Goa, March 1999.

Organised "Yield Curve Analytics" by Prof. Marti Subrahmanyam, IGIDR, March 1999.

Vaidya Rajendra R.

Attended the Final Workshop of the International Competitiveness, Trade and Finance project held at the Trade and Industrial Policy Secretariat, Johannesburg, during November 30 – December 2, 1998.

Research Staff, Capacity-21 Project:

Pandey Vijaylaxmi

Participated in the International Human Dimension Programme on Climate Change for IHDP/START International Human Dimensions Workshop at Bonn, Germany, August 8-21, 1998.

Participated in the International Conference on "Environmental Governance" at IGIDR, Mumbai, December 8-10, 1998.

Organised a seminar on "Environmental Management" for postgraduate students at SNDT College, Mumbai, January 19, 1999.

Participated in National workshop on " Evaluation of Environmental Laws and Proposals for Reforms" held at NLSIU at Bangalore January 30 –31, 1999.

Participated in a Technical Advisory Committee meeting held for Rural Pollution and Health Impacts at IGIDR, Mumbai, March 4, 1999.

Raghuram Tata L.

Presented a paper on "water quality management: Issues and challenges" at the regional workshop on water quality management, CWRDM, Kozikode, May 19-20, 1998.

Presented an invited paper "environmental governance issues in water quality management" at the national conference on Synergisation of water management- expanding the scope of private-public-people's participation, organized by Confederation of Indian Industries, New Delhi, August 30-31, 1998.

Presented a paper on "freshwater quality management Strategies for India" at international workshop on Environmental Governance for Sustainable Development, IGIDR, Mumbai, December 8-10, 1998.

Students:

Anoop Singh

Attended the International Conference on Sustainable Future of the Global System, UNU/IAS, Tokyo, Japan, February 23-24, 1999.

Presented a seminar on Issues in Energy & Environmental Policy in India: Inter-fuel Substitution, Energy Efficiency, Energy Demand and CO_2 Emissions Reduction Options in Indian Industry, UNU/IAS, Tokyo, March 9, 1999.

Haripriya G.S.

Presented a paper "Carbon Storage in India's Wood Products" at the International Conference on Tropical forests and Climate change, Manila, Philippines, October 19–22, 1998.

Presented a paper "Integrating Forest Accounts into the System of National Accounts in India" (along with Jyoti K. Parikh) at the Fifth Biennial meeting of the International Society for Ecological Economics, Santiago, Chile, November 16–19, 1998.

Awarded All India Management Association – Bangalore Management Association (AIMA-BMA) Trophy, a citation and a cash prize for the Ph.D. thesis 'Environmental Accounting, Carbon Sequestration Potential and Policies for Sustainable Management of Forests' being adjudged as the Second Best Contemporary Thesis of the year at the National Doctoral Consortium, Indian Institute of Sciences (IISC) Bangalore, November 24–26, 1998.

Presented the thesis "Environmental Accounting, Carbon Sequestration Potential and Policies for Sustainable Management of Forests", at the National Doctoral Consortium of Management, at Indian Institute of Sciences (IISC), Bangalore, November 24–26, 1998.

Participated as a resource person at the Management Development Program (MDP) and gave training to the Indian Forest Service officers on "Environmental Accounting" at Indian Institute of Management (IIM), Lucknow, January 4–8, 1999.

Vardhana Saple

Presented a paper "Motives for Product Market Diversification: A study of the Indian Corporate Sector", at the conference on Recent Advances in Quantitative Methods, application to economic problems, held at The Indian Statistical Institute, Bangalore, December, 1998.

6. Research Publications of IGIDR

Books and Articles

Jyoti K. Parikh and Kirit S. Parikh, "Accounting and valuation of environment", Vol. 2, Case Studies from the ESCAP Region, UN-ESCAP, New York, 1998.

Pieter van Beukering and V. K. Sharma Waste paper trade and recycling in India, Jodhpur, Scientific Publishers, 1998.

Reprint/Preprint Papers

RP-98-288 B. Sudhakara Reddy and R.M. Shrestha, "Barriers to the Adoption of Efficient Electricity Technologies: A Case Study of India", *International Journal of Energy Research*, 22, 1998.

RP-98-289 Jyoti Parikh and B. Sudhakara Reddy, "Revisiting Carbon Sequestration for Joint Implementation", in P.W.F. Riemer, A.Y. Smith and K.V. Thambimuthu (eds.), *Greenhouse Gas Mitigation*, Elsevier Science Ltd., 1998.

RP-98-290 Jyoti Parikh, Manoj K. Panda and N.S. Murthy, "Consumption Patterns by Income Groups and Carbon Dioxide Implications for India: 1990-2010", *International Journal of Energy Issues*, 9(4-6), 1997.

RP-98-291 Basudeb Guha-Khasnobis, "Sensitivity of the Rupee-Dollar Exchange Rate: A VAR Analysis", *Journal of Foreign Exchange and International Finance*, April-June, 1998.

RP-98-292 Basudeb Guha-Khasnobis and Sridhar K. Dash, "Risk Premium in the Indian Foreign Exchange Market", *International Journal of Development Banking*, January-June, 1998.

RP-98-293 B. Sudhakara Reddy, "Energy Efficient Options: Techno-Economic Potentials for Mitigating GHG Emissions", *International Journal of Environment and Pollution*, 9(2-3), 1998.

RP-98-294 R. Ramanathan and S. Geetha, "Socio-Economic Impact Assessment of Industrial Projects in India", *Impact Assessment and Project Appraisal*, 16(1), 1998.

RP-98-295 Ajit Ranade, "Maharashtra's EGS: Regional Patterns, Scope for Reforms and Replication", *The Indian Journal of Labour Economics*, 41(2), 1998.

RP-98-296 Raghbendra Jha, "Challenge of Macroeconomic Management after the 1998-99 Union Budget", *Economic and Political Weekly*, 1998.

RP-98-297 Ashima Goyal and Shridhar Dash, "Arbitrage: An Explanation for South-East Asian Crisis and Indian Immunity", *Economic and Political Weekly*, 1998.

RP-98-298 Sudipa Majumdar and Bibhas Saha, "Job Security, Wage Bargaining and Duopoly Outcomes", *Journal of International Trade and Economic Development*, 7(4), 1998.

RP-98-299 Raghbendra Jha and Hari Nagarajan, "Wholesaler Stocks and Hoarding in Rice Markets in India", *Economic and Political Weekly*, 33(41), 1998.

RP-98-300 Raghbendra Jha, Puneet Chitkara and Santanu Gupta, "Productivity, Technical and Allocative Efficiency and Farm Size in Wheat Farming in India: A DEA Approach", *Applied Economics*, 7(1), 2000.

RP-98-301 Mahendra Dev and Ajit Ranade, "Cash Versus Food for Public Works Programs", *World Development*, forthcoming.

RP-98-302 S. Mahendra Dev and Ajit Ranade, "Rising Food Prices and Rural Poverty: Going Beyond Correlations", *Economic and Political Weekly*, 33(39), 1998.

RP-98-303 Vikas Rawal and Madhura Swaminathan, "Changing Trajectories: Agricultural Growth in West Bengal, 1950 to 1996", *Economic and Political Weekly*, 33(40), 1998.

RP-98-304 Madhura Swaminathan, "Economic Growth and the Persistence of Child Labor: Evidence from an Indian City", *World Development*, 26(8), 1998.

RP-98-305 R. Ramanathan, "A Multicriteria Methodology for Global Negotiations on Climate Change", *IEEE Transactions on Systems, Man and Cybernetics Part C: Applications and Reviews*, 28(4), 1998.

RP-98-306 Piyush Tiwari and Jyoti Parikh, "Affordability, Housing Demand and Housing Policy in Urban India", *Urban Studies*, 35(11), 1998.

RP-98-307 Joseph Berechman, Sougata Poddar and Oz Shy, "Network Structure and Entry in the Deregulated Airline Industry", *Keio Economic Studies* (Forthcoming).

RP-99-308 Raghbendra Jha, M.S.Mohanty, S.Chatterjee and P.Chitkara, "Tax Efficiency in Selected Indian States", *Empirical Economics*, 24(4), 1999.

RP-99-309 Ashima Goyal, "Do Foreign Inflows Let Expectations Dominate History?", *Journal of Foreign Exchange and International Finance*, 12(3), 1998.

RP-99-310 Robin Boadway, Isao Horiba and Raghbendra Jha, "The Provision of Public Services by Government Funded Decentralized Agencies", *Public Choice*, 100(2), 1999.

RP-99-311 V. K. Sharma, "Development of Air Quality Indices for Mumbai, India", *International Journal of Environment and Pollution*, 11(1), 1999.

RP-99-312 V. K. Sharma, "Gaps in Environmental Policy: A Focus on General and Air Pollution Problems", *Environmental Policy and Law*, 28(2), 1998.

RP-99-313 Raghbendra Jha and Hari K. Nagarajan, "Market Integration, Price Efficiency and Short-Run Dynamics: A Tale of Two National Stock Markets", *Economic and Political Weekly*, 34(3 & 4), 1999.

RP-99-314 Raghbendra Jha, K. V. Bhanu Murthy, Hari K. Nagarajan and Ashok K. Seth, "Real Consumption Levels and the Public Distribution System in India", *Economic and Political Weekly*, forthcoming.

RP-99-315 Raghbendra Jha and Mark Rhodes, "Some Imperatives of the Green Revolution: Technical Efficiency and Ownership of Inputs in Indian Agriculture", *Agricultural and Resource Economics Review*, forthcoming.

RP-99-316 Ajit Ranade and Rajeev Ahuja, "Life Insurance in India: Emerging Issues", *Economic and Political Weekly*, 34(3&4), 1999.

RP-99-317 R. Nagaraj, "How Good are India's Industrial Statistics?: An Exploratory Note", *Economic and Political Weekly*, 34(6), 1999.

RP-99-318 K. V. Ramaswamy, "The Search for Flexibility in Indian Manufacturing: New Evidence on Outsourcing Activities", *Economic and Political Weekly*, 34(6), 1999.

RP-99-319 Madhura Swaminathan, "Aspects of Poverty and Living Standards in Mumbai", in J. Masselos and S. Patel (eds.) *The End of Bombay, The Beginnings of Mumbai*, Oxford University Press, New Delhi, forthcoming.

RP-99-320 Raghbendra Jha and Ibotombi S. Longjam, "Will the Right Monetary Aggregate for India Please Stand Up?", *Economic and Political Weekly*, 34(10-11), 1999.

RP-99-321 A. Ganesh-Kumar, "Spatial Variability in Crop Yields: The Case of Cereals Across Districts in Andhra Pradesh", *Indian Journal of Agricultural Economics*, 54(1), 1999.

RP-99-322 Raghbendra Jha, "Some Rudimentary Macroeconomics of the Budgetary Deficit and Debt", in A. Vasudevan, D. Nachane and A. Kamik (eds.) *Fifty Years of Development Economics: Essays in Honour of Professor Brahmananda*, Himalaya Publishing House, Mumbai, 1999.

Discussion Papers

DP-98-144 P.J.J. Herings and H.M. Polemarchakis, "Pareto Improving Price Regulation when the Asset Market is Incomplete", April 1998.

DP-98-145 Mahendra Dev and Ajit Ranade "Cash versus Food for Public Works Program", May 1998.

DP-98-146 Tirthankar Roy, "Economic Reforms and the Textile Industry in India", June 1998.

DP-98-147 Ashima Goyal, "Transitional Exchange Rate Policy in a Low Per Capita Income Country", June 1998.

DP-98-148 Sougata Poddar, "Capacity, Entry and Demand Uncertainty", August 1998.

DP-98-149 Sudipta Dutta Roy, "Lags in Employment Adjustment and Inter-Industry Differentials: Analysis Using Dynamic Inter-Related Factor Demand Functions", August 1998.

DP-98-150 A. Ganesh-Kumar, Gangadhar Darbha and Kirit S. Parikh, "Impact of a Hike in the Administered Prices of Petroleum Products: Analysis Using an Applied General Equilibrium Model for India", September 1998.

DP-98-151 Ajay Shah and Susan Thomas, "Market Microstructure Considerations in Index Construction", October 1998.

DP-99-152 Manoj Panda and Kali P. Rath, "Price Changes and Some Underlying Aspects of Measurement of Poverty", January 1999.

Proceedings/Project Report

PP-038 A. Ganesh-Kumar, Kunal Sen and Rajendra R. Vaidya, "Finance and Changing Trade Patterns in Developing Countries: A Case Study of India", Report submitted to the International Development Research Centre (IDRC), Canada, 1998.

PP-039 Shikha Jha and P.V. Srinivasan, "Grain Price Stabilization Policies in India", Report prepared for the World Bank, 1997.

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7. Awards, Fellowships and Honours

During the year faculty members participated in a variety of academic activities, as listed below. Such participation is actively encouraged by the Institute and is important for disseminating Institute research results, for contributing to national and international policy debates and to get peer group responses to our activities.

Parikh Kirit S.

Fellow, The National Academy of Sciences, India.

Senior Economic Adviser to the Administrator, UNDP, New York. October 1997-September 1998 (On leave from Indira Gandhi Institute of Development Research)

Member, Economic Advisory Council to the Prime Minister, w.e.f. 27-8-1998

Member, Editorial Board, Technology in Society, an international journal.

Member, Editorial Board, Environmental Modeling & Assessment.

Member, Editorial Advisory Board, Agricultural Economics.

Associate Editor, Energy Economics.

Member, Working Group on Reorientation of Public Distribution System, Development Policy Division, Planning Commission.

Member, Energy Policy Committee, Planning Commission.

Agrawal Pradeep

Referee, Indian Journal of Labour Economics.

Dev Mahendra S.

Member, National Committee on Minimum Wages, appointed by National Labour Committee, 1998.

Member, National Committee on Agriculture, Confederation of Indian Industry, 1997-98.

Member, Task Force on Land Utilization and Crop Statistics, appointed by ICSSR.

Gokarn Subir V.

Member, Economic Reforms and Business Policy Committee of the Indian Merchants' chamber, Mumbai, 1997-98.

Received the Fulbright Research Fellowship for 1997-98, visiting the Economic Growth Center, Yale University, New Haven, USA.

Goyal Ashima

Member, Exim Bank thesis award committee.

Jha Raghbendra

Member, Panel of Experts, Fiscal Affairs Division, International Monetary Fund.

Associate Editor, Journal of International Tax and Public Finance, with effect from January 1999.

Referee, Journal of Routledge Publishers.

Referee, International Tax and Public Finance.

Referee, Canadian Journal of Economics.

Referee, Journal of Public Economics.

Referee, Journal of Industrial Economics.

Referee, Journal of Development Economics.

Referee, Journal of Agricultural Economics.

Referee, Journal of Quantitative Economics.

Referee, Economic and Political Weekly.

Referee, European Journal of Political Economy.

Referee, Journal of Comparative Economics.

Visiting Faculty, University of Warwick, UK.

Peer Reviewer, Journal of Industrial Economics, Journal of Comparative Economics, Journal of Development Economics.

Nagaraj R.

Member, Working Group on Employment for 9th Plan, Planning Commission.

Member, Steering Committee, Resource Mobilization for 9th Plan, Kerala Planning Board.

Chairman, Task Force on 'Data base for Decentralised Planning in Kerala', Kerala Planning Board.

Parikh Jyoti K.

Member, Advisory Panel on Global Environmental Issues, Ministry of Environment and Forests, Government of India.

Member, Committee for working out methodology for quantifying the tangible and intangible benefits of the forestry.

Member, Expert Advisory committee for the World Bank project on "State Environmental Action Programme" managed by Gujarat Ecology Commission, Vadodara.

Reviewing Editor, Inter-governmental Panel for Climate Change (IPCC), III Assessment Report.

Member, Scientific and Technical Advisory Panel (STAP) to Global Environment Facility (GEF).

Member, Advisory Committee on AIJ Issues, Ministry of Environment and Forests.

Member, START (A Global Change System for Analysis, Research and Training) Scientific Steering Committee (SSC), USA.

Member, Expert Committee on Environmental Economics .

Chairperson, Environmental Economics Research Committee, India: Capacity Building Project, aided by the World Bank.

Member, Advisory Committee of IGES, Japan.

Member, Advisory Committee of Central Electricity Regulatory Commission.

Reviewer, Energy, The International Journal, Pergamon Press.

Reviewer, Energy Policy.

Reviewer, Energy economics.

Member, Editorial Board of Utilities Policy, Energy, The International Journal.

Ramanathan R.

Referee, Journal of Multi-Criteria Decision Analysis; Omega - The International Journal of Management Science.

Member, The Indian Academy for Mathematical Modelling in Engineering and Sciences (IAMMES).

Reddy Sudhakara B.

Member, Maharashtra State Planning Board (Energy), Govt.of Maharashtra, Bombay.

Guest Editor, International Journal of Global Energy Issues.

Guest Editor, The International Journal of Environment and Pollution.

Member, Editorial Advisory Board, International Journal of Sustainable Development, Inderscince Publications, Switzerland.

Member, Oganising Committee, International Symposium on Energy and Environment, Trabzon University, Trabzon, Turkey.

Saha Bibhas

Referee, Journal of Economics, Review of Development Economics.

Referee, Review of Development Economics.

Sarkar Subrata

Member, India and Southeast Asia Meeting of the Econometric Society, 1998.

Sen Anindya

Member, Technical Advisory Committee for Social Sciences Division, Indian Statistical Institute, 1997-98.

Shah Ajay

Member, SEBI's "Certification Committee" (1999).

Chairman, NSE "Index Committee".

Member, Board of Directors, UTI Securities Exchange.

Member, National Securities Clearing Corporation "Committee for Risk Containment".

Member, Board of Directors, Centre for Monitoring Indian Economy.

Member, Board of Directors, National Securities Clearing Corporation.

Member, Board of Directors, OTC Exchange of India.

Member, Board of Directors, ITC Classic Thread Needle Company.

Member, Executive Committee, National Securities Depository Ltd.

Member, National Securities Depository "Computer Security Committee", 1997.

Member, "International Castor Oil Futures Contract Committee", Bombay Oilseeds&Oils Exchange, Vashi.

Member, "Project OASIS Expert Committee" on old age social and income security (chaired by S. A. Dave), Ministry of Social Justice and Empowerment.

Member, FICCI Working Group on Capital Markets (chaired by Ashok V. Desai), 1998.

Member, "Board of Scholars", Centre for Civil Society, Delhi.

Member, "India Steering Committee", Global Association of Risk Professionals, Bombay.

Member, SEBI's "G. P. Gupta Committee on Market Making" (1998).

Member, SEBI Committee on Policy for Derivatives.

Member, SEBI Committee on Policy for Market Making.

Member, SEBI Economists Forum.

Member, NSDL Computer Securities Committee.

Member, NSE Committee for the Development of the Debt Market.

Member, IISL Index Policy Committee.

Member, NSE Steering Committee on Certification.

Member, NSE Curriculum and Training Committee.

Member, Investment Committee for Endowment Fund, IIT Bombay.

Sharma Vinod K.

Member, Editorial Board, International Journal of Life Cycle Assessment, Ecomed Publishers, Landsberg, Germany, 1999.

Member, Report Editing Committee, UNEP/APEC/AIST/NEDO, symposium on Life Cycle Analysis, 1999.

Member, Editorial Advisory Board, Environmental Monitoring and Assessment, Kluwer Academic Publishers, The Netherlands 1998-99.

Member, Editorial Board, Indian Aerosol Science and Technology Association, Bombay, India, 1998-99.

Referee to few International Journals published from Europe and USA by Pergamon Press, Academic Press, A&WMA , Kluwer Academic Publishers, Ecomed Publishers 1998-99.

Member, Board of Studies, S.N.D.T. University, Mumbai, 1998-99.

Suryanarayana M.H.

Member, International Team of Experts to Finalise Policies for Poverty Reduction in China, UNDP and China Institute for Reform and Development, Hainan, 1998.

Member, Expert Group on Living Standards Measurement Studies, Government of Tamil Nadu, Chennai.

Swaminathan Madhura

Member, Board of the International Association of Feminist Economics, 1998-2000.

Awarded the first Sir Ratan Tata Fellowship, at the London School of Economics and Politics, February to August, 1998.

Thomas Susan

Member, NSE ``Index Committee".

Member, NSE ``Curriculum Formulation and Training Committee".

Member, Board of Directors, Geojit Securities Ltd.

Vaidya Rajendra R.

Awarded the Ford Foundation Post Doctoral Fellowship from August 1997 to August 1998 at Boston University.

Students:

Anoop Singh

Awarded a Ph.D. Fellowship by United Nations University/Institute for Advanced Studies (UNU/IAS), Tokyo from 19th November 1998 for a period up to 8 months.

8. Visitors at IGIDR

Date	Name of Visitor	Title of Seminar
2-4-1998	Heracles Polemarchakis CORE, Catholic University, Belgium; and Jayasri Dutta University of Cambridge	Nash-Walras Equilibria.
6-4-1998	Anjana Das TERI, New Delhi.	Energy Demand of Selected Manufacturing Industries in India and Associated CO_2 Emissions.
15-5-1998	Sudipta Dutta Ray	Inter-Industry Differentials and Lags in Adjustment Patterns: An Analysis Using Dynamic Interrelated Factor Demands.
18,20,22-5-1998	Kunal Sengupta RBI Chair Professor, JNU, New Delhi.	The Economics of Electoral Arrangements.
28-5-1998	Sameer Rege	General Equilibrium Analysis of India's Trade Reforms.
13-8-1998	Sebastian Morris IIM, Ahmedabad	Indian Economy: Reasons for Current Slow Down and Growth Prospects in the Medium Term.
13-10-1998	Arijit Mukherjee School of International Studies, JNU, New Delhi.	Technology Transfer Under Asymmetric Information: The Role of Equity Participation.
26-11-1998	Veena Pailwar NCAER, New Delhi.	A CGE Analysis of Money, Finance and Economic Activity.
27-11-1998	Rajul Pandya-Lorch IFPRI, Washington, D.C., USA.	A 2020 Vision for Food, Agriculture and the Implications for South Asia.
30-11-1998	Sugata Marjit CSSS, Calcutta	Trade, Inequality and the Developing Economy.
1-12-1998	Hiranya Mukhopadhyay NIPFP, New Delhi	Cascading Revenue Neutrality and VAT: Some Theoretical Results.
17-12-1998	Kali Rath Associate Professor University of Notre Dame, USA.	Some Results on Inelastic and Elastic Demand Model of Product Differentiation.
21-12-1998	Ashok Desai	Reforming the Capital Market.
22-12-1998	Ashok Desai	Current State of the Indian Economy.
5-1-1999	Joshua Bishop	Private Sector Participation in Sustainable Forest Management.
6-1-1999	Samuel Bowles University of Massachusetts, USA	Rethinking the Efficiency-Equality Tradeoff: Sustainable Wealth Redistribution.
14-1-1999	Robert Cassen Professor Emeritus at the London School of Economics.	Why Population Matters and What Can Be Done about It?

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Date	Name of Visitor	Title of Seminar
1-2-1999	Armin D. Rosencranz Stanford University, USA.	Trade and Environment.
4-2-1999	Kausik Chowdhuri ISI, New Delhi.	Breaking Trend Versus Random Walk in Stock Prices Evidence from Emerging Markets.
24-2-1999	Vivek Murthy IIM, Bangalore.	An Assessment of the East Asian Debacle.
3-3-1999	Sudhakar Yedla IIT, Kharagpur.	Biomethanation: An Alternative Energy Source – Appropriate Choice for Next Millenium.

9. Student Activities at IGIDR

Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
1990-91					
1.	Deb Chattopadhyay	Economic Operation of the Power System in India	Jyoti Parikh	Kankar Bhattacharya	Completed
2.	Piyush Tiwari	Energy and Environment Constraint Housing Markets in India	Jyoti Parikh	Kirit S. Parikh	Completed
3.	Saumen Majumdar	Incentive Compatible General Equilibrium Electricity Pricing	Jyoti Parikh	Kirit S. Parikh	Completed
1991-92					
4.	Mukesh Anand	Shadow Prices for India: A Guide to Policy Reforms	P.V. Srinivasan	Raghbendra Jha Shikha Jha	Submitted
5.	Indranil Pan	Industrial Dispute – A Probabilistic Approach	Bibhas Saha	Anindya Sen V.K. Ramachandran	Ongoing
6.	Rajendra Rane	Risk, Returns, Anomalies and Efficiency of the Indian Stock Market: A Study of Cross-Sectional and Calendar Effects in the Bombay Stock Exchange (1964-95)	Kirit Parikh Subir Gokarn	Rajendra Vaidya P.V. Srinivasan	Ongoing
7.	Mridul Sagar	Modelling Exchange Rate Dynamic for Indian Economy	Raghabendra Jha	Nachane (BU) D. Ray (RBI) R. Krishnan	Ongoing
8.	Sudhir Sharma	Soil Nutrient Available and Sustainability of Agriculture in Punjab	Kirit Parikh	J.P. Painuly Mahendra Dev	Ongoing
9.	N. Satyanarayana Murthy	Energy, Environment and Sustainable Development: A Case Study of India	Jyoti Parikh Kirit Parikh	Manoj Panda	Ongoing
1992-93					
10.	Anoop Singh	Energy and Environmental Policy Modelling	Kirit Parikh Jyoti Parikh	Subrata Sarkar Shikha Jha	Ongoing
11.	Brinda Viswanathan.	Some Econometric Issues in Consumer Behaviour Analysis	M.H. Suryanarayana	Kirit Parikh Subrata Sarkar	Completed

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Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
12.	Gangadhar Darbha.	Role of Capital Markets Imperfections in Monetary Transmission Mechanism: Some Indian Evidence	Kirit Parikh	Veena Mishra A. Ganesh Kumar	Thesis submitted
13.	Pradheepa Neelakantan	Incentives and Information in Organizations	Anindya Sen	Bibhas Saha Shikha Jha	Completed
14.	Raghavendra Rao.	Policy Modelling of the Oil and Gas Sector in India	Jyoti Parikh	Kirit S. Parikh Kankar Bhattacharya	Completed
15.	Subhajit Bhattacharya	Industrial and Trade Policies in International Strategic Environment	Anindya Sen	Bibhas Saha Subrata Sarkar	Ongoing
16.	Sameer Rege	Applied General Equilibrium Analysis of India's Tax and Trade Policy	Kirit Parikh	P.V. Srinivasan Shikha Jha	Ongoing
17.	Saibal Ghosh	Economics of Wage Bargaining	Anindya Sen Subrata Sarkar	Bibhas Saha	Ongoing
18.	Sudipta Dutta Ray	Employment, Turnover and Wages: A Study of the Organized Labour Market in India	Veena Mishra Subrata Sarkar	Bibhas Saha	Ongoing
19.	Sudipa Majumdar	Entry Deregulation Labour Union Responses and Allocative Inefficiency: A Study of the Airline Industry in India	Subrata Sarkar Bibhas Saha	Sougata Poddar	Ongoing
20.	Partha Ray	Role of Credit in Monetary Transmission	Veena Mishra	Bibhas Saha Subrata Sarkar	Ongoing
21.	K.Santha Kavi Kumar	Modelling and Analysis of Climate Change Impacts on Indian Agriculture	Jyoti Parikh	Kirit Parikh A. Ganesh-Kumar	Completed
22.	Saumya Shankar B.	Trade Effects of Exchange Rate Uncertainty: A Case Study of the Indian Scenario (1975-1994)	Veena Mishra	R. Krishnan	Ongoing
23.	Anamitra Saha	Determinants of Adoption of HYV Rice in West Bengal	Madhura Swaminathan	S. Mahendra Dev Subrata Sarkar Ramachandran	Thesis Submitted

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Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
1993-94					
24.	B.A.N. Sharma	Modeling Frameworks for Electric Generation and Transmission Planning	Jyoti Parikh Kankar Bhattacharya	Kirit Parikh R. Ramanathan	Ongoing
25.	Vinish Kathuria	Technology Transfer, Productivity Spillover and Technical Change – A Study of the Indian Manufacturing Industry	Subir Gokarn Subrata Sarkar	K.V. Ramaswamy	Ongoing
26.	Nibedita Das	Optimal Regulatory Policy: Applications to the Indian Telecommunications Sector	Raghbendra Jha P.G. Babu	Ajit Mishra	Thesis Submitted
27.	Shridhar Dash	Indian Asset Markets: Some Empirical Issues	Ashima Goyal	Ajay Shah Subrata Sarkar	Completed
28.	Tushar Waghmare	Market Microstructure and Performance: A Study of Indian Stock Exchanges	Subir Gokarn	Rajendra V. Subrata Sarkar Ajay Shah	Ongoing
29.	Jayatu Sen C	The Indian Credit Rating Industry: An Evaluation	Subrata Sarkar Veena Mishra	Ajay Shah	Ongoing
30.	Vikas Rawal	Irrigation Development in West Bengal: 1977-78 to 1995-96	Ramachandran	Madhura S. Mahendra Dev	Ongoing
1994-95					
31.	Santanu Gupta	Essays in Fiscal Federalism and Fiscal Expenditures	Raghbendra Jha	P.G. Babu Jayati Sarkar	Ongoing
32.	Rajeev Ahuja	Essays on Insurance Markets	Ajit Ranade	Kirit Parikh Bibhas Saha	Ongoing
33.	Saumitra Bhaduri	Patterns and Determinants of Capital Structure: A Study of the Indian Corporate Sector	Subir Gokarn Subrata Sarkar	B. Guha-Khasnobis Jayati Sarkar	Ongoing
34.	Puneet Chitkara	Estimation of Performance Benchmarks, Inefficiency Measurement and Pricing of Power	Raghbendra Jha Kankar B.	Subrata Sarkar Ramanathan	Thesis Submitted
35.	G.S. Haripriya	Environmental Accounting, Carbon Sequestration Potential and Policies for Carbon Mitigation in India	Jyoti Parikh V.K. Sharma	Kirit Parikh B. Sudhakara Reddy	Ongoing

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Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
36.	Sagar Koparkar	Bank, Credit, Asset Securitisation and Financing Infrastructur: A Case Study of India	Raghbendra Jha Ajit Ranade	Jayati Sarkar	Ongoing
37.	Satish Pandey	Cogeneration: Technoeconomic Analysis of Operational Planning Assets	Kirit Parikh Kankar B.	Jyoti Parikh	Ongoing
38.	Vardhana Saple	Diversification, Merger and Their Effect on Firm Performance: A study of the Indian Corporate Sector	Subir Gokarn Rajendra R.	Anindya Sen Subrata Sarkar	Ongoing
39.	Mudit K	Long-term Supply Strategies for Commercial Energy Sector in India	Jyoti Parikh Anjana Das	Kirit Parikh	Ongoing
40.	Barnali Nag	Economic and Policy Analysis of Climate Change in India	Jyoti Parikh V.K. Sharma	Kirit Parikh	Ongoing
41.	Kiran Karande	The Multidivisional Structure	Ajit Ranade Ajay Shah	Anindya Sen	Ongoing
1995-96					
42.	Manas Paul	Issues in Equilibrium Real Exchange Rate and Its Relevance to India	Raghbendra Jha	Ashima Goyal	Ongoing
1996-97 (Ph.D.)					
43.	Chiranjib Gupta	Have OECD Countries Relocated Their Pollution Intensive Industries to India	Kirit Parikh	Manoj Panda	Ongoing
44.	Mita Chaudhary	Role of Financial Institutions in Corporate Growth	Subrata Sarkar	Jayati Sarkar	Ongoing
45.	Ibotombi S. Longjam	Savings and Demand for Financial Asset in India: An Aggregate Index Theoretic Approach	Raghbendra Jha	Ashima Goyal	Ongoing
46.	Mandira Sarma	Estimation Performance Evaluation of Alternative VaR Models	Susan Thomas Ajay Shah		Ongoing
47.	Jesim Pais	Urban Informal Labour Force in India and Economic Policy Changes in the 1990s	Madhura S. V.K. Ramachandran		Ongoing

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Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
1996-97 (M.Phil.)					
48.	Dinabandhu Bag	The Economics of Pesticides Application in Agriculture and Environmental Damage	Jyoti Parikh A. Ganesh Kumar		Completed
49.	Deba Prasad Rath	Alternative Approaches to Money Supply Process: Theory and Evidence	Raghbendra Jha		Thesis Submitted
50.	Partha S. Chatterjee	R & D and Market Incompleteness	P.G. Babu		Ongoing
51.	Nivedita Goswami	Industrial Determinants of Ownership: A Case Study of the Indian Corporate Sector	Jayati Sarkar		Ongoing
52.	Soma Dey	Renegotiation and Incomplete Contracts: Efficiency Issues	P.G. Babu		Ongoing
53.	Yashajit Saha	Employment, Wages and Productivity in Indian Public Sector	Jayati Sarkar		Ongoing
54.	Ravi Prakash S.	Measuring Impact of Classification of Bombay Stock Exchange Group A Stocks	Ajay Shah Susan Thomas		Ongoing
1997-98 (Ph.D.)					
55.	Rajib Das	Causes and Consequences of 1995-96 Liquidity Crunch in India	Veena Mishra	Subrata Sarkar R.Krishnan	Ongoing
56.	Kakali Kanjilal	Term Structure of Interest Rates: Some Macroeconomic Issues	Raghbendra Jha		Ongoing
57.	Rajarshi Pandit	Organizational Characteristics, Restructuring Options and Firm Performance: A Study of Indian Corporate Sector	Subrata Sarkar		Ongoing
58.	Bikram De	Essays on Business Groups	Jayati Sarkar	Subrata Sarkar	Ongoing
59.	Sanjay K. Singh	Planning Infrastructure: The Transport Sector and Its Linkages with Environmental Issues	Raghbendra Jha		Ongoing

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Sr. No.	Name of Student	Thesis Topic	Supervisor/ Guide	Committee Members	Status
60.	Saurabh Ghosh	Governance through Market for Corporate Control and Managerial Incentives: A Study on India	Subrata Sarkar		Ongoing
1997-98 (M.Phil.)					
61.	Syed Abuzar Moonis	Time Variations in BETA: Evidence from the Indian Stock Market	Ajay Shah Susan Thomas		Ongoing
62.	Manasi Panshikar	Currency Crises and Contagion	Raghbendra Jha Subrata Sarkar		Ongoing
63.	Kshitija Donde	Anticipated Money, Unanticipated Money and Real Effect: A Test of the Barro Proposition in the Indian Context	Raghbendra Jha		Ongoing
64.	Suhas Saha	Two Essays on Application of Supermodularity in Economics	P.G. Babu		Ongoing
65.	Phanindra Goyari	Analysis of Cropping Pattern Changes in North-Eastern India During 1970-71 to 1994-95.	A. Ganesh Kumar Madhura S.		Ongoing

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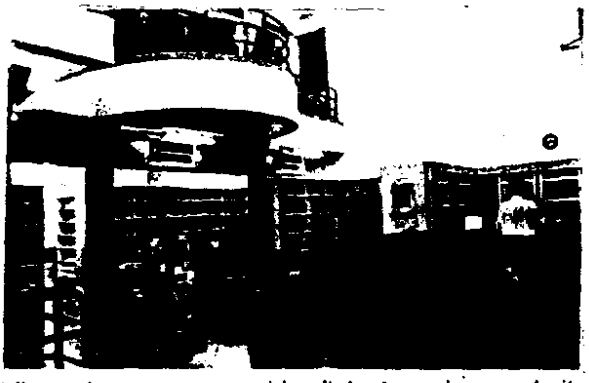
10. Institute Facilities

10.1 Library and Information Services



The library of the Institute is rapidly building up to be one of the leading professional research and reference libraries in the country. All bibliographic details of books, journals and CD-ROM databases are accessible through the campus-wide Ethernet network. The library has over 40,000 printed documents and it subscribes to over 470 national and international journals. It has established contacts with over 100 national and international organizations for exchange of the Institute's publications and inter-library loan arrangement. Library homepage provides links to various websites which are of importance to economists.

10.2 Computing Facilities

The IGIDR computing infrastructure consists of the hardware infrastructure (including the various operating systems), the software and various databases. In addition, there is a help desk facility and ongoing maintenance and support activity.

Hardware

The Computer Centre is equipped with various servers, based on the Digital Alpha chip technology, Sun Ultra Sparc, and others on Intel based technology, which act as hubs for the network. These servers provide Messaging, Computing and Database application services, print and file sharing services, library services and also Intranet and Internet access services. The bigger main servers are DEC Alpha 4100S, DEC Alpha 600S, DEC Alpha 3300LX and SUN Netra-J, with RAM size between 1 Gigabyte to 64 Megabyte and a combined disk space of almost 100 GB and a RAID environment. One DEC Alpha 255 MHz with 64MB RAM, two Pentiums of 166 Mhz with 32 Mb of RAM, and one Pentiums 200 Mhz with 32MB RAM serve as Intranet, Internet, News servers and Gateway to the Internet. Two Sun Java Stations, various 386, 486 and Pentium based PCs and VT100 terminals situated all over the campus are connected to the servers via an ethernet-based local area network (LAN) on fibre optic segmented backbone.

Six HP Jet Direct Network Laser printers are connected to the network, and there are other laser, inkjet and dot matrix printers, and also a CD ROM station that can load 14 CDs simultaneously.

Other hardware at IGIDR includes a HP 4C Colour Scanner, Calcomp Digitizer, CD- Recorder, 2/4, 4/8 and 12/24 GB DAT drives, roaming CD ROM drive, IDE cartridge drives and Magneto Optical drives.

The multimedia centre consists of a T230pro Real Time Frame Grabber, PCI based Flexcam Pro Digital Studio, TVIEW Computer to TV Adapter, and an EXTRON VGA to PAL/NTSC converter.

IGIDR's LAN is also hooked into the Internet and WWW through a 64kbps capacity leased data circuit connected to Videsh Sanchar Nigam Ltd (VSNL).

Operating Systems

The operating system for the main servers is Digital Unix and SUN Solaris. The Pentiums have SCO Unix or Linux and Windows NT. Most of the PCs run on Windows (Win95 or Win98 or WinNT) operating system and also have X Windows interface. Network connectivity for all Windows clients, including file and print services and database services is managed by SAMBA a public domain software. In addition there is a help desk facility and ongoing maintenance and support activity. All computers at IGIDR are interconnected and operate in a highly networked environment.

In addition the computing facility also includes a computerized library system.

Software

Apart from operating systems, the software at IGIDR consists of (*a*) econometric and statistical software packages that run under MSDOS, Windows or Unix, (*b*) office and suite products (*c*) programming languages and (*d*) other commercial, proprietary and non-commercial products. There is a continuous process of upgrading both software and hardware.

The econometric and statistical packages are Stata, SAS, TSP, Microfit, Gauss, Limdep, DEA, Shazam, GAMS, Mathematica and IMSL library of routines. Office automation and word processing software like MS Office, Lotus Smartsuite, and Word Perfect are also available. The programming languages used are C, Fortran and Digital Visual Fortran, Pascal, perl and awk. Other softwares like TeX (a typesetting and printing software), antivirus toolkit (for protecting PCs from viruses), SPANS explorer for GIS are also available.

10.3 Databases and Books

IGIDR maintains several databases that contain national and international economic data. Some of the bigger databases are Prowess and India Trades (produced by CMIE), Advanced Stock Analysis (ASA), Capitaline OLE from Capital Markets, STARS (World Bank), International Financial Statistics, Economic Literature (Econlit), Social Science Citation Index (SCSI), FAO Statistics, World Energy database, and INTELEC. The computer centre stocks a large collection of valuable manuals and other related documents. The library also maintains a big collection of computer books, guides and related publications.

The Computer Centre also conducts various training and orientation seminars/lectures on several computer-related topics and software packages including E-Mail, Win95, Unix, CIMM, Capatiline Ole, Internet technologies, and Netscape, to enhance and upgrade the computer skills of the user community of IGIDR.

10.4 Amenities

The campus includes office buildings for research and administrative staff, seminar rooms of different sizes, a 500-seat auditorium, library, computer centre and a cafeteria. Housing for the staff is provided on the campus. A guest house/hostel building provides furnished rooms for students and visiting scholars. There are also some recreational facilities which include a 20-metre swimming pool, a tennis

court, an indoor badminton court, a table tennis room, a small jogging track, a fully equipped weight training centre and a children's park at the Institute.

11. Personnel at IGIDR

Faculty and the areas of Interest:

Director

Parikh Kirit S. *Sc.D. (Civil Engg.), M.S. (Economics and Engg), MIT, USA*	*Development policy, policies and planning models, technology policy, environmental policy and agricultural policy.*

Senior Professor

Parikh Jyoti K. *Ph.D. (Physics), University of Maryland, USA*	*Energy systems, energy modelling, science and technology, power systems policy and modelling, climate change, sustainable development, environmental econoixa.*

Professors

Dev Mahendra S. (On Leave) *Ph.D. (Economics), Delhi School of Economics*	*Agricultural economics, farm and non-farm employment, safety nets for the poor.*
Jha Raghbendra *Ph.D. (Economics), Columbia University, USA*	*Macroeconomics, public economics, applied econometrics, economics of development.*
Jha Shikha *Ph.D. (Economics), Indian Statistical Institute, New Delhi*	*Public economics, agricultural economics and development economics.*
Sen Anindya (On Leave) *Ph.D. (Economics), University of Southern California, USA*	*Theory of the firm, industrial organization, regulation, law and economics.*
Suryanarayana M.H., *Ph.D. (Economics), Indian Statistical Institute, Calcutta*	*Consumer demand analysis and development economics.*

Associate Professors

Agrawal Pradeep *Ph.D. (Economics), Stanford University, USA*	*Development economics, economic theory, financial markets, Economics of institutions and reforms.*
Geetha S. *Ph.D. (Operations Research), Indian Institute of Technology, Mumbai*	*Econometrics, operations research.*
Gokarn Subir V. (On Leave) *Ph.D. (Economics), Case Western Reserve University, USA*	*Industrial economics, financial economics, comparative development.*

Goyal Ashima *Ph.D. (Economics), University of Mumbai*	*Institutional macroeconomics, development and finance, theory and applications.*
Krishnan R. *Ph.D. (Economics), University of Mumbai*	*Monetary economics, econometrics.*
Mishra Veena *Ph.D. (Economics), University of Western Ontario, Canada*	*Macroeconomics, monetary economics, international trade and finance.*
Nagaraj R. *Ph.D. (Economics), Centre for Development Studies, Thiruvananthapuram*	*Development economics, industrial economics.*
Painuly J.P. (On Leave) *Fellow, Indian Institute of Management, Bangalore*	*Energy economics and energy modelling, environment.*
Panda Manoj *Ph.D. (Economics), Indian Statistical Institute, New Delhi*	*Applied general equilibrium, environmental economics, issues in poverty and human development.*
Ramachandran V.K. *Ph.D. (Economics), University of Madras*	*Agrarian studies, rural development studies.*
Reddy Sudhakara B. *Ph.D. (Energy Management), Indian Institute of Science, Bangalore*	*Energy systems, policy and planning, demand side management, forestry, agriculture and transport systems, natural resource accounting.*
Roy Tirthankar *Ph.D. (Economics), Centre for Development Studies, Thiruvananthapuram*	*Economic history, textiles, small-scale industry.*
Saha Bibhas *Ph.D. (Economics), University of Southern California, USA*	*Microeconomics, Industrial organization, labour economics.*
Sharma Vinod K. *Ph.D. (Environment Science and Engineering), Indian Institute of Technology Mumbai*	*Local, regional and global environmental issues.*
Srinivasan P.V. *Ph.D. (Economics), Indian Statistical Institute, New Delhi*	*Development economics, public finance, food policy, economics of poverty and inequality.*
Sarkar Subrata *Ph.D. (Economics), University of Southern California, USA*	*Econometrics, empirical industrial organization.*
Swaminathan Madhura *D.Phil.(Economics), University of Oxford, UK*	*Agricultural economics, economic development and the Indian economy.*
Vaidya Rajendra R. *Ph.D. (Economics), University of Poona*	*Industrial economics, macroeconomics.*

Assistant Professors

Babu, P.G. *Ph.D. (Economics), Indian Institute of Science, Bangalore*	*Economics of information, non-cooperative game theory, environmental economics.*
Bhattacharya Kankar (On Leave) *Ph.D. (Electrical Engg.), Indian Institute of Technology, New Delhi*	*Power flow studies and economic operation of power systems, power systems dynamics, stability and control.*
Das Anjana *Ph.D. (Electrical Engg.), Indian Institute of Technology, New Delhi*	*Energy economics, energy and environment modelling.*
Ganesh-Kumar A. *Ph.D. (Economics), Indian Statistical Institute, Bangalore*	*Agricultural policy, econometrics, macro modelling.*
Guha-Khasnobis Basudeb (On Leave) *Ph.D. (Economics), University of Rochester, USA*	*International trade and finance, trade and environment, economic liberalization, development economics.*
Poddar Sougata *Ph.D. (Economics), CORE, Universite Catholique de Louvain, Belgium*	*Microeconomics, industrial organization, imperfect competition, applied game theory.*
Ramanathan R. *Ph.D (Industrial Management), Indian Institute of Technology, Chennai*	*Energy, transport and environmental economics, socio-economic impact assessment, multiple criteria decision making.*
Ramaswamy K.V. *Ph.D. (Economics), University of Delhi*	*Small-scale industry, technological change and productivity growth, development economics.*
Ranade Ajit. *Ph.D. (Economics), Brown University, USA*	*Economic theory, game theory, development economics and public policy.*
Sarkar Jayati *Ph.D. (Economics), University of Southern California, USA*	*Institutional and economic development, public policy analysis, industry studies.*
Shah Ajay *Ph.D. (Economics), University of Southern California, USA*	*Financial economics, econometrics.*
Thomas Susan *Ph.D. (Economics), University of Southern California, USA*	*Applied econometrics, finance.*

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Research Staff

Capacity-21 Project

Datye Hemant S. *Ph.D. (Large Mammal Ecology), Mumbai University*	*Biodiversity, environmental economics, marine and terrestrial ecology, ethnobiology, socio-economics, EIA.*
Pandey Vijaylaxmi *Ph.D. (Agricultural Economics), G.B.Pant University of Agriculture & Technology*	*Agricultural economics, forestry, agricultural finance.*
Raghu Ram Tata L. *Ph.D. (Biodeiversity Impact Assessment) Saurashtra University*	*EIA, environmental economics, ecology, sustainable use of natural resources.*

EMCaB Project

Shrivastava R.S. *Ph.D. (Dairy Economics, Statistics & Management) National Dairy Research Institute*	*Agricultural Economics and Farm Management*

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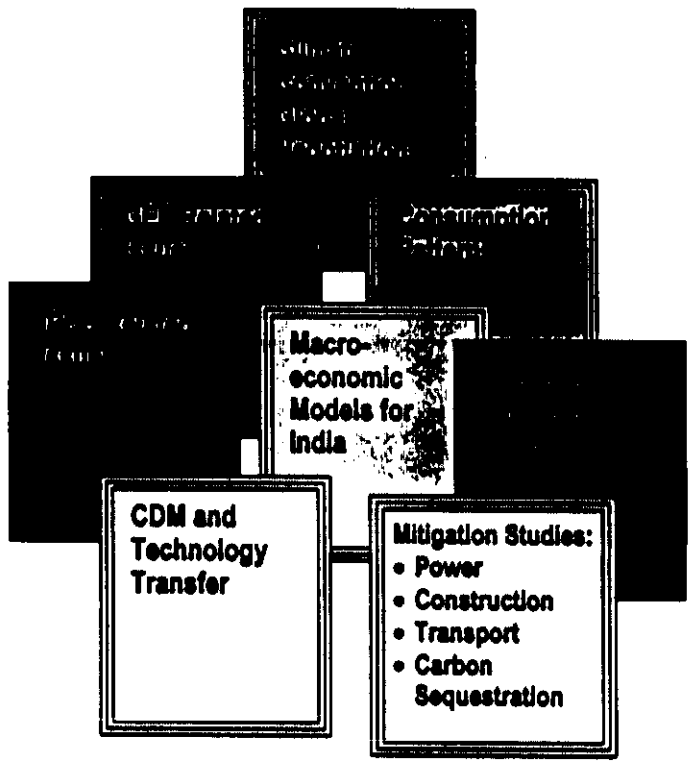
CLIMATE CHANGE STUDIES AT IGIDR



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CLIMATE CHANGE STUDIES AT IGIDR

Indira Gandhi Institute of
Development Research (IGIDR)
(A Deemed University)

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Preface

This year marks a decade long involvement of IGIDR in the climate change area that began prior to earth summit at Rio.

IGIDR's work covers many areas and disciplines (see back cover). IGIDR studies show that multi-disciplinary research that addresses policy issues pertaining to energy and environmental problems is critical for strategic planning and policy formulation in the Indian energy and environmental sectors. In 1989, IGIDR hosted a national brainstorming workshop on Sustainability: Definition, Measurement and Monitoring which contributed to the development of the National Conservation Strategy adopted by the Government of India. Prior to the Earth Summit, Rio, United Nations Conference on Environment and Development (UNCED) sponsored a study at IGIDR on consumption patterns that dealt with inequity at international level in resource-use and their linkages with climate change issues. Subsequently, a number of areas of local, national and global interests are covered that range from sustainable development, trade and environment, environmental accounting and valuation and so on. These are long term issues which are also complimented with analysis of short term and medium term issues of national concerns. In this brochure we report on our activities mainly in the area of climate change.

With the understanding obtained from research, IGIDR has actively participated in national and international policy dialogues. Thus, IGIDR has interacted at various fora and with various organizations such as Ministry of Environment and Forests, United Nations Development Programme (UNDP), Intergovernmental Panel on Climate Change (IPCC), Global Environment Facility (GEF), United Nations Conference on Environment and Development (UNCED) and at Intergovernmental Negotiations Committee (INC) deliberations prior to the Earth Summit at Rio. In addition, IGIDR interacts with academics and policy makers through research papers, popular articles, editorials and media events.

IGIDR research activities include

- Faculty involvement in committees and panels.
- Project studies
- Ph.D. theses
- Conference participation
- Research publications and popular articles.

The studies and activities aim to answer questions like:

- What are the issues in global environmental negotiations and how can they be co-operatively addressed?
- What are India's likely emission scenarios under various policies?
- Which sectors will be affected and which sectors can take up mitigating role?

These questions are answered through analysis in three major areas that also include several sub-topics.

- **Analysis of North-South issues**: consumption patterns, IPCC response strategies, GEF-incremental costs and paradigm of partnership, Joint implementation, Analysis of economic instruments to reduce GHG emissions.
- **Top down modelling or national issues for India**: climate change and India's energy policy options: carbon flows in the Indian economy, energy forecasting with macro-economic modelling for investments and imports, consumption patterns in India by rural and urban income groups and associated carbon emissions, trade and environment.
- **Bottom up modelling or sectoral issues for India**: Carbon dioxide emissions by power systems in India, demand side management and auxilliary and transmission losses, Carbon dioxide emissions in building construction through common practices as well as low cost constructions, transport sector, solid waste management and carbon sequestration are some of the on-going themes.

All these areas together cover emission scenarios, mitigation measures, analysis of economic instruments and impact analysis, altogether providing in-depth studies for *integrated analysis*.

IGIDR activities in climate change span 12 research projects, 7 Ph.D. theses though not exclusively dealing with climate change, 50 books, monographs, research articles and important conference articles.

The publications are listed below. When abstracts are readily available, they are also included. Only *a few* of the conference papers are reported.

In addition to climate change studies, IGIDR is involved in wide ranging activities that include research, teaching and training, surveys, consensus building efforts and so on, by analyzing policies and discussing it with various stakeholders. For example, IGIDR is selected by the ministry of environment and forests and UNDP to implement a major project on capacity building in environmental economics where it is bringing a whole range of institutions together to work in a coordinated and collaborative effort in the area of air and water pollution, land, forests and wetlands.

IGIDR is also a core institute with specific responsibility for a subcommittee on environmental economics research where priority areas for research support in environmental economics are identified and such research projects are funded. This project termed "Environmental Management Capacity Building: Technical Assistance Project (EMCaB-TAP)" is aided by the World Bank and implemented by the Ministry of Environment and Forests, Government of India.

Jyoti Parikh

Staff and Students Involved

There is core staff involved in teaching and completing research projects. Other staff also gets involved from time to time according to their interests. The faculty members and project staff involved are listed below alphabetically under each category.

Core Staff:

Parikh Kirit S.	**Founder Director**
Member	Advisory Committee on Global Environmental Issues
Lead author	IPCC II & III Assessment Reports
Parikh Jyoti K.	**Senior Professor**
Member	Scientific and Technical Advisory Panel for UNEP for GEF
Member	AIJ Committee of Ministry of Environment and Forests, Govt. of India, New Delhi.
Convening lead author	IPCC II Assessment Report
Reviewing Editor	IPCC III Assessment Report
Painuly J.P.	**Associate Professor**
Member,	STAP roster
Currently at UNEP RISO, Denmark.	
Reddy B. Sudhakara	Associate Professor
Sharma V.K.	Associate Professor
Ramanathan R.	Associate Professor

Other Contributing Staff:

Panda Manoj	Associate Professor
Babu P.G.	Assistant Professor

In addition, a number of students do their M.Phil. and Ph.D. theses on issues of environmental policy.

Past and present students and their work on climate change

Deb Chattopadhyay	Power Sector
Piyush Tiwari	Construction Sector
Saumen Majumdar	Macroeconomic Model
Kavi Kumar	Impact Model for Agriculture IPCC II Assessment Report.
N. S. Murthy	Models and Scenarios for Sustainable Development.
G. Haripriya	Carbon Sequestration by Indian Forests.
Barnali Nag	Carbon Emissions and infertility.

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List of Projects: Sustainable Development and Climate Change

Title of Project	Funding Agency
Sustainable Development:	
Consumption Pattern by Income Groups and Environmental Implications for India	UNDP, New York
Consumption Patterns: Driving forces of Environmental Stress	UNCED, Geneva.
Structural Transformation Process Towards Sustainable Development.	Swiss Development Corporation
Models for Sustainable Development	ESCAP, Bangkok.
Sustainable Development, Global Commons and India's Policy Options	Rockefeller Foundation.
Climate Change:	
IPCC WG-III SAR Decision Making Framework	IPCC., Second Assessment
Thematic Issues for Climate Change for GEF	IVM, Amsterdam
Limiting Carbon Dioxide Emissions Through Economic Instruments: Application to India and Canada	Canadian International Development Agency, Ottawa, Canada.
Development of Climate Change Impact Model for India	NIES, Japan.
Environmentally Sound Energy Development Strategies (Phase - II) for India.	UNEP, RISO, Denmark.
Environmentally Sound Energy Development Strategies (Phase - I) for India	UNEP, RISO, Denmark.
GHG mitigation from transport sector.	AIT/SIDA, Bangkok.

Ph.D. and M.Phil. Theses Dealing with Climate Change (directly or indirectly)

Researcher Name	Topic	Degree	Status
Piyush Tiwari	Economics of Urban Housing Markets and Construction sector in India	Ph.D.	Completed
Deb Chattopadhyay	Economic Operations of Power System in India (2 Chapters Deal with Power System and Environment Economics)	Ph.D.	Completed
Soumen Majumdar	Energy and Economic Linkages: Impacts, Investments, Efficiency and Pricing Issues	Ph.D.	Completed
Satyanarayana Murthy	Energy, Environment and Sustainable Development	Ph.D.	Submitted
Santha Kavi Kumar	Modelling and Analysis of Global Climate Change Impacts on Indian Agriculture.	Ph.D.	Completed
G.S. Haripriya	Environmental Accounting, Carbon Sequestration Potential and Sustainable Management of Forests in India	Ph.D.	Submitted
Barnali Nag	Economic and Policy Analysis of Climate Change in India	Ph.D.	Ongoing

Ph.D. Supervisor: Professor Jyoti Parikh.
Many of these have resulted in journal articles which are listed.

International Issues

Climate Convention and Policy Instruments

★ Jyoti K.Parikh, Roy Culpeper and Davis Runnalls, J.P. Painuly (Eds.), (1997), *Climate Change and North-South Cooperation*, Tata McGraw Hills Publishing Co. Ltd., New Delhi.

The Earth Summit at Rio in 1992 was important for all the nations on this planet. Biodiversity, sustainable development, climate change, global warming, greenhouse gases and better understanding between the developed and developing countries were some of the issues which absorbed the world community. This book examines the post-summit initiatives and the scientific, political and economic issues from the perspective of joint implementation between the North and South. It comes as a result of a collaborative effort between the authors working in reputed institutions in India and Canada.

★ J.Parikh and K.Arrow (1996), "Decision Making Framework for Climate Change", in *Poverty, Environment and Economic Development*, N.S.S. Narayana and A.Sen (eds), Interline Publications Pvt. Ltd., Bangalore, India, 1996.

Jyoti Parikh (1997), "What is India Doing to Minimise GHG Emissions?: Policies, Programmes and Institutions", Presented at Bangladesh and at COP3 Kyoto.

It is often assumed that the non-Annex I countries are "not doing anything" to reduce greenhouse gas (GHG) emissions. It is shown here with a case study of India, that they are doing a lot. What is more is that there is a consensus in the Government as well as among the people in these societies to follow resource conserving practices. Policies, programmes and institutions are in place. The present article shows that "own-initiative" programmes have already shown results in quantitative terms in several areas : for example, energy efficiency and conservation programmes in terms of reduced energy intensities, coal substitution in terms of reduced shares in total energy and programmes and increased targets through institutions for the renewables. In addition, efforts for plantations generate carbon sinks and efforts for reducing air pollution also reduce GHG emissions. India has cultural traditions that suggest "Reduce consumption, Reuse products and Recycle materials". Moreover, due to sheer poverty and deprivation, carbon emissions are as low as 54 kg and 91 kg per person for rural and urban poor respectively as compared to 250 kg all-India average and 1100 kg world average. The poor often do not have water, fuel, light bulbs and infrastructure such as schools, hospitals, roads or electric power. It is suggested that more support to safeguard good practices emerging from cultural traditions, external funds for "own-initiative" programmes and technology transfer for modern technologies can lead to even greater impact. At the same time, efforts to eliminate poverty and deprivation are needed. Poverty alleviation may reduce emissions due to land-use change but increase the emissions related to improved living standards. The increase due to latter can be reduced by careful planning and better technologies.

Jyoti K. Parikh (1998), "Linking Technology Transfer with Clean Development Mechanism (CDM): A Developing Country Perspective", Presented at Columbia University.

Framework Convention on Climate Change (FCCC) expressly commits the Annex 1 countries to provide financial resources and technology to developing countries so as to control, reduce or prevent GHG emissions. The present paper argues that the ultimate goal of any action in the field of transfer of technology (TT) should not be just applying particular technological solutions to the GHG problem, but to enhance the capabilities of developing countries to assess the need, select, import, assimilate, adapt and develop the appropriate technologies. The paper also looks into the various dimensions of TT that results in capacity building in developing countries. High up-front costs and lack of awareness (information) has resulted in significant under-utilization of capacities, thus acting as major barriers in their diffusion. The paper also looks into the various market and government related barriers forestalling the diffusion of various GHG reducing technologies.

Jyoti Parikh and Kirit Parikh (1998), "Free Ride through Delay: Risk and Accountability for Climate Change", , *Journal of Environment and Development Economics*, Vol.3, Part 3, 1998.

What the concerns of developing countries if they wish to be active and decisive partners in the collective decision making process? These are:

★ represents a book or a monograph.

- What concentration levels along with the associated risks are acceptable to the developing countries?
- How could it be ensured that the risks to the developing countries, and not just the costs to the developed countries, are minimized?
- If Annex-I countries prolong their commitments to reduce the emissions, they use up limited carbon emission budgets available for future. How will it be available to the developing countries when they need it for their growth?

Babu, P.G.,, (1998), "Some Issues in Climate Change Decision-making", *International Journal of Environment and Pollution*, Vol. 9 (2).

Jyoti Parikh, P.G. Babu and K.S. Kavi Kumar, (1997), "Climate Change, North-South Co-operation and Collective Decision-Making Post-Rio", *Journal of International Development*, Vol.9, No.3, 403-413.

P.G. Babu, N.S. Murthy and K.S.Kavi Kumar, (1997), "An Overlapping Generations Model with Exhaustible Resources and Stock Pollution", *Ecological Economics*, 21, IGIDR-RP No. 232.

R. Ramanathan, (1997), "A Multi-Criteria Framework to the Global Negotiations on Climate Change", IGIDR-DP No.141. A revised version has been published in the *IEEE Transactions on Systems, Man and Cybernetics - Part C: Applications and Reviews*, 28(4), November 1998, 541-548.

Global negotiations on environmental issues are essentially multidimensional: there is no single factor that governs the concerns of all parties involved. In this paper, we review some of the studies in the literature that analyze the outcomes of these negotiations and estimate the costs and benefits for different parties in adopting any particular position in the process. The multidimensional nature of these negotiations is brought out. We suggest a multicriteria methodology to support these negotiations, and we illustrate how it can be used to allocate the greenhouse gas reduction targets for a future year. The suggested methodology, which makes special reference to the multiplicative version of the Analytic Hierarchy Process (multiplicative AHP or MAHP), is shown to aid group decisions in negotiations.

P.G.Babu and Bibhas Saha, (1996), "Efficient Emission Reduction through Joint Implementation", *Environment and Development Economics*, Vol.1(4), IGIDR-RP No. 239.

This paper models joint implementation (JI) for emission reduction between a developed and a developing country. When the per unit price of JI abatement is negotiated, the relative payoffs deviate from the ratio of bargaining powers. When firms bargain, country-wise gains can increase with a greater abatement target. But if the governments bargain, the developing country's gains increase at the expense of the developed country as the target increases. However, the Pareto optimal JI can be achieved only when the governments negotiate over both abatement as well as transfer.

Jyoti Parikh, (1995), "North-South Cooperation in Climate Change through Joint Implementation", *International Environmental Affairs*. 7(1), IGIDR-RP No.142.

In view of on-going debate on whether Joint Implementation (JI) for projects addressing climate change i.e., by the North investing in the South should be permitted the article examines a variety of issues ranging from cost-effectiveness to North, sustainable development in the South, fair compensation, debate about the carbon-sink projects, links with carbon reduction targets by the North, effectiveness from Global environmental objectives. Some of the issues are analysed by several view points but primarily from the Southern perspectives. The article suggests that North can consider JI among portfolio of options for climate change mitigation. Even if credit for JI is not given internationally, it is in the interest of North to give internal credit for JI to private enterprises in terms of carbon tax rebates. The analysis indicates that while joint implementation in energy efficiency benefits the south, it cannot be said the same about the "carbon-sink" projects where land rights, risk sharing, long term opportunity costs and threats to biodiversity are some of the problems. JI should be only considered in addition to the Annex I countries commitments as one of the options in portfolio to contain developing countries emissions without compromising their development. The article concludes by supporting pilot phase of JI, which should be closed monitored.

Jyoti Parikh, (1994), "North-South Issues for Climate Change", *Economic and Political Weekly*, pp. 2940-2943, November 5-12.

The debate on climate change acquires a different dimension when the disparities between regions is considered in terms of responsibilities for emissions and concentrations and vulnerability to the effects brought on

by climate change. This article reflects on North-South issues surrounding the climate change debate. The author also highlights certain issues which are difficult to address in conventional cost-benefit analysis.

Jyoti Parikh, (1994), "Joint Implementation Survey: II Supporting North-South Cooperation", *Climate Change Bulletin*, Issue 4, 3rd Quarter.

Jyoti Parikh, P.G. Babu and K.Parikh, (1994), "Decision Making Framework to Address Climate Change", in *Steps Towards a Decision making Framework to Address Climate Change*, G.Pillet and F.Gassmann (Eds.), Paul Scherrer Institute, Switzerland.

Consumption Patterns

★ Jyoti Parikh, Kirit Parikh, Subir Gokarn, J.P. Painuly, Bibhas Saha and Vibhooti Shukla, (1991), "Consumption Patterns: The Driving Force of Environmental Stress", Prepared for the United Nations Conference on Environment and Development (UNCED), by IGIDR.

Jyoti Parikh, Manoj Panda and N. S. Murthy, (1997), "Consumption Pattern by Income Groups and Carbon dioxide Implications for India: 1990-2010", *International Journal of Global Energy Issues*, Vol.9, Nos.4-5.

J. Parikh and J.P. Painuly, (1994), "Population, Consumption Patterns and Global Warming", *AMBIO*, Vol. 23, No. 7.

Jyoti Parikh and Kirit Parikh, (1991), "Role of Unsustainable Consumption Patterns and Population in Global Environmental Stress", *International Journal of Sustainable Development*, Vol.1, No.1, pp.108-118.

IPCC Related Issues

K.Arrow, J.Parikh, J.Pillet, K.S. Kavi Kumar and P.G. Babu (1996), "Decision Making Framework to Address Climate Change", *Chapter 2 of IPCC WG III, Second Assessment Report*, Cambridge Univ. Press, Cambridge, U.K.

K.J. Arrow, J.Parikh, G.Pillet, et.al., (1996), "Decision-Making Framework for Addressing Climate Change", in J.P. Bruce, H.Lee and E.F. Haites (Ed.), *Climate Change 1995: Economic and Social Dimensions of Climate Change*, Cambridge University Press.

Jyoti Parikh (1992), "IPCC Response Strategies Unfair to the South", *Nature*, Vol.360, pp.507-508, 10th December.

GEF Related Issues

Vinish Kathuria and Jyoti K. Parikh, "Technology Transfer for GHG Reduction: A Framework and Case Studies for India".

Framework Convention on Climate Change (FCCC) expressly commits the Annex 1 countries to provide financial resources and technology to developing countries so as to control, reduce or prevent GHG emissions. The present paper argues that the ultimate goal of any action in the field of transfer of technology (TT) should not be just applying particular technological solutions to the GHG problem, but to enhance the capabilities of developing countries to assess the need, select, import, assimilate, adapt and develop the appropriate technologies. The paper also looks into the various dimensions of TT that results in capacity building in developing countries. Using case studies of two GHG reducing technologies - one from the demand side (Compact Fluorescent Lamp, CFL) and other from the supply side (Photo-voltaic Cells, PVs), the present paper tries to find out whether the TT has been adequate in significant capacity building or not. The case studies show that the technology absorption is still incomplete. High up-front costs and lack of awareness (information) has resulted in significant under-utilization of capacities, thus acting as major barriers in their diffusion. The paper also looks into the various market and government related barriers forestalling the diffusion of various GHG reducing technologies.

J.K. Parikh and R. Banerjee, (1994), "Promoting Faster Diffusion of Energy Efficiency with Type 1 Projects", International Journal of Environment and Pollution, Vol. 4, Nos. 1/2.

The Framework on Climate Change Convention provides for incremental costs for those measures that help developing countries to reduce carbon dioxide emissions. The Global Environmental Facility (GEF) was set up to fund projects to provide incremental costs. Some argue that this means that fossil-fuel efficient technologies should not be included because they are economic on their own right and there is no 'incrementality' about them. This paper argues that even if they are 'economic', it is desirable to set up programmes for faster diffusion to achieve better results. An illustrative example of the promotion of energy-efficient motors (EEM) in the high tension industry sector in Maharashtra State in India is presented. In the cost-sharing programme case, 50% of the incremental cost difference of the EEM is borne by the GEF. A programme results in *additional* adoption of 203 000 motors and a net saving of 1.6 million tonnes of carbon, reducing the overall cost to $16 per tonne of carbon. The GEF would find it worthwhile to promote Type 1 projects that could lead to reduction of carbon dioxide emission.

Macroeconomic Models

★ Jyoti K Parikh, (1993), "Response Strategies to Climate Change by India", Submitted to Ministry of Environment and Forests for ADB Project.

★ Jyoti K. Parikh (Ed.), (1996), *Energy Models: Beyond 2000*, Jyoti K.Parikh, Tata McGraw Hills Publishing Co. Ltd., New Delhi.

N.S. Murthy, M. Panda and J. Parikh, (1997), "Economic Growth, Energy Demand and Carbon Dioxide Emissions in India: 1990-2020", Environment and Development Economics, Vol. 2. IGIDR-RP No. 271.

This article investigates the linkages between economic growth, energy consumption and carbon dioxide (CO_2) emissions in India by analysing the structure of production and consumption in the Indian economy. We begin with an examination of the consumption pattern of six different income classes, three each in urban and rural India, and then estimate the direct and indirect energy and CO_2 emission coefficients for supporting production in various sectors. This provides us with a basis for estimating the energy and emission content of the consumption baskets of the different income classes in India. CO_2 emissions are projected to increase from 0.18 tonnes of carbon (tC) per capita in 1990 to about 0.62 tC per capital in 2020 under the reference scenario which corresponds to a GDP growth rate of 5.5% per annum. We then analyse scenarios of technology improvement in which emissions are reduced to 0.47 tC per capita in 2020. Our projection methodology takes into account the changes in aggregate consumption pattern due to mobility of the population across the income classes and from rural to urban areas, besides the increase in per capita consumption of all classes.

Murthy, N.S., Manoj Panda, Jyoti Parikh, (1997), "Economic development, poverty reduction and carbon emissions in India", *Energy Economics* 19, pp.327-354. IGIDR-RP 268.

This paper analyses carbon dioxide (CO_2) emissions from energy consumption using in input-output (I-O) model, for different sectors of the Indian economy in 1990. Alternative scenarios are developed for 2005. The I-O model considers structural changes in aggregate consumption behaviour and sectoral composition of output between 1990 and 2005. Alternative energy efficiency programmes are compared for their potential CO_2 reduction in 2005. Under ambitious poverty reduction targets, the annual growth rate of CO_2 emissions increases from 4.8% to 5.9%. However, energy efficiency programmes could reduce the average annual growth rate of CO_2 emissions back to 4.9%. It is also seen that reducing CO_2 through oil conservation is a preferred policy for India compared with saving coal.

N. Satyanarayana Murthy, Manoj Panda and Kirit Parikh, "CO_2 Emissions Reduction Strategies and Economic Development of India", To be published in EDE.

This paper examines the consequences of alternative CO_2 emission reduction strategies on economic development and, in particular, the implications for the poor by empirically implementing an economy-wide model for India over a 35-year time horizon. A multi-sectoral, inter-temporal model in the activity analysis framework is used for this purpose. The model with specific technological alternatives,

endogenous income distribution, truly dynamic behaviour and covering the whole economy is an integrated top-down bottom-up model. The results show that CO_2 emission reduction imposes costs in terms of lower GDP and higher poverty. Cumulative emission reduction targets are, however, preferable to annual reduction targets and that a dynamically optimum strategy can help reduce the burden of emission reductions. The scenarios involving compensation for the loss in welfare are not very encouraging as they require large capital inflows. Contrasted with these, scenarios involving tradable emission quota give India an incentive to be carbon efficient. It becomes a net seller for the first 25 years and because of reduction in carbon intensity it would demand less in later years when it becomes a net buyer. The results suggest that for India, and other developing countries, the window of opportunity to sell carbon quotas is the next two decades or so.

Saumen Majumdar and Jyoti Parikh (1997), "Energy Demand Forecasts with Investment Constraints", , *Journal of Forecasting*, Vol.15, 549-576, 1997. IGIDR-RP No.251.

Jyoti Parikh and Subir Gokarn, (1993), "Climate Change and India's Energy Policy Options: New Perspectives on Sectoral CO_2 Emissions and Incremental Costs", *Global Environmental Change*, 3(3).

This paper presents an analysis of CO_2 emissions in the Indian economy and examines the implications of alternative policies to reduce them. This analysis goes beyond the conventional approaches of looking at energy supply structure and end-uses of energy. Instead, it examines flows of energy in the economy of India through a 60-sector input-output model. The authors show that direct emissions of CO_2 are highest in the electricity sector followed by iron and steel, road and air transport, and coal tar. If a similar analysis by final demand is carried out, incorporating both direct and indirect emissions, the highest emitting sector is construction, followed by food crops, road and air transport, and so on. This indicates that, in addition to energy efficiency, improving construction efficiency, could also lead to CO_2 savings (by using less energy-intensive materials or by making optimal use of them). It is also shown, by generating alternative energy policy scenarios, that if India saves energy from coal rather than from imported oil to reduce CO_2 emission, then savings foregone are more than Rs.5634 million for only 10% of energy saving. Sectoral priorities also change. To save coal, the power sector, iron and steel, coal tar, etc will require attention. To save oil, transport, refinery and fertilizers will require attention. Similar arguments are made for substitution of coal by oil and gas. Additional costs of Rs. 10 billion would be incurred by 10% substitution of coal by oil and gas as compared to the current policy of substituting oil and gas with coal. This article offers another interpretation of the notion of 'incremental costs' though comparison of two alternative development strategies.

D.Chattopadhyay and Saumen Majumdar, (1993), "Impact of Oil Price Shock on Carbon Emissions in India: An Econometric Analysis", IGIDR-DP No. 95.

Sectoral Studies

Power Sector

★ Jyoti Parikh, J.P.Painuly and K.Bhattacharya, (1996), *Environmentally Sound Energy Efficient Strategies: A Case Study of the Power Sector in India*, Report submitted to UNEP Collaborating Centre on Energy and Environment, RISO, Denmark, 1996.

★ Jyoti Parikh, B.Sudhakara Reddy and Rangan Banerjee, (1994), *Planning for Demand Side Management (DSM) Options in the Electricity Sector*, Tata McGraw Hills Publishing Co. Ltd.,New Delhi.

B.Sudhakara Reddy and Jyoti K. Parikh, (1997), "Economic and Environmental Impacts of Demand Side Management Programmes", *Energy Policy*, Vol.25, No.3, 1997.

This paper studies 12 DSM options which could be implemented in various categories of industries in India. It examines their costs and economic and environmental impacts, and estimates yearly targets for the next 15 years (1995-2010). The results indicate that savings of 24616 MW and 122991 GWh can be achieved over the base line growth with a cost of Rs. 325568 million (in present values). Finally, the potential environmental trade-off between system cost and power plant emission reductions is discussed. This is an effort to carry out bottom-up modelling, which mainly looks at programme costs where

much of the funds come from customers themselves. However, they require extra support through DSM programmes.

D.Chattopadhyay and J.K. Parikh, (1993), "CO_2 Emissions Reduction from Power System in India", , *Natural Resources Forum*, Vol. 17, No.4, pp.251-261, Nov. 1993.

The power system in India accounts for nearly one-third of CO_2 emissions of the country as a whole. A comparison of some of the technical options to reduce CO_2 emissions is presented in this paper. A linear programming framework is used to simulate the integrated optimal operation of the three regional grids, and it is shown that such operations lead to lower fuel costs and the lower CO_2 emissions. The same framework is used to see how a rise in thermal efficiency translates into a CO_2 emissions reduction. Reduced fuel requirements also lead to reductions in other pollutants i.e. SO_2, NO_x and fly ash. The reductions in CO_2 emissions and other pollutants are at far lower cost in the case of integrated optimal operations as compared to reductions due to gas fuelled generation or thermal efficiency improvements. However, thermal efficiency improvements under optimal integrated operations result in much higher reductions in operating costs, coal consumption and total emissions of all pollutants.

Urban Development and Construction Sector

Piyush Tiwari, Jyoti Parikh and Vinod Sharma, (1996), "Performance Evaluation of Cost Effective Buildings: A Cost, Emissions and Employment Point of View", Building and Environment, IGIDR-RP No. 143.

Given the uphill task of providing housing for all within short time frame and making them affordable, the construction activity has to look into various low cost options of construction using locally available building materials. This paper evaluates various dimensions of low cost techniques. For the same engineering criterion to be satisfied, a room of dimension 3.5m x 3.5m 3.14m constructed using low cost techniques costs only 66% of the conventional construction. Since, these materials are low energy consuming, the associated carbon dioxide emissions are also low. The carbon dioxide emissions with conventional method of construction is 5.88 tonnes compared to 2.42 tonnes in the low cost method of construction. There is a possibility of further reducing the emissions by 23% at 0.03% increase in the cost. Another implicit advantage for a country like India with surplus labour force, is that the employment increases with reduction in carbon dioxide emissions due to switch towards labour intensive techniques.

Jyoti Parikh and Vibhooti Shukla, (1995), "Urbanization, Energy Use and Greenhouse Effects in Economic Development: Results from a Cross-national Study of Developing Countries", *Global Environmental Change*, Vol 5, No.2 pp. 87-103.

This paper seeks an exploratory assessment of the possible global greenhouse consequences of economic development in general and urbanization in particular, especially insofar as they relate to changing patterns of energy use. First, the nature of the relationship between urbanization and increased resource use is elaborated upon, and the impact of the development transition upon levels of energy consumption is empirically analyzed in a multiple regression framework, using cross-national variations in urbanization and other development indicators to estimate a fixed-effects model of the determinants of energy usage. The same set of hypothesized determinants is then used to measure their contribution to estimated greenhouse gas (GHG) emissions for the full set of countries. Next, we focus upon the subsample of developing countries to study the effects of urbanization upon their evolving profiles of energy use, disaggregated by final use sector and fuel type, and estimate the magnitude of the greenhouse effects attributable to each of these component fuel uses. Finally, we present some of the implications of the results for policies toward urbanization and energy strategies for developing countries in the context of global environmental management imperatives.

Piyush Tiwari and Jyoti Parikh, (1995), "Cost of CO_2 Reduction in Building Construction", *Energy, The International Journal*, 20(6), IGIDR-RP-145.

The construction sector accounts for the highest share (17%) of CO_2 emissions by final demand in the Indian economy because it uses highly energy-intensive materials and the need for shelters is very high. This sector is highly vulnerable to changes in pricing structure. Various construction techniques have been analyzed and it is shown that a room of length 3.5 m, breadth 3.5m and height 3.14 m would lead to about 6 tonnes of CO_2 emissions if constructed at the minimum possible cost. These costs are distributed as follows: foundation – 25%, walls – 46%, roof – 16%, floor – 4.8%, and plastering – 8.6%. If cement is replaced by lime, the cost of construction increases by 0.14% for a 3% reduction in emissions. Further reduction in emissions is achieved by using stone

instead of bricks. The cost increases by 0.54% for a 4% reduction. However, for a 21% reduction, the cost escalates by 27%. We also examine impacts on employment, materials used etc., due to changes in techniques.

Transport Sector

★ Jyoti Parikh, Manoj K Panda, R. Ramanathan, Piyush Tiwari and N.S. Murthy, *Structural Transformation Process Towards Sustainable Development in India: Macro-economic Scenarios and Analysis of Transport and Construction Sectors*, Report submitted to INFRAS, Zurich.

R.Ramanathan and Jyoti K. Parikh, (1999), "Transport Sector in India: An Analysis in the Context of Sustainable Development", *Transport Policy*, (6)1, 35-45.

A brief review of the Indian transport sector in the past few decades is provided in this paper. It is shown that the period has witnessed a gradual transformation from rail-dominated transport to road-dominated transport. Infrastructure bottlenecks such as lack of roads and railways network and aircraft are the limiting factors. Emission of local pollutants and carbon dioxide due to fuel consumption in transport have been estimated. Future transport performance is projected using cointegrating econometric models. The models project that passenger traffic in India is likely to grow at more than 8% per year and freight traffic at more than 5% per year during the period 1990-2021. This will increase the energy consumption and CO_2 emissions at equivalent rates. The effects of various policy options aimed at reducing energy consumption and CO_2 emission are analyzed using a scenario approach. The scenario analysis shows that efficiency improvements can reduce future energy consumption and CO_2 emissions by 26%. If the modal split is promoted in favour of public transport modes (rail and public road transport), about 45% reduction in energy requirements and CO2 emissions is expected.

R. Ramanathan, (1996), "Indian Transport Sector: Energy and Environmental Implications", *Energy Sources*, 18(7), 791-805.

Transport is an essential ingredient for economic development of a nation. It also has energy and environmental implications. This paper discusses the trends in energy consumption and environmental emissions in the context of the operations of the Indian transportation sector. It provides a brief overview of the performance of the sector, and shows that the energy consumption pattern is closely related to it. The analysis shows that there has been improvements in efficiencies of all the modes of transport (except the coal traction of railways) in the last decade. The emission of local air pollutants due to road transport is estimated. Finally, the emissions of carbon dioxide due to the operation of the transport sector are also estimated. Diesel vehicles emit maximum amount carbon dioxide (17.7 million tonnes of carbon equivalent out of 26.45), and can be advantageously considered for controlling future carbon dioxide emissions.

Jyoti K. Parikh and R. Ramanathan, (1997), "Trends in Transport Sector in India", *Energy Scenario*, 1(1), 15-20.

Carbon Sequestration

★ Jyoti K.Parikh and B.Sudhakara Reddy, (Eds.) (1997), *Sustainable Regeneration of Degraded Lands through People's Participation*, Tata McGraw Hill Publishing Co.Ltd., New Delhi, 1997.

Haripriya G.S. and Jyoti K. Parikh, (1998), "Socioeconomic Development and Demand for Timber Products: A Panel Data Analysis", Global Environmental Change, (8)3, pp. 249-262

This paper analyses the relationship between consumption of timber products and socioeconomic variables by estimating timber consumption functions, using fixed and random effects methods. To this end, we regress the per capita consumption of timber products (roundwood equivalent) of a sample of developed and developing countries over the period 1976 to 1989 on various national indicators relevant to the development transition. The panel nature of the data facilitates us to track trends in consumption as economic development proceeds. The results suggest that the response of the timber consumption with respect to changes in the variables is sensitive to factors specific to the country concerned. The coefficients of all the variables are inelastic and it is found that income, density and price are the main determinant variables although other variables also affect the consumption. The observations of this study are expected to assist the policy makers in projecting future requirements of timber with more reliability.

Jyoti Parikh and B.Sudhakara Reddy, (1998), "Revisiting Carbon Sequestration for Joint Implementation", *Energy Conversion and Management.* (forthcoming).

In this paper the cost of carbon sequestration through a tree plantation was estimated based on the data from a village in the Karnataka state in India. The major costs of the plantation programme such as land cost, setup and development costs are during the initial years while there are maintenance costs during the life cycle of the plantation. Other than environmental benefits, the plantation provides monetary benefits through the sale of products as well as employment opportunities to local people. For a Joint Implementation (JI) programme, we consider here two scenarios (i) no cutting after trees reach maturity, i.e., stock unchanged and (ii) sustainable cutting (partial harvesting of stock and replanting) for 12 year and 20 year cycles. The cost of carbon sequestration ranges from $16 to $18 per tonne of carbon. However, it is pointed out that the JI should neither be based on incremental costs (as given here) nor full costs but on the basis of sharing benefits fairly. This would require information on the long-run marginal costs or avoided costs in the industrialized countries. This is often not known to the developing countries resulting in asymmetry of information.

Impact on Agriculture Sector

★ Jyoti Parikh and K.S.Kavi Kumar, (1998), "Climate Change Impacts on Indian Agriculture: Ricardian Approach", In Dinar et.al., *Measuring the Impact of Climate Change on Indian Agriculture*, World Bank Technical Paper No. 402, Washington, D.C.

K.S.Kavi Kumar and Jyoti Parikh, (1997), "Climate Change Impacts on Indian Agriculture: Results from Crop Modelling Approach", Presented at the workshop, *Measuring the Impacts of Climate Change on Indian and Brazilian agriculture*, held at the World Bank, Washington D.C., 5-7 May 1997.

K.S. Kavi Kumar and Jyoti Parikh, "Climate Change Impacts on Indian Agriculture: Net Revenue Approach - Analysis of Annual Effects", Communicated for journal publication.

Jyoti K. Parikh and R. Ramanathan, (1998), "Linkages among Energy, Agriculture and Environment in Rural India", *Energy Economics*, Vol.21, No.6, pp.561-585.

The interconnections between energy, agriculture and environment in rural India are analyzed in this paper using a systems perspective. Rural areas of developing countries use biomass for fuel, fodder, fertilizer and other purposes, and it is necessary to understand the fuel-fodder-fertilizer relationships for optimal biomass allocation. The allocation is explored using a linear programming model. First, the model is validated by simulating it using data for the year 1990-91. The model is then applied for the year 2000, and several scenarios are generated to obtain answers to various policy questions. The results show that it is necessary to increase fertilizer consumption, to increase efficiencies of cooking stoves, to improve livestock feed, and/or to decrease population growth for maximizing the revenue generated in the rural system of India. It shows that when the prices of fertilizers increase, a large increase in kerosene requirements can be expected. It also points to the necessity to increase kerosene consumption to reduce emissions (due to non-commercial fuels) and soil fertility loss. For example, the carbon dioxide emissions associated with the scenarios range from 137.50 to 62.50 million tons (in carbon equivalent terms) for the high and low cases respectively. Correspondingly, kerosene consumption ranges from 0.18 kilo tons to 15.49 kilo tons

"Rural Energy Planning Incorporating Energy and Agricultural Interactions", *RERIC - International Energy Journal*, 17(1), 73-81.

Indira Gandhi Institute of Development Research (IGIDR)

Indira Gandhi Institute of Development Research (IGIDR), an advanced research institute in Mumbai, was inaugurated by Prime Minister Rajiv Gandhi in December 1987. It is established by the Reserve Bank of India for the study of national and global issues relating to economic development to promote and conduct research, to teach and train and to promote national and international collaboration.

The institute is located on a 14 acre site on a hillside 20 minutes drive from Mumbai's national and international airports.

Current research activities cover the following areas:

a) macroeconomic, trade, monetary and fiscal policies, pace and sequence of reforms and applied general equilibrium modelling.

b) poverty, employment and redistribution.

c) energy systems.

d) technology assessment.

e) environment and development - sustainable development, natural resource accounting, greenhouse effects and global negotiations.

f) agricultural and rural development.

g) comparative studies.

h) industrial structure, conduct and performance.

To facilitate dissemination of its policy oriented research the Institute encourages work in collaboration with government departments and international agencies. Past work has involved studies for the economic advisory council to the Prime Minister, Planning Commission, Department of Energy, Ministry of Environment and Forests, UNCED, UNDP, UNCTAD, ESCAP, The Asian Development Bank and the World Bank.

The Institute frequently hosts national and international conferences.

The Institute is a deemed university and conducts M.Phil/Ph.D. programmes in development policy. It is designed to create professionals who are capable of conducting policy analysis, relating to national and global development issues, in a quantitative and inter-disciplinary manner.

The Institute has at present some 37 faculty members and 50 M.Phil/Ph.D. students.

NATIONAL CHEMICAL LABORATORY

The National Chemical Laboratory, was established in January, 1950 under the Council of Scientific & Industrial Research (CSIR). Its mission is to *" advance knowledge and to apply chemical sciences for the good of people"*.

Today NCL is a vibrant organization that is striving to deliver outstanding performances in each sphere of its activities and live up to the mission that it was entrusted with. NCL has one of the best track records in the nation through its contributions to the corpus of human knowledge in the area of chemistry and allied disciplines, its contributions via the development of process, materials and products, its ability to maintain national resource centers of expertise, facilities, information and knowledge, its contributions to the Indian and global industry through R&D services, its contribution in creating and training a cadre of highly skilled scientific workers and its role in national and international scientific associations, governmental bodies etc.

The Vision of NCL is to:

- Practice highest quality science
- Provide highest degree of innovation in applied research
- Effectively couple R&D goals to market needs
- Forge national and global partnerships in R&D to deliver
- Processes and products to the market place

The vision has been achieved by sustaining undisputed leadership in chemical sciences and encouraging basic research leading to the emergence of new intellectual frontiers as well as innovation in technology.

FACILITIES AVAILABLE

NCL has world-class infrastructure to support the science & technology activities. The facilities include pilot plants, sophisticated instruments, information infrastructure, and workshop. Services based on these facilities are also made available to clients.

Some of the facilities in different areas are listed under following heads:

- Catalysis
- Polymers
- Biotechnology
- Organic Chemical Technology
- Materials
- Process Design & Development
- Pilot Plants
- Analytical Sciences

SERVICES OFFERED

Services Offered and Modes of Interaction

NCL focuses on developing state-of-the-art technologies for clients in India and abroad and associated fundamental research.

Licensing

- Emerging from exploratory research funded in-house
- Restricted to technology intensive areas
- Normally protected by patents
- Further development of contracts feasible for scale-up and product development
- Patent licensing

Contract Research

- Well defined projects identified by industry / laboratory
- Undertaken only if completely funded by industry
- Limited exclusivity to industrial sponsor

Collaborative Projects

- Based on complementary strengths
- Intellectual property rights owned jointly

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- Sharing of benefits from third party licensing

Consultancy Services

- Product, application and market development
- Process improvements and modernization
- Process simulation and optimization
- Process development and engineering
- Technology search, evaluation and selection

Information Based Products and Services

- Technology monitoring, assessment and forecasting
- Multi-client studies on emerging technologies and new products
- Technical information retrieval, collection, documentation and management

Technical Services

- Analysis and testing
- Training
- Technical assistance
- Fabrication / production of special products

RESEARCH WORK

NCL is a science and knowledge based research, development and consulting organization. Since established, NCL is internationally known for its excellence in scientific research in chemistry and chemical engineering, and for its outstanding track record of industrial research.

NCL provides a unique global R&D platform with its client base today extending to several leading companies, both in India and abroad.

Activities

NCL's activities can be categorized into the following categories:

- Exploratory research and science
- Applied research and technology
- Consultancy and scientific services
- Housing and maintaining national resource centers
- Education, training, dissemination and popularization
- Contributions to the scientific professions

Climate Change impact issues related activities at National Chemical Laboratory

Considerable research work is carried out at NCL, Pune on alternatives to CFC's for refrigeration and air conditioning. Some areas are as follows:

- Alternative to CFC'c for Air Conditioning and Refrigeration (AC & R) sector
- Clean Development Mechanism (CDM) simulation for hydrocarbon refrigerators
- Montreal Protocol – Kyoto Protocol cross cutting issues

NCL has been involved in various national and international activities. NCL was actively involved in the India's Country Program and its implementation. NCL is a member of ECOFRIG project since 1993 and HIDECOR project since 1999 along with IIT, Delhi and other institutions. Both of these projects are sponsored by Swiss Agency for Development and Cooperation (SDC), New Delhi and INFRAS, Zurich.

Dr. Devotta is a member for the UNEP Technology Options Committee for Refrigeration and airconditiong under the Montreal Protocol and also a member of the IPCC WG III group for Special Report on Technology Transfer. Dr. Devotta is the National

coordinator for the International Institute for Refrigeration. He is recipient of 1997 Stratosperic Ozone Protection Award of US-EPA for technical and scientific leadership to eliminate CFC's in the refrigeration sector.

Exploratory Research and Science

Primarily involves explorations on a subject to discover principles and improved understanding. This is often the necessary precursor to applied research. Performed largely through research scholars studying for a Ph. D. under the guidance of our scientists. Activity is often funded by grants and project mode funding from national and multi-national government agencies. Sometimes funded with a long-term perspective by industry. Output is often in the form of research publications and student dissertations. Outcome is an improved understanding of chemicals, materials, organisms, phenomenon and techniques that can be used in applied research.

Applied Research and Technology

Primarily involves research and development directed towards developing a process, material or product that can deliver potential benefits to industry and the people at large. Often market driven. Performed largely through staff, project assistants and sometimes research scholars. Activity is mostly funded by the industry and project mode funding from national and multi-national government agencies. Output is in the form of patents, non-patented proprietary technology (and engineering packages), confidential reports to clients and specialized software. Outcomes include processes, materials and products that are potential wealth creators and direct impact on the bottom line of companies through improvements, alternative cost-effective routes and inventions.

KEY PERSONNEL

Directors

Dr. Paul Ratnasamy ,Head, Research Planning & Business Development (RPBD)

Dr. R. R. Hirwani, Head, Scientific & Management Information Systems (SMIS)

Heads of Business Areas

Catalysis	Dr.A.V.Ramaswamy
Polymers	Dr.S.Sivaram
Biotechnology	Dr.P.K.Ranjekar
Organic Chemical Technology	Dr.T. Ravindranathan
Materials	Dr.P.Ganguly

NCL Fact file

Human Resources

Scientific Staff : 350 (Ph.D.s - 200)
With specialization in Chemistry, Material Sciences, Life Sciences and Chemical Engineering

Doctorate and Post-doctoral Fellows - approx. 300

Physical Resources

- State-of-the-art analytical and scientific facilities
- Information services
- Pilot plant for the fine chemicals and catalyst manufacturing
- High pressure hydrogenation facilities
- Glass blowing shop

INTERNATIONAL SUPPORT

NCL's clients include Indian, foreign and multi-national companies. They have served both global giants and start-ups. NCL has embraced and realigned itself to the wave of globalization while still striving to maintain its influence on Indian companies.

Some of the Global Clients are listed as below:

- ARCO, USA
- Dow Chemicals, USA
- DuPont, USA
- Eastman Chem. Co., USA
- FMC Corp, USA
- GE Plastics, USA
- ICI, Belgium
- IRDCI, Ministry of Industry and Trade, Indonesia
- JPCID, Peoples' Republic of China
- Neste Oil Corporation, Finland
- Polaroid Corporation, USA
- Rhone Poulenc, France
- Unilever, UK
- UOP Inc., USA

National Chemical Laboratory,
Pune 411008, INDIA.

Dr. Paul Ratnasamy
Director

July 25, 2000

Mr. Vinay Deodhar
Project Finance Specialist
The Louis Berger Group Inc.
C-6/7, Safdarjung Development Area
New Delhi 110 016

Fax : 011-6518807

Dear Mr. Deodhar,

GEP-CCS Project : CLIN 04 – Institutions to Co-host the Forum on Climate Change Research

This is with reference to the dialogue we had with you on the above. We are glad to confirm our in principle acceptance to host a forum for the research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing paper would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

With kind regards,

Yours sincerely,

P. Ratnasamy

(Paul Ratnasamy)

☎ : (91)-20- 5893030 (Off)
(91)-20-5898906 (Res)

Fax : (91)-20-5893355/5894761
e-mail : prs@ems.ncl.res.in
URL : http://www.ncl-india.org

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Information needed for Forum Institution

a) General

Organization Name	**National Chemical Laboratory**
Address	Dr.Homi Bhabha Road, Pune 411 008
Type of institution (Academic, Research, Industry)	Research (& Development) in Chemistry and chemical technology
Contact Name, Telephone, Fax, E-mail	Dr.S.Devotta, Scientist and Head, Process Development Division Ph.020-5893058 Fax: 020-5893359 Email : sdevotta@pd.ncl.res.in
Facilities available at each potential location	Each division in NCL has ready facilities of telephone, telefax , e-mail and photocopying

b) Conferencing Facilities

Size of meeting/conference rooms	• **Auditorium to accommodate 500 persons at a time** • **Lecture hall to accommodate 150 persons at a time** • **Additionally one conference hall and one board room to accommodate 10 to 15 persons (each)** • **Each division has meeting rooms to accommodate 10 persons** • **Computers/projectors, copying can be arranged in the meetings**
Catering facilities for participants	• **With prior intimation catering arrangement can be done to serve tea / coffee / snacks** • **Lunch can be arranged in the Cafeteria (centralized arrangement)**
Recent conferences and forums at organization location	• **Our conference facilities are being used not only by NCL but by other organizations** • **We are equipped to cater international conferences as well**

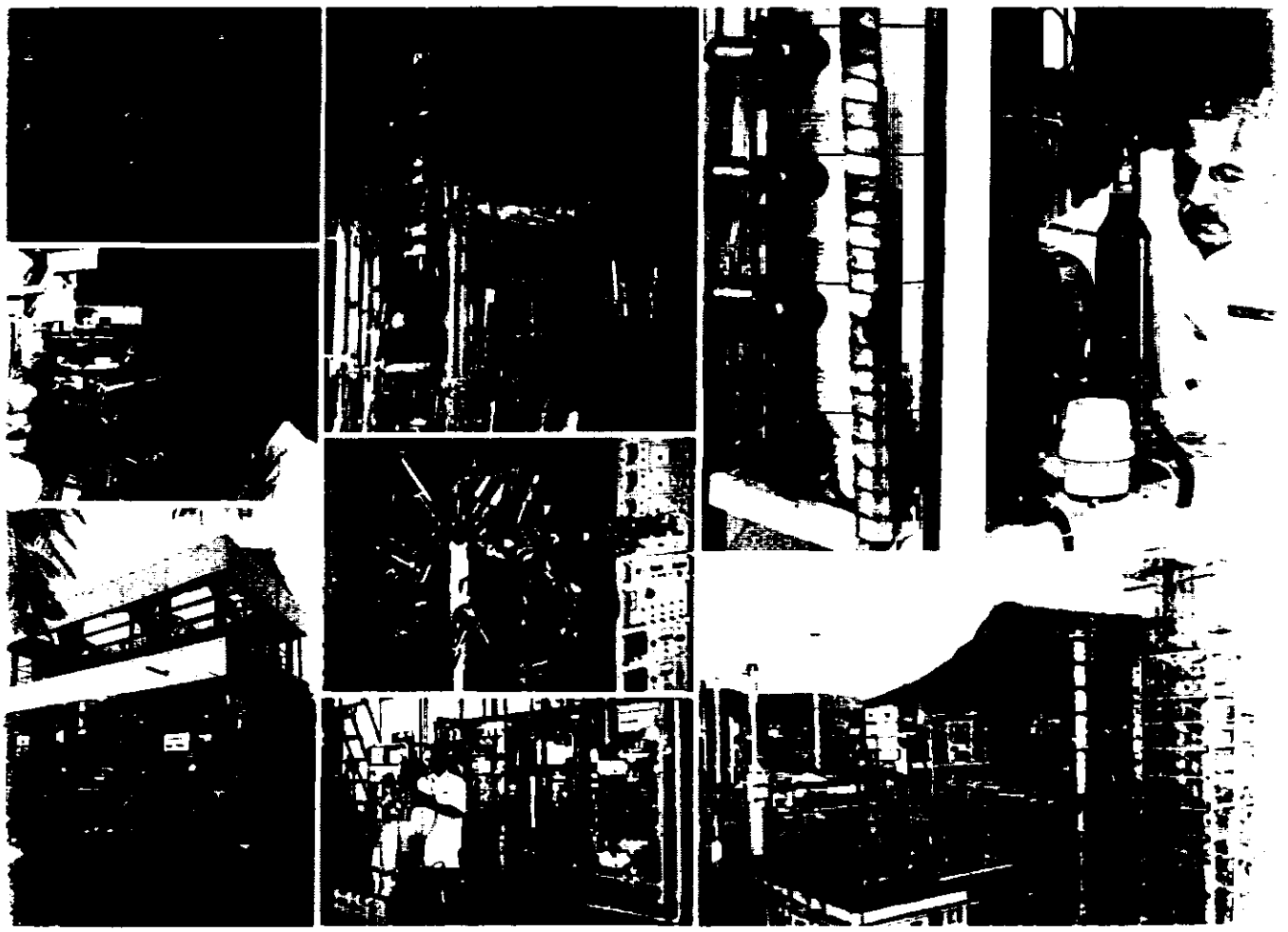
c) Accommodation/logistics

Housing accommodations nearby (rates)	It is possible to accommodate 20 persons in our own guest house. Arrangements for extra 50 persons can be done in our neighbouring institutions
Local and international transport available	Pune is well connected by air and rail to major cities like Mumbai, Delhi, Chennai, Bangalore

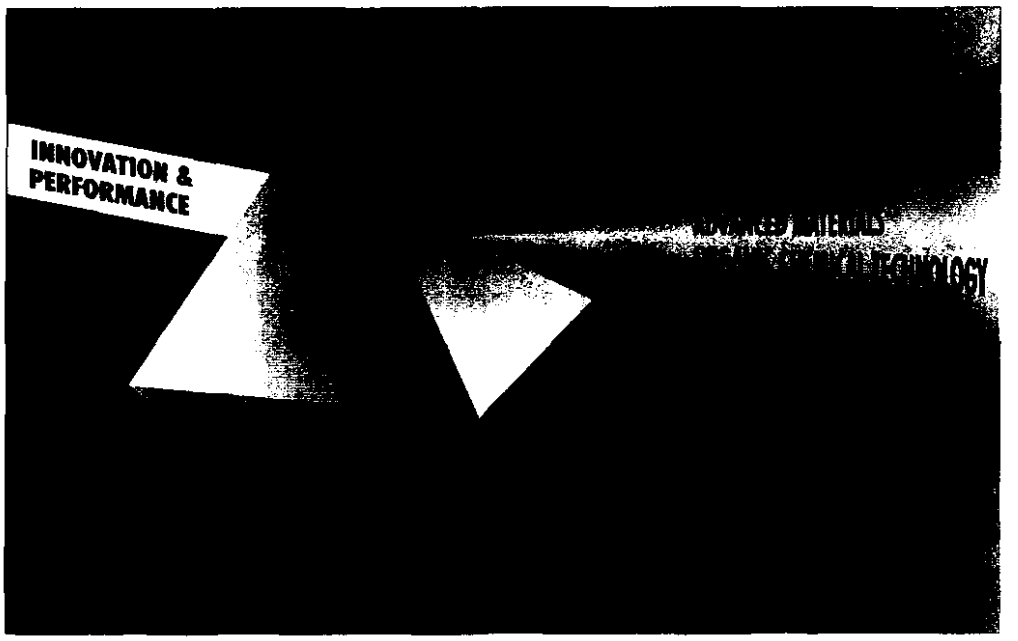
d) Miscellaneous

Working environment : busy, tranquil, noisy, quiet, etc. Facilities Environment : City,Urban, academic, Rural : Potential entertainment/ receational activities	• Our campus is comfortable • All city facilities are available. • One/two tourists attractions are in the city in addition to hill station of Mahabaleshwar and Panchgani (which are 3 hours drive from Pune) • Pune city has many academic institutes like engineering, medical, defence (R&D), oriental institutes, in addition to industries like TELCO, Bajaj, HAL

Keeping pace with change
.... Breaking New Ground



National Chemical Laboratory, Pune, India

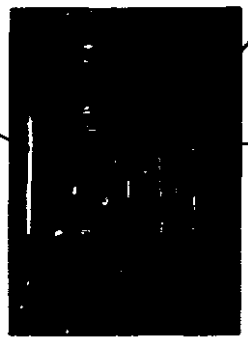


National Chemical Laboratory (NCL) is a science and knowledge based research, development and consulting organization. Established in 1950, NCL is internationally known for its excellence in scientific research in chemistry and chemical engineering, and its outstanding track record of industrial research involving partnerships with industry from concept to commercialization.

NCL provides a unique global R&D platform with its client base today extending to several leading multinationals.

Mission

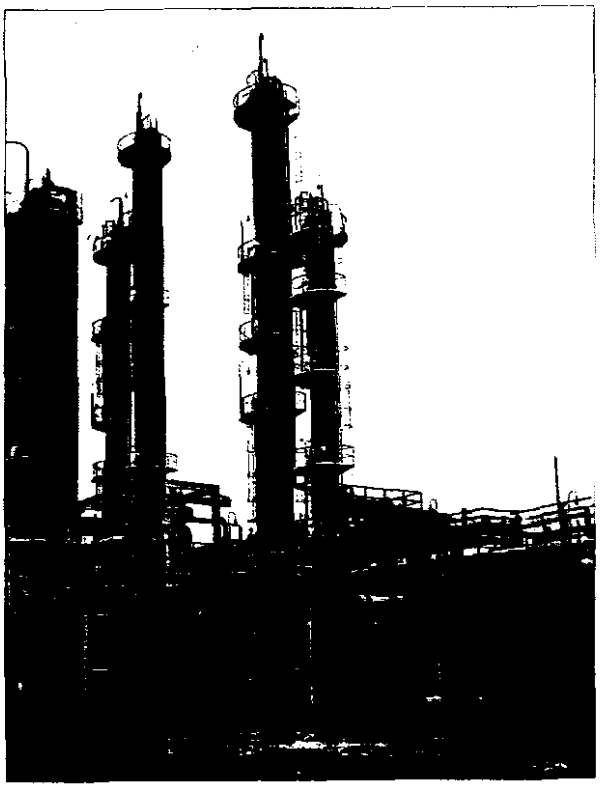
NCL's mission is to advance knowledge and to serve the industry. It uses the cutting edge of science to develop globally competitive technologies.



NCL is your partner from concept to commercialization

Functions

- **Discover new effects**
- **Understand the underlying science**
- **Develop new processes, products and applications**
- **Protect intellectual property**
- **Transfer skills and technologies to industry**



The Set-Up

NCL comprises 9 research divisions covering diverse aspects of chemistry, chemical engineering and multiple interfaces between chemistry and biology. Multidisciplinary projects spanning across seamless laboratories within NCL give it a special character. A division of research planning and business development helps in planning, business development and public relations. A scientific and management information services unit organizes the vital networking of information across NCL, and beyond it. These structures respond dynamically to the ever-changing environment.

Our People

NCL's 350 scientists of whom 200 are Ph.Ds with post-doctoral and industrial experience, constitute a formidable workforce. Many of them, apart from receiving national and international recognition, have been deeply involved with industry and also the Indian Government in national level planning. Some have consulted for industrial firms in US, Europe and Japan. Some have helped in the restructuring of publicly funded research institutions in other countries like China and Indonesia. In addition to the regular full-time staff about 250 young scholars work for their doctorate degree under the supervision of senior scientists. This resource is utilised to explore the new frontiers of science.

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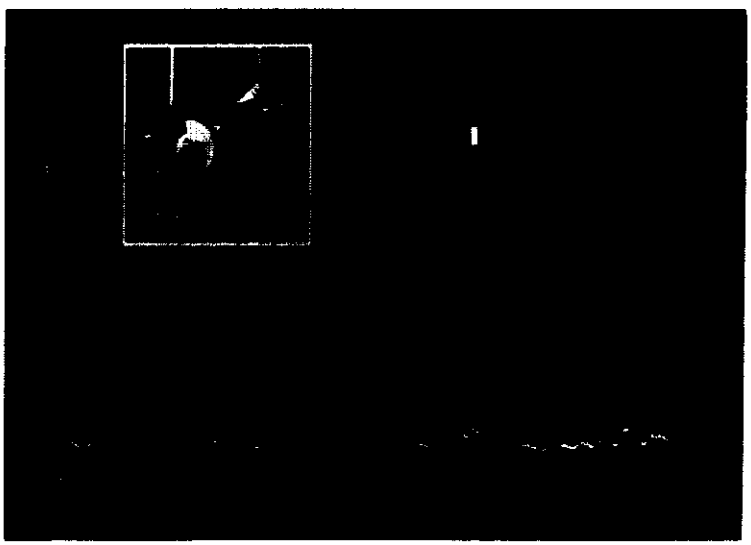
With world-class expertise and facilities in synthesis, characterization, testing, and pilot-plant production of commercial catalysts, NCL is uniquely placed to develop globally competitive technologies. A distinguishing feature is its multidisciplinary strength, its process development activity based on a strong scientific basis and also its emphasis on developing 'green' technologies.

Core competencies : These exist in diverse areas including :

- Zeolite catalysts (ZSM-5, Beta, TS-1,2), and solid acid catalysts (supported heteropoly acids and solid super acids);
- Oxidation catalysts based on transition metals (molecular sieves containing titanium, vanadium, molybdenum, and chromium as well as mixed oxide catalysts like iron-molybdenum, and vanadium-molybdenum);
- Homogeneous catalysts for carbonylation and oxycarbonylation.

Several commercial successes, clientele spread across the globe and formation of spin-off companies based on its research are high points of catalysis work at NCL.

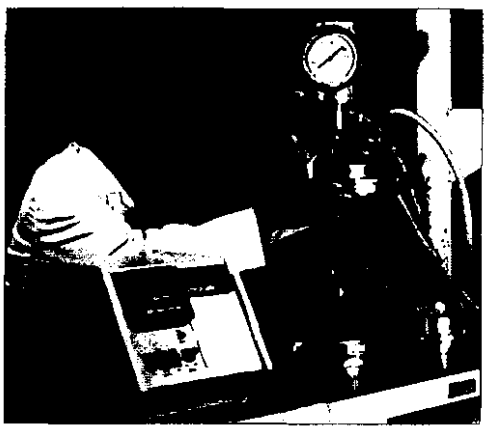
NCL places great emphasis on evaluating the life cycle of catalysts, a key determinant for the success of a commercial catalyst



NCL's world class facilities for catalyst characterization are an important link in the innovation chain

Areas of activity : These include petroleum refining, petrochemicals and even fine chemicals.

- Refining - catalysts for hydrodewaxing and naphtha reforming, FCC additives, etc.
- Petrochemicals - isomerization of xylenes, ethylbenzene, styrene, C_6/C_9 transalkylation, maleic anhydride, methyl ethyl ketone, acetic acid and others.
- Fine chemicals - benzofuran, guaiacol, pyridines, m-phenoxybenzaldehyde, hydroquinone/ catechol, *p*-hydroxyanisole, propionic acid, phenyl acetic acid, etc.



The ability to synthesize and characterize catalysts on gramme scale is a key point.

The ability to supply a few hundred kilogrammes of catalysts for commercial testing and production- thanks to its new pilot plant-places NCL in a unique position

NCL's resolve to develop green technologies using clean chemistry is aided by its unusual creativity in catalysis.

- **Accent on clean chemistry :** NCL's endeavour is to develop green technologies using clean chemistry. One strategy is to replace hazardous catalysts like hydrofluoric acid and aluminium chloride. Successful examples are alkylation, isomerization, etherification, and oligomerization.

  The other thrust is on oxidation catalysts like TS-1,2; VS-1,2; Sn-MFI, V-NCL-1 and Fe-zeolities. Solid chlorination catalysts for cleaner processes for *p*-chlorotoluene, *p*-dichlorobenzene, 4-chloro-o-xylene and chloronaphthalenes also fall into this category.

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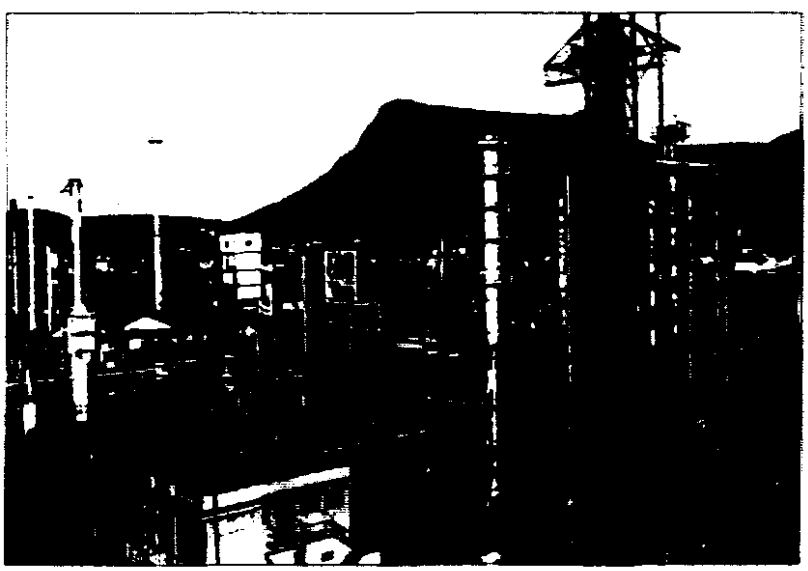
- **Accent on building up newer routes to feedstocks** : Typical examples are : oligomerization of C_3-C_4 olefins to get gasoline and jet fuel; oligomerization of n-butenes to C_{16}-C_{30} olefins leading to high-viscosity oil base stock, and oxidative coupling of methane to ethane and ethylene as well as oxidative conversion of methane to syngas.

Some NCL catalysts in use in industry around the world in petroleum refining, petrochemicals, and fine chemicals

NCL catalysts are loaded in several commercial reactors around the world today spanning petroleum refining, petrochemicals and fine chemical companies.



NCL's Albene technology for the production of ethylbenzene at Hindustan Polymers in India. An example of a unique catalytic process, which reduces the number of steps as well as the hazards

Supported by world-class specialists with a background in chemistry, physics, engineering and processing, and a full complement of laboratory facilities for polymers synthesis, characterization and processing, NCL has the largest interdisciplinary polymer research centre in India.

Core competencies : These cover polymer synthesis, polymer compounding and processing, polymer reaction engineering, microencapsulation and membrane materials.

Polymer synthesis is focussed on free radical, polycondensation, anionic, cationic, ring-opening, group transfer and Ziegler-Natta polymerization processes.

Polymer compounding and processing includes blends, alloys and composites, reactive extrusion processes and membrane casting and fabrication.

Polymer reaction engineering has a sharp focus on computer simulation of reactors and downstream processes, process modelling and engineering.

Microencapsulation involves using several innovative techniques to develop controlled-release formulations with active ingredients such as drugs, agrochemicals and biological products such as vaccines.

An uncompromising believer in quality, NCL has state-of-the-art facilities for testing polymers and polymer products.

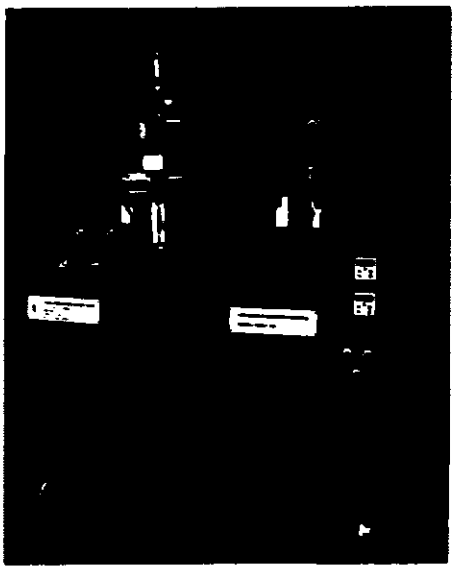
Academic excellence combined with purposeful industrial involvement is a high point of NCL's polymer research.

NCL continuously explores new structures and seeks new properties to develop polymers of the 21st century

Key Thrust Areas

Polymer scientists at NCL continuously seek new properties in polymers through new approaches to the synthesis and processing of polymers. The present thrust of research is on :

- New routes to synthesize monomers, modifiers, additives and polymers
- Novel initiators and catalysts for synthesis of polymers with controlled structures
- Polymer blends/compatibilization
- Value enhancement through polymer modifications
- Microencapsulation for controlled release applications
- Environmentally compatible materials
- Speciality polymers



Low pressure polyurethane foam machine using NCL expertise

At the cutting edge :

The current research at the cutting edge of polymer science and technology has led to :

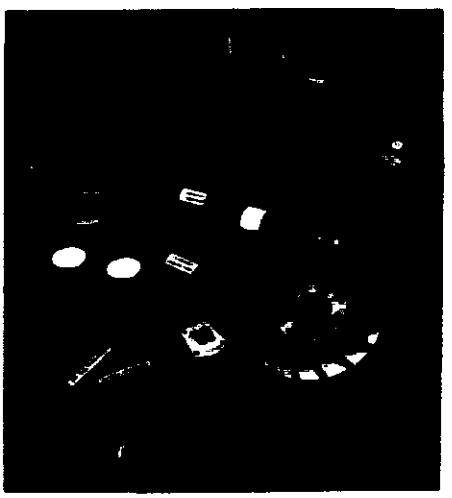
- Design of novel membrane materials for gas separation through molecular modelling
- Polymers with controlled molecular structure for use as viscosity index improvers
- Novel self-associating polymers for drag reduction
- Intelligent materials based on gel science for application in separation technologies, enzyme mimics, etc.
- Manipulation of polymer surfaces / interfaces for producing materials with improved barrier / adhesive properties
- Water-borne adhesives and surface coatings with enhanced eco-friendliness

NCL provides partnership from concept to application development and participates in continuous improvement of processes and also products even after they have been commercialised.

Commercial successes :

NCL's research contributions in polymers have led to the commercialization of many technologies and products. Some examples are :

- Fibre reinforced plastics for making two-wheeler components
- Polyurethane-based water-proofing compounds.
- High performance polyethylene cable compounds produced by reactive compounding
- Superabsorbing polymers
- Polymer supports for immobilization of enzymes
- Polymer processing for low pressure polyurethane foam



Some of NCL's polymer products commercialised

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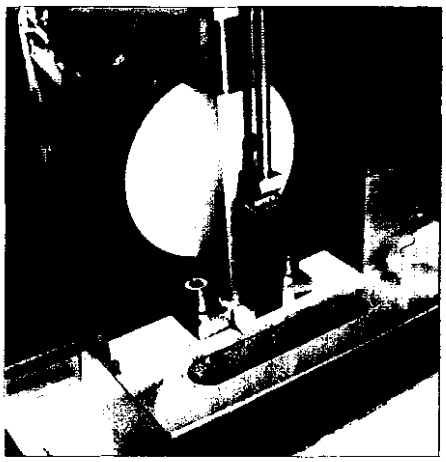
The goal of the materials programme at NCL is to develop new materials and to improve the reliability, affordability and quality of all materials. Once oriented towards developing chemicals and materials for electronics industry, NCL now increasingly concentrates on tailoring materials to achieve specific properties and on precise control of processing.

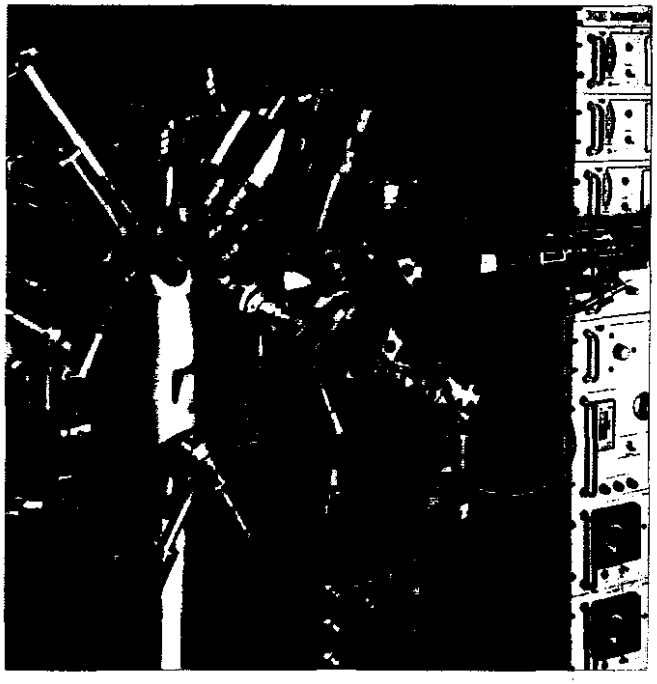
Core Competencies: These cover inorganic materials synthesis, characterisation and applications as engineered materials for a wide diversity of industrial applications.

The R&D activities range from fundamental research on materials structures to discovering new effects. The range of materials under study is remarkable.



Langmuir-Blodgett film on silicon wafer

An ability to tailor molecules to perform specific functions in industrial and consumer applications by using its strong multidisciplinary force places engineered materials research at NCL at a vantage point.



Electron spectroscopy for materials analysis

The NCL R&D programme encompasses ultra thin films of oxides for high temperature superconductors, nano-composites to produce economically viable solar energy, humidity and gas sensors based on surface engineered ceramics, novel battery materials and photoluminescent gels for application in flat screen full colour displays.

NCL's continuous endeavour is to explore the cutting edge of science with a view to opening up new frontiers of materials technology. Its recent work on Langmuir-Blodgett (LB) films, with its great potential for application in molecular electronics, non-linear optics and sensors, is a case in point. The discovery made at NCL that films of amphiphiles can be obtained through self organization without the agency of a condensed solid-phase Langmuir monolayer opens up exciting new possibilities in materials synthesis. Investigations of the structure of LB films, on the one hand, have given new insights, and on the other, have resulted in deposition of nanoparticles of TiO_2, which can be employed for harvesting solar energy.

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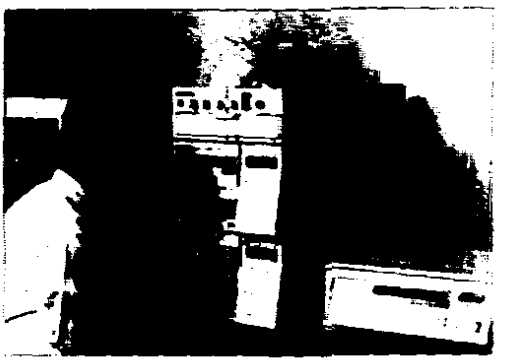
Organic Chemical Technology

Built on the platform of four decades of rich traditions in organic chemistry, backed by modern tools and methodologies, and inspired by a powerful interdisciplinary environment, NCL is meeting the challenge of the technologies of tomorrow. Its strong linkages with user industry and its varied experience of a diverse range of technologies have placed it in a unique position to tackle current and futuristic problems.

Core competencies :

These include complex multistep organic syntheses, syntheses employing homogeneous and heterogeneous catalysis, bioorganic chemistry, microbial transformations, and isolation of useful molecules from natural products.



Modern tools give an insight into the composition and structure of complex molecules

NCL has been instrumental in catalyzing the growth of Indian chemical industry since the mid-70s

NCL's superior five-step process for vitamin B_2 commercialized by Lupin, makes India one of the select licensors of this exclusive technology

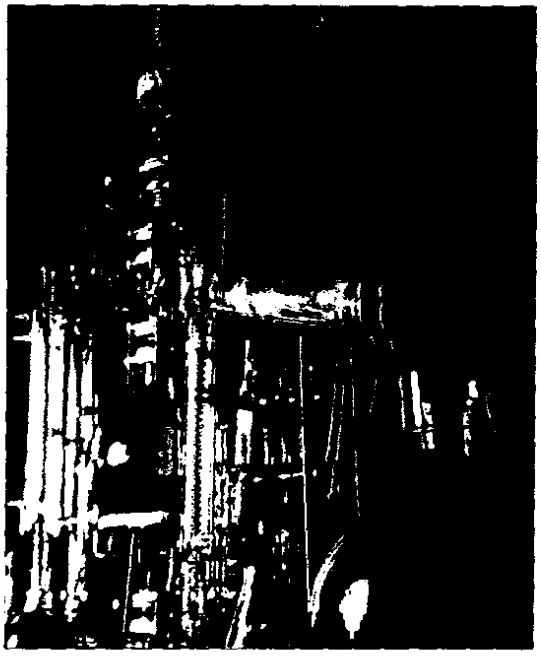
Some recent successes include

- Complex syntheses of brassinolide, biotin, prostaglandins, vitamin B_2, etc.
- A unique synthesis of the ranitidine intermediate, methylamino methylthio nitroethane, using a zeolite catalyst; and that of methyl N-methyl-carbamate, the key intermediate for carbamate pesticides, show NCL's continued thrust towards *clean chemistry*.
- Novel fluorescent oligonucleotide probes for replacing hazardous radioactive probes is a recent example of NCL's prowess in bioorganic chemistry

- A microbial transformation-based synthesis of phenylglycine is illustrative of NCL's special niche in research across disciplines.
- NCL continues to probe nature for useful molecules. The anticancer drugs vinblastine and vincristine from *Catharanthus roseus*, two eco-friendly pesticides from the Indian neem, and morphine and codeine from opium illustrate NCL's resolve to exploit India's biodiversity.

NCL probes nature for potential drugs, pesticides, etc. Molecules with promise, once identified, are extensively investigated to elucidate their structure.

NCL combines innovative chemistry, chemical engineering and process development to offer complete technology packages.



NCL's Kg. Lab. is a key step in scale up, besides producing quantities for trials.

New Vistas

NCL uses its knowledge-base to identify and synthesize new molecules with scientific and commercial potential. Specific targets are anti-cancer, anti-HIV agents, cardiac and antimalarial drugs, plant growth promoters and organic-intermediates for fine and speciality chemicals.

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BIOTECHNOLOGY

NCL's forays in biotechnology are in tune with the modern-day explosion of knowledge in this area. The multidisciplinary strength in NCL extends from microbial transformations in organic synthesis to polymer immobilization of enzymes. Modern plant biotechnology is NCL's special niche.

Core competencies :

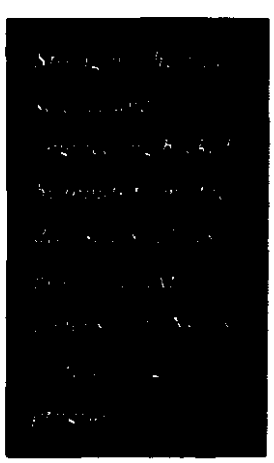
These lie mainly in four areas; microbial technology, fermentation technology, plant molecular biology and plant tissue culture.

Microbial technology :

NCL hosts the National Collection of Industrial Microorganisms. This resource is continuously screened to exploit the country's rich biodiversity. The actinomycete strain *Chainia* capable of secreting cellulase-free xylanase with an ability to remove xylanase selectively from dissolving pulp; the alkalophilic *Bacillus* secreting high-activity cellulase-free enzyme; the high-activity alkaline protease secreting strain of *Conidiobolus*; chitinase production by a high-activity strain of *Myrothecium verrucaria*, α & β - *galactosidases* and pactinases for food applications, application of alkalophilic *actinomycetes* in recovery of metals such as chromium from industrial effluents and the identification of chitin-degrading enzymes typify NCL's uniqueness. NCL will continue to search nature for molecules with useful properties.

Fermentation Technology :

Production of Gibberellic acid using a mutant strain of *Gibberella Fujikuroi* and continuous fermentation technology for production of alcohol from molasses using a unique self-immobilizing yeast are examples of fermentation research at NCL.



Such modern fermentation facilities enable exploitation of promising strains and development of novel processes like the production of Gibberellic Acid.

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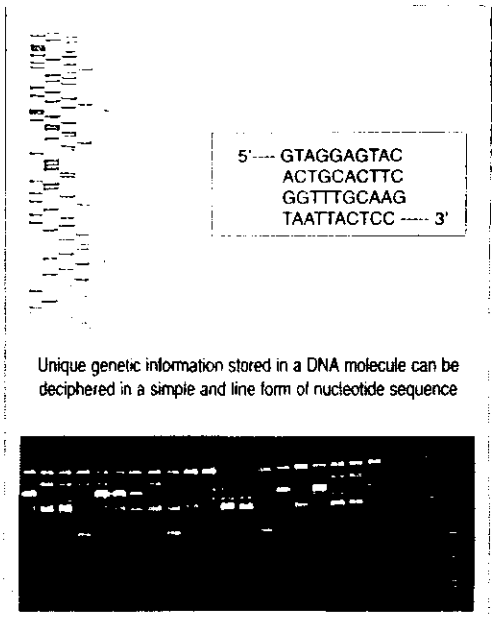
Plant molecular biology :

The plant molecular biology group at NCL is engaged in extensive research on plant genome analysis for crop improvements.

The focal points of the current research are the development of DNA marker technology and genetic engineering for crop improvement for rice, wheat, pearl millet, chickpea and cotton.

The main interests are the development of DNA fingerprints for use in the protection of breeder's rights on newly released varieties, to tag agronomically important genes such as disease resistance, high protein content and quality traits using DNA markers and to assess genetic variability in hybrid seed production.

order to transfer plant molecular biology research results from laboratory to land, NCL has also established valuable linkages with several agricultural research institutes and universities around the country.



Unique genetic information stored in a DNA molecule can be deciphered in a simple and line form of nucleotide sequence

DNA fingerprinting of Indian elite rice varieties

DNA nucleotide sequence and DNA fingerprinting of Indian elite rice varieties.

NCL's plant molecular biology programme has continuously received support from international agencies like Rockefeller Foundation and McKnight Foundation, USA

Thermocycler for polymerase chain reaction along with electrophoresis assembly : Tool for genome analysis

Plant tissue culture :

NCL has been one of the leading laboratories in the world in this area for over a quarter of a century, and has carried out pioneering work in developing techniques for the micropropagation of a wide range of plants and trees.

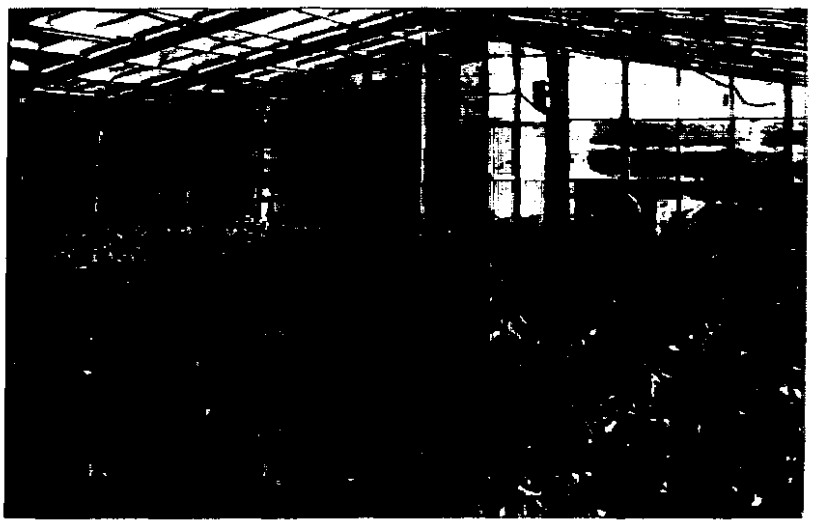
The aim is to :

- rapidly introduce new varieties of plants;
- produce disease-free stock;
- introduce improved uniformity of plant material;
- propagate recalcitrant plants;
- create new genotypes; and
- achieve long-term storage of valuable germplasm.

A completely automated pilot plant and greenhouse have enabled NCL to offer effective services.

The new automated pilot plant tissue culture facility is a big step forward in moving from lab to land

Exploiting India's rich biodiversity and increasing its bioproductivity through the instrument of modern biotechnology runs through as a theme in much of what NCL does.



NCL's automated and computer-controlled green house

NCL's impressive successes in plant tissue culture include development of a disease-resistant and high-yielding variety of sugarcane and elite eucalyptus, bamboo and salvadora forest trees, and isolation of superior variants of cardamom, turmeric and ginger. NCL's cardamom variety has boosted commercial production and export of cardamom from India.

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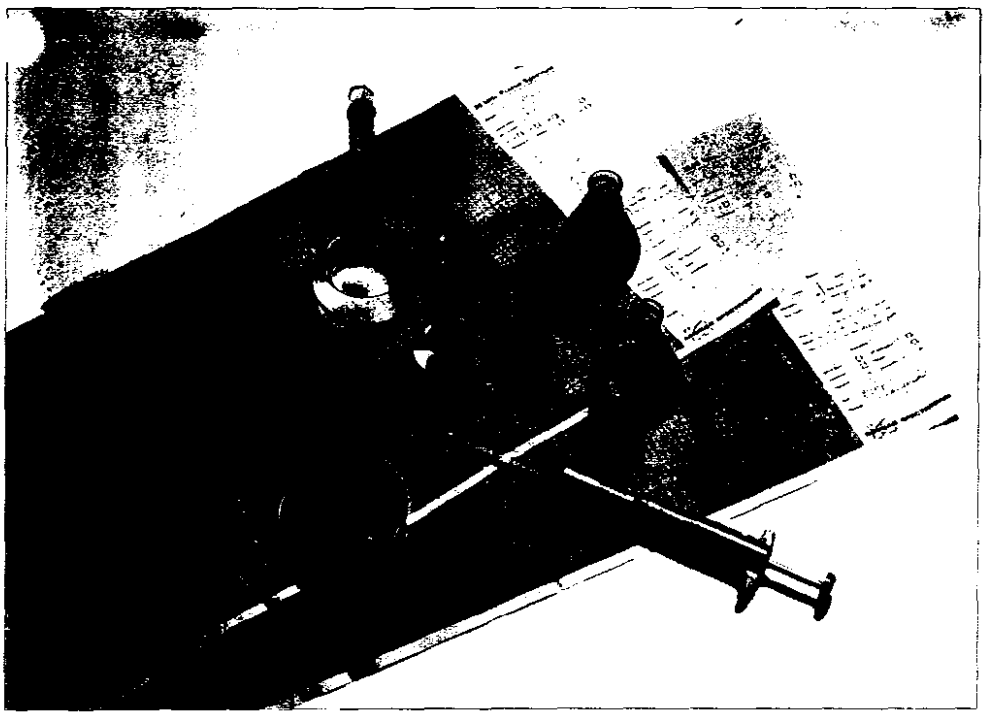
NCL strongly believes that globally-competitive technologies can be built only with a strong science base. NCL invests heavily in basic research, which is linked closely to its applied goals. Although NCL is not a university, it conducts its fundamental research in an academic ambience. NCL's scientists are recognized as Ph.D. guides by many well-known universities in India. At any time, they guide about 250 research fellows in their doctoral work. Besides this, some scientists in NCL exclusively devote themselves to fundamental research in frontier areas. NCL has so far published 6500 research papers in journals of international repute.

NCL's explorations continue relentlessly. They include photoinduced electron transfer reactions, organometallic compounds in asymmetric synthesis, synthesis of DNA analogues with potential applications in non-radioactive diagnostics and antigene antisense therapeutics, living anionic polymerizations, coupled cluster methods, non-linear dynamics of chemical reactions, use of wavelets analysis in analysing complex times series data, noise analysis and so on.

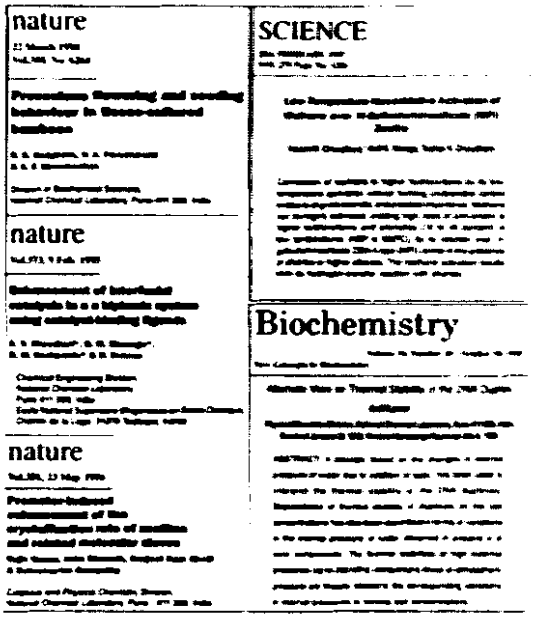
Continuous pu[illegible] of science empow[illegible] NCL to reach[illegible] greater heights in [illegible] technological goa[illegible]



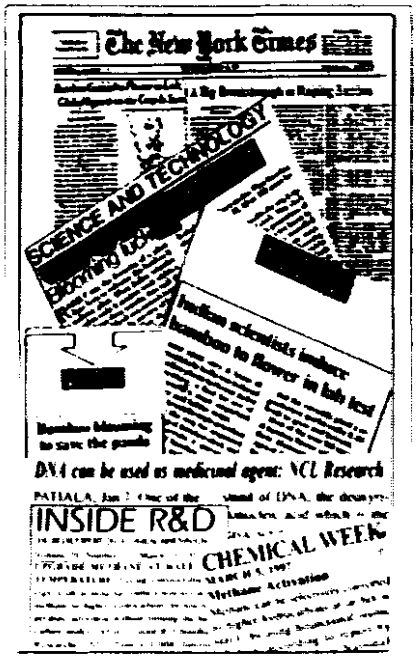
A continuous intellectual ferment in chemistry at NCL provides the driving force for many of its unique technologies.

NCL's exploration of catalysis is directed towards synthesis and potential applications of homogeneous and heterogeneous catalysts in petrochemicals and fine chemicals production including catalytic reaction engineering. NCL scientists have succeeded in converting methane to higher hydrocarbons at low temperatures. This discovery is of great scientific and practical importance. NCL has also made pioneering contributions in developing biphasic catalysts based on a novel concept of "Interfacial catalysis" for hydrogenation and hydroformylation reactions. This biphasic system is a major advancement in separation of the expensive metal complex catalysts and products.

NCL's seamless laboratories in chemical, biological and engineering sciences work in synergy to produce a powerful multidisciplinary force. For instance, NCL's innovation on inducing enzyme-like activity in stimuli-responsive polymeric gels (Gelzymes) and its exploration of zeolites with enzyme-like activity (Zeozymes) signify the unique synthesis of NCL's diverse strengths.



NCL's research papers in prestigeous international journals open up new vistas and the world reaction to scientific breakthroughs at NCL is instantaneous and spontaneous.



NCL creates an environment in which innovations of the highest order can flower. NCL's breakthrough in the tissue culturing of bamboo in 1990 hit world headlines - it was a first-ever success in the world to make bamboo flower within weeks as against years in nature.

NCL believes that new skills in science need to be brought in continuously to give its technologies a competitive edge. Groups working on neural networks, parallel processing, fractals, chaos, etc. ensure that this happens.

NCL also believes that occasionally one must explore 'crazy' ideas, which might go beyond any logical or structural analysis, as only then will real breakthroughs occur. NCL supports 'Kite flying' projects with special funding so that explosive creativity can always be nurtured.

A non-profit organisation namely NCLRF (National Chemical Laboratory Research Foundation), promoted by NCL, recognises the extra-ordinary creativity in basic research and its conversion into technologies.

Such state-of-the-art tools are used to explore diverse fields - from computational chemistry to computational fluid dynamics.

NCL's work on modelling and simulation has given some unusual insights into the working of complex industrial reactors and has led to a substantial improvement in productivity.

High resolution solid state NMR is used to explore molecular level events in hydrogels.

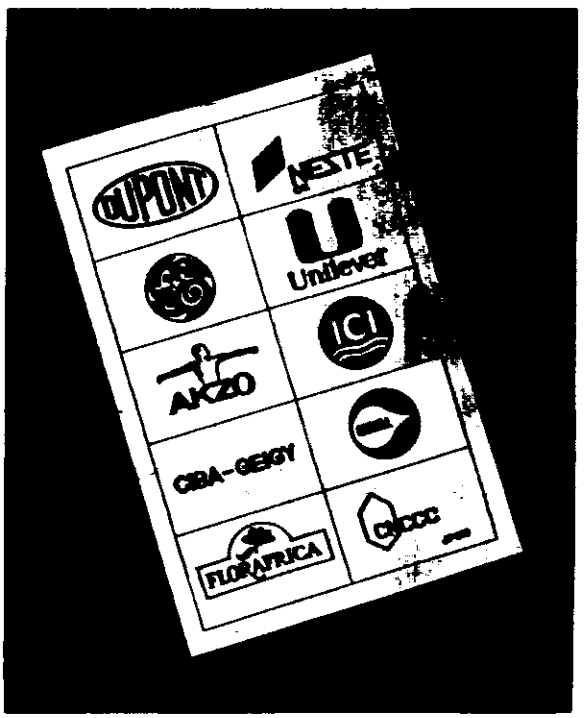
Globalization

Realizing that the chain of concept to commercialization extends over transnational boundaries today, NCL decided to become a part of the global network. Today it has among its clients some of the leading multinationals in the world. NCL made the first export of technologies of high tech materials from India to the western world.

NCL considers itself a global R&D platform. Its global interactions are in the form of contract research, joint development, technology licensing and technical and consultancy services. NCL recognizes the key determinants of success in global partnerships. Therefore it pays special attention to the delivery in time of processes and products of international quality, maintenance of confidentiality, protection of intellectual property and strong communication links with the collaborators through flexible and effective mechanisms.

NCL believes in generation of world class intellectual property and in its protection. Among the Indian research organizations, NCL files the highest number of patents, both nationally and internationally.

NCL in global market



NCL's repeat international customers are a testimony to this. NCL's services have now been offered both in the developing world and the developed world.

Thus its relationships range from Florafrica in Ivory Coast to General Electric in USA, and from JPCID in China to ICI in Europe. National Chemical Laboratory is already being recognized as an International Chemical Laboratory

NCL is being viewed as a global R&D partner by many leaders of industry in the world today

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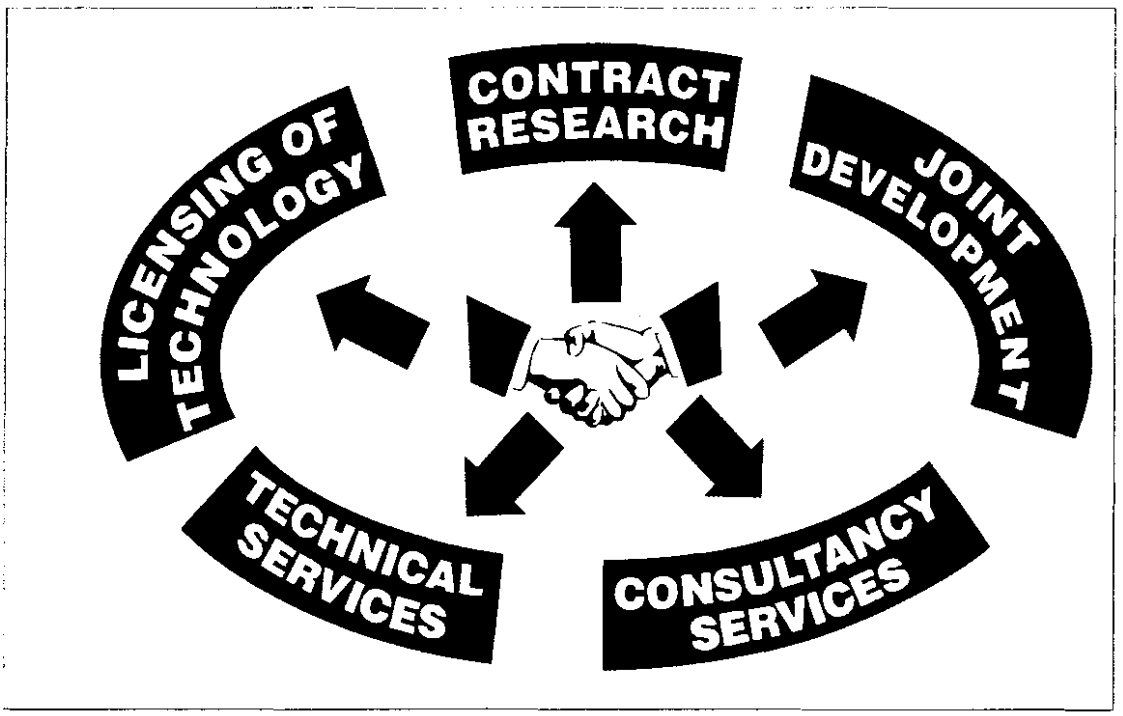
SERVICES RENDERED

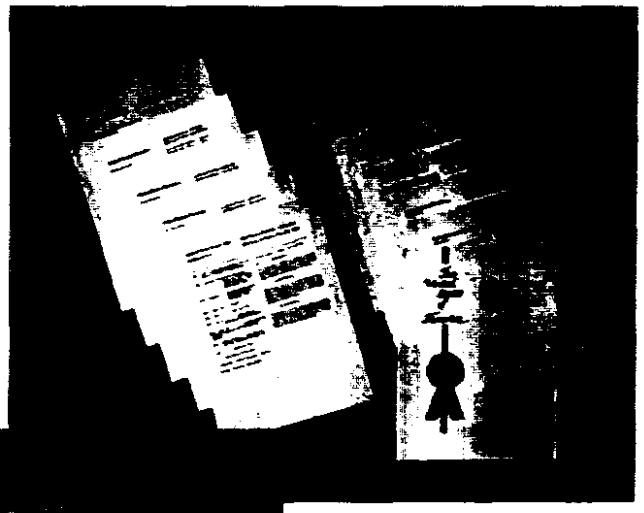


NCL's HELPING HAND

- Development of new Products and Processes
- Process Design and Engineering
- Process Simulation, Optimization and Energy conservation
- Process Improvements and Modernization Studies
- Product Application and Market Development
- Project Planning and Development
- Technology Search, Evaluation and Selection
- Research and Technology Management
- Analytical and Other Technical Services
- Information based Services : Technology Monitoring, Assessment and Forecasting, Multiclient Studies on Emerging Technologies and New Products, etc.

Our Vision

- Highest quality science
- Highest degree of innovation in applied research
- Coupling R&D goals with market needs
- Continuous rejuvenation of skill bases in response to the environment
- International partnerships in R&D



NCL ceaselessly explores new frontiers for new knowledge but it believes strongly that mere exploration without exploitation is sterile. It thus exploits new knowledge to create wealth. NCL's international patents and world class publications over the years reflect its philosophy.

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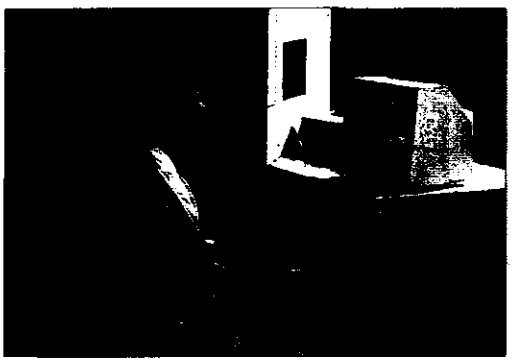
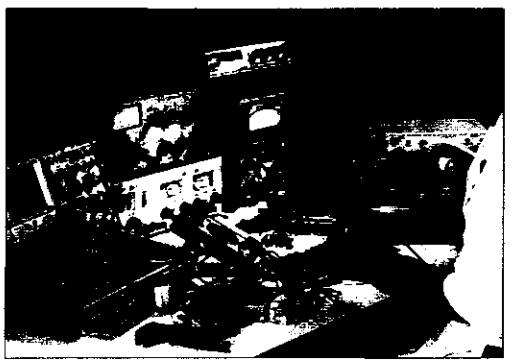
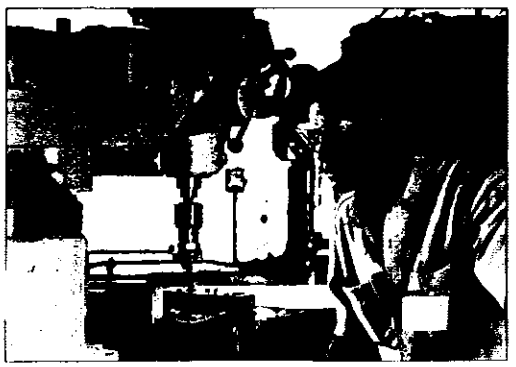
SUPPORT SYSTEM

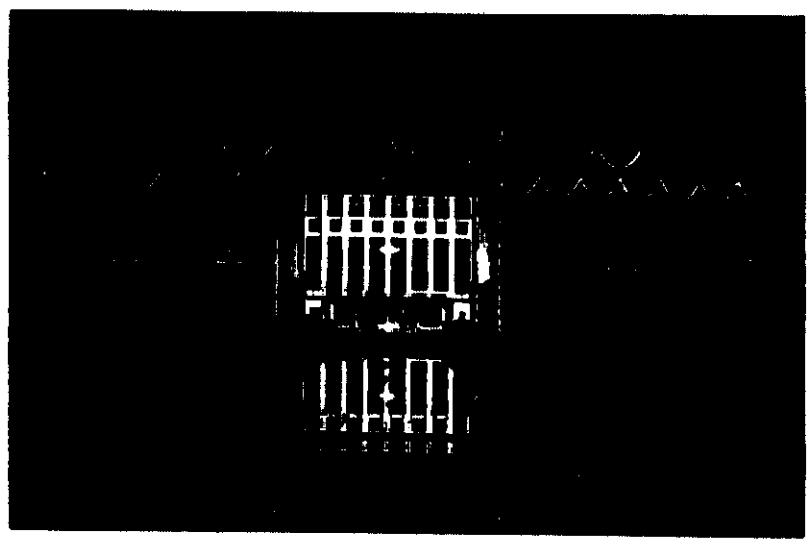
The pursuit of excellence at NCL gets an unfailing support from a world class system that consists of instruments, equipment and personnel to operate them. These facilities range from the machinery and equipment at its workshop and glass blowing section to sophisticated instruments for analysis, characterization and structure elucidation. The facilities and the expertise are also offered to clients as part of NCL's services to them.







NCL - THE GOLDEN YEARS



NATIONAL CHEMICAL LABORATORY
PUNE INDIA

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Celebrating 50 years of leadership

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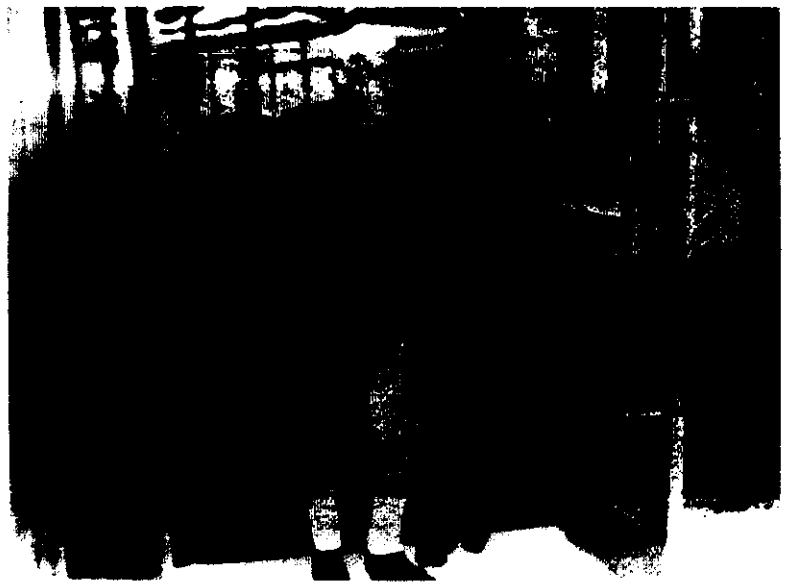
URL : www.ncl-india.org

Hon'ble Shri B.G. Kher, Prime Minister, Government of Bombay State, laying the Foundation Stone of National Chemical Laboratory on 6th April 1947.



Foreword

The National Chemical Laboratory was inaugurated on 3rd January, 1950 and given a motto "The purpose of this laboratory is to advance knowledge and to apply chemical sciences, for the good of the people." How do we assess the performance of NCL during the past 50 years? Do we judge it on the basis of its achievement in the academic field, by its contribution to the corpus of Human knowledge in the area of chemistry and related sciences, by the number and quality of its publications in reputed journals in India and abroad? Or, by its contribution to Human Resources Development in the form of providing higher education and training (Ph.D.) in chemistry? Or, by the proprietary intellectual property developed by its scientists in the form of patents? Or, by its contributions to the development and growth of the Indian chemical industry in the form of novel and innovative technologies? Or, by the pace of its evolution toward a corporate R&D center of international status, earning its revenues from the chemical industry, both in India and abroad, by carrying out cutting-edge technological research at the frontiers of knowledge? During the past 50 years, the National Chemical Laboratory has been a leader in all the above activities. And, irrespective of which of the above "Windows" of observation and assessment is chosen for evaluation, NCL's track record is truly outstanding. The following pages give a brief historical and statistical profile of NCL.

P. Ratnasamy

Paul Ratnasamy
Director
National Chemical Laboratory

3rd January 2000

NCL – THE GOLDEN YEARS

The Beginning

The National Chemical Laboratory (NCL), the brainchild of Sir Shanti Swarup Bhatnagar, the first Director of Council of Scientific and Industrial Research (CSIR), was planned in 1942. The foundation stone of the National Chemical Laboratory (NCL) in Pune was laid on April 6, 1947 by Shri B.G.Kher, Prime Minister of Bombay State. It was inaugurated on 3 January 1950 by the Prime Minister Shri Pandit Jawaharlal Nehru. Poona (as it was then known) was chosen as the site for locating the NCL because among the philanthropists and patriotic industrialists who came forth to complement the efforts of the national leaders and statesmen was the House of Tatas, which had made a handsome donation of Rs.8.3 lakhs with the condition that it be located in this city. The first choice for building it was close to the Governor's House but there were fears of pollution from that quarter and consequently 475 acres of land near Pashan village were acquired from the Army and construction begun. Even as the construction proceeded, the chemical section of the laboratory of CSIR in New Delhi was officially merged with the NCL and shifted to Poona and the Biochemistry Division of the laboratory started functioning.

The inauguration was attended by a number of eminent scientists from all over the world besides distinguished statesmen. Among them were Sir Robert Robinson, NL, President of the Royal Society, Dr. Arthur Compton, NL, Dr. Irene Joliot-Curie, NL, Prof. J.D.Bernal, NL, Prof. Hermann Mark, Dr. E.U.Condon, NL, Prof. P.Auger, Prof. O.E.H.Rydberg and Prof. C.V.Raman, NL.

The Early Years

Prof. J.W.McBain took charge as the first Director. The scientific work of the laboratory was carried out in seven Divisions, each in the charge of an Assistant Director. These were the Division of Biochemistry (Dr.M.Damodaran), Division of Chemical Engineering (Dr.H.C.Bijawat), Division of Inorganic Chemistry (Dr.J.Gupta), Division of Organic Chemistry (Dr.R.C.Shah), Division of Physical Chemistry (Dr.S.S.Marsden), Division of Plastics and Polymers and Division of Survey and Information (Dr.K.G.Mathur). Even the Administrative Division was headed by a scientist, Dr.B.D.Laroia.

Prof.McBain, a colloid chemist had realised very early that the main purpose of NCL was to assist the Indian chemical industry. However, he did

not minimise the importance of good basic research. Thus, NCL, while attempting to push back the frontiers of knowledge, tried to handle problems of immediate interest to the industry. He retired in 1952 and returned to his native USA.

Dr.G.I.Finch, who took over from him, had a tenure of five years. In those five years NCL earned fame as an advanced centre of chemical research. In particular, research on the organic chemistry of essential oils, under the leadership of Dr.S.C.Bhattacharya, became widely known.

Dr.K.Venkataraman succeeded Dr.Finch in 1957. KV, as he soon came to be known, was no stranger to NCL, having been the Chairman of the Chemical Research Committee and the Executive Council of NCL prior to his joining the laboratory. It was in his tenure, which lasted till 1966, that Dr.Sukh Dev joined NCL and built a flourishing group working in natural products chemistry. KV was a legend in many ways and had the unique position of starting teaching and research in chemical technology (right from his UDCT days) and for inculcating a strong library culture. While research in organic chemistry thus attained international status, that in the area of physical chemistry was not far behind, with Dr.A.P.B.Sinha and Dr.K.P.Sinha making their mark.

The Revolution

The research activities continued along these lines throughout the fifties and even part of the sixties. The laboratory established itself as a leading research institute. The first two reviewing committees had expressed general satisfaction about its progress, stating that the activities were in consonance with the mandate set out by the National Planning Committee. However, the third reviewing committee, headed by Sir Ramaswamy Mudaliar, was critical of NCL "leaning towards fundamental research". This was around the time when Dr.B.D.Tilak had joined NCL as Joint Director (in 1965), to take over as Director a year later.

Dr.Tilak set about bringing a cultural change in the research activities of the laboratory. A number of research management steps were taken aimed at restructuring and reorienting the activities. New areas like dyestuffs, drug intermediates, heterocyclics, pharmaceuticals and pesticides were initiated. Chemical engineering was given an added boost, as it was realised that expertise in that area was crucial to the development of commercial grade technologies. This resulted in the development of a number of technologies which were transferred to small-scale private sector companies. [illegible]

transfer was not an easy process. Despite proven pilot plant studies and guarantees of performance backed by bank guarantees, the industry was sceptical and hesitant to accept it. After considerable effort on all fronts, the technology was commercialised. That plant is still working in a highly profitable mode.

The Silver Jubilee

By the time NCL completed 25 years of its existence in 1975 the number of parties utilising know-how developed by NCL had grown from a mere 18 in 1965 to a healthy 61. Likewise, the number of parties to whom the know-how was licensed but where production had not yet commenced had risen to 93. The number of processes in production was 46, with the value of production estimated at Rs.650 lakhs.

New Frontiers – the Eighties

Dr.L.K.Doraiswamy took over from Dr.Tilak in 1978. Steps were taken in the late seventies and early eighties to strengthen certain niche areas, as also to initiate research in those areas which were likely to take centre-stage in the years to come. In the early eighties NCL shifted emphasis to **high-tech** areas of catalysis, polymers, biotechnology and advanced materials. Scientific and technical excellence was the guiding vision. Recruitment of young scientists of outstanding merit was vigorously undertaken. Research in plant tissue culture was encouraged. A major breakthrough came in the form of the induction of early flowering of bamboo, which caught worldwide attention. At the same time, the track record of NCL was bringing industry seeking NCL technologies in ever-greater numbers. A series of novel industrial catalysts were developed and technologies for their production and utilisation were transferred to industry both in the country and abroad.

From the year 1975 NCL has won special citations in eight prestigious awards instituted by the Indian Chemical Manufacturers' Association. In 1991 NCL won an award on its own. They are as follows:

1975 - ICMA Award for Process Design & Process Engineering of Chemical Plants.
("Process design and successful commissioning of the plant for the manufacture of Chloromethanes from Methane": Awarded to M/s.Standard Alkali, Mumbai.)

1983 - ICMA Award for Forward Development of Technology.

sophisticated chemical engineering": Awarded to M/s.Hico Products Ltd., Mumbai.)

1985 - The Sir P.C.Ray Award for Development of Indigenous Technology.
("Process for manufacture of Ethylenediamine and Polyethylamines under relatively high pressure and corrosive conditions, producing a spectrum of products": Awarded to M/s.Diamines and Chemicals Ltd., Ahmedabad.)

1985 – The ICMA Award for Forward Development of Technology.
("Isomerization of Xylenes containing ethyl benzene": Awarded to M/s.Indian Petrochemicals Corpn. Ltd., Vadodara.)

1989 - ICMA Acharya P.C.Ray Award for Development of Technology Indigenously.
("Process technology for Vitamin B6. The process involves a series of complex eight-step organic chemical synthesis, offering unusual challenges in handling extremely corrosive and toxic chemicals, design challenges due to the reactants undergoing phase changes and finally demanding a high quality for the product to meet international standards": Awarded to M/s.Lupin Laboratories Ltd., Mumbai.)

1989 - ICMA Award for Novel & Complex Technology for the First Time in India having a Widespread Impact on Chemical Industry and Economy.
("NCL has demonstrated its capability of developing novel world class catalysts in a high-tech area and has developed a catalyst – Enclite-2 – which produces ethyl benzene from dilute ethanol and benzene in a single step process, thus eliminating the dehydration step in the conventional process": Awarded to M/s.Hindustan Polymers, Visakhapatnam.)

1990 - ICMA Acharya P.C.Ray Award for Development of Technology Indigenously.
("Process involving a unique route for the manufacture of butyl & 2-ethyl hexyl acrylates, as well as co-production of aqueous acrylic acid to serve the Indian market": Awarded to M/s.Indian Petrochemicals Corporation Ltd., Vadodara.)

1990 - ICMA Award for Export of Chemical Products.
performance zeolite catalysts, named as E[illegible]es, having a widespread impact in various refinery and petrochemical processes".)

1991 - ICMA Award for Export of Engineering Services Rendered Overseas.
("R&D Management Consultancy Assignment in China".)

NCL has transferred the following major technologies to industry:

* Xylofining technology for xylene isomerization (IPCL, Vadodara)
* Albene technology for ethylbenzenes (Hindustan Polymers, Visakhapatnam)
* Polymer alloys/blends and components (Bajaj Auto Ltd., Pune)
* Technology for catalyst for formaldehyde (International Catalysts Ltd., Pune)
* Technology for catalyst for styrene (Polychem Ltd., Mumbai)
* Technology for catalyst for conversion of C_4 feedstocks to methylethyl ketone (International Catalysts Ltd., Pune)
* Piperazine and ethylenediamine (Diamines and Chemicals Ltd., Vadodara)
* Eucalyptus by plant tissue culture (Tata Tea Ltd., Munnar)

International Chemical Laboratory – the Nineties

Dr.R.A.Mashelkar took over from Dr.Doraiswamy in 1989, and was in turn succeeded by Dr.P.Ratnasamy in 1995. During this period, with the process of economic liberalisation set in motion in the country, NCL set its sights higher and took its first steps towards globalising its activities. This resulted in international industrial enterprises coming to NCL either for contract research, consultancy or technology development in increasing numbers. Today, with the major part of its industrial earnings from industries abroad, the National Chemical Laboratory is well on its way to becoming international in character and outlook in the 21st century.

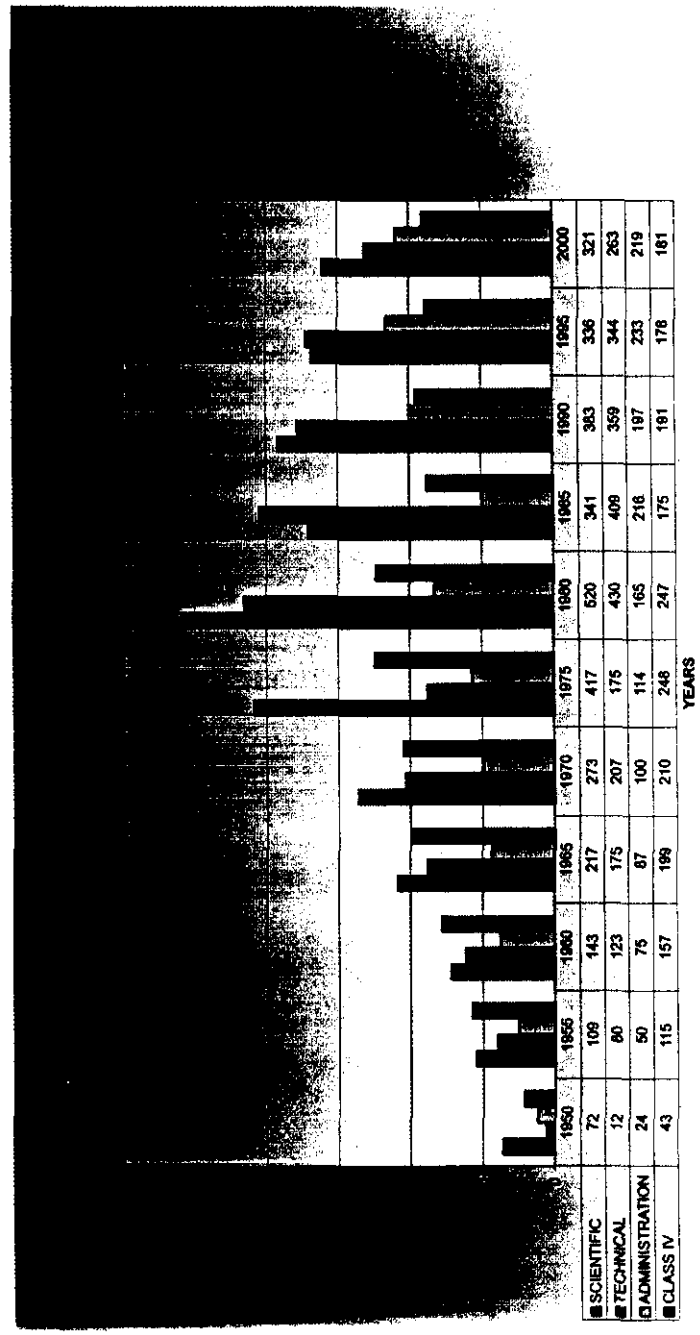
The Golden Jubilee

It was on the 3rd January 1999 that NCL celebrated its 50 years of leadership. Shri Mukesh Ambani, Vice Chairman and Managing Director of Reliance Industries Limited, Shri Mohan Dharia, President of Vanaraj, Dr.E.C.Subba Rao of Tata Research Development and Design Centre, our former Director of NCL Dr.B.D.Tilak were some of the distinguished guests on the occasion. Shri Ambani spoke on "Chemical Industry in the next

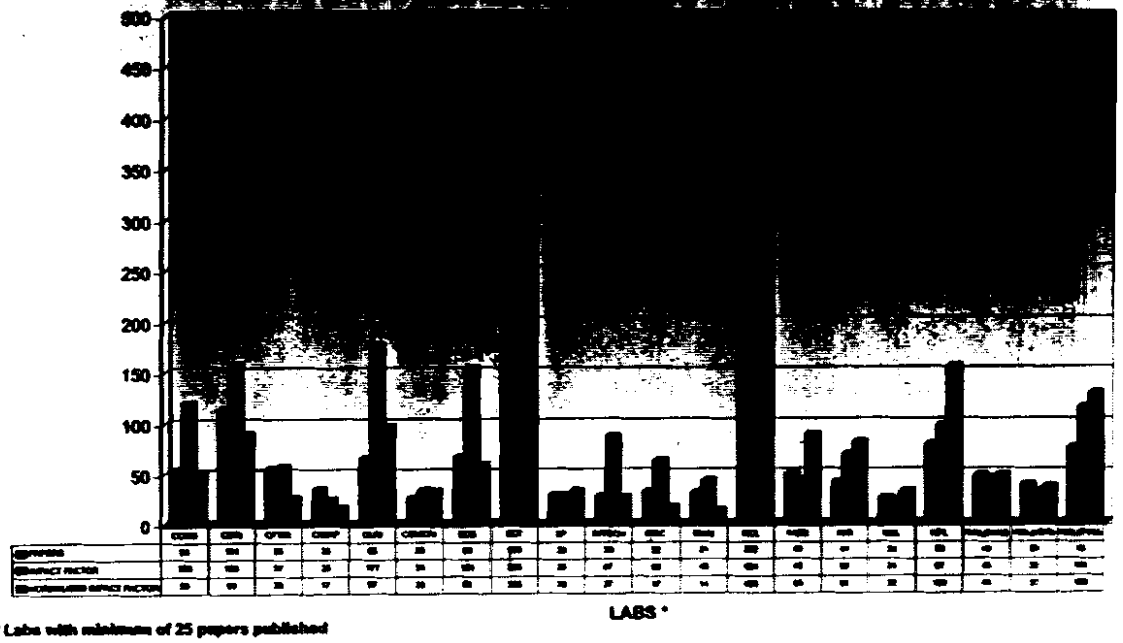
Years". S... Mohan Dharia in his address encouraged NCL to contribute t... reforms in the social and economic system. In appreciation of NCL's mission, he said, "*With the purpose to advance knowledge and application of chemical science for the good of the people, this prestigeous institute has been playing a pioneering role in the progress of our country. NCL's portfolio of India and Foreign Patents is the largest amongst all the R&D laboratories in India. NCL has always remained on the forefront in the field of scientific knowledge and technical innovation and is now regarded as the No.1 institute under the CSIR system in the country*".

The Vision

NCL has had a great beginning, a beginning that coincided with the rebirth of an ancient people and civilisation. As we stand on the threshold of new century and millennium, we see an exciting and challenging landscape ahead of us. **Our successful past legacy, our current capabilities and potential, our vision of a glorious future and our determination to achieve it will ensure that the NCL of the future will be an organisation with the contemporary management and administrative framework where high quality research in the frontier areas of chemical sciences and technology will be carried out using state-of-the-art equipment and infrastructural facilities.**

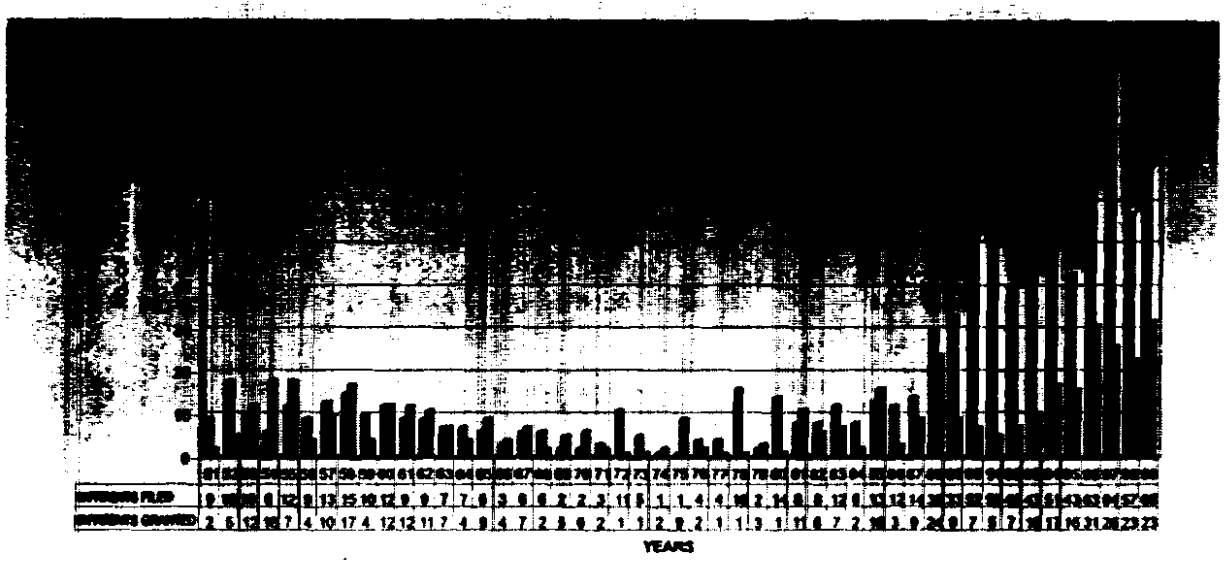


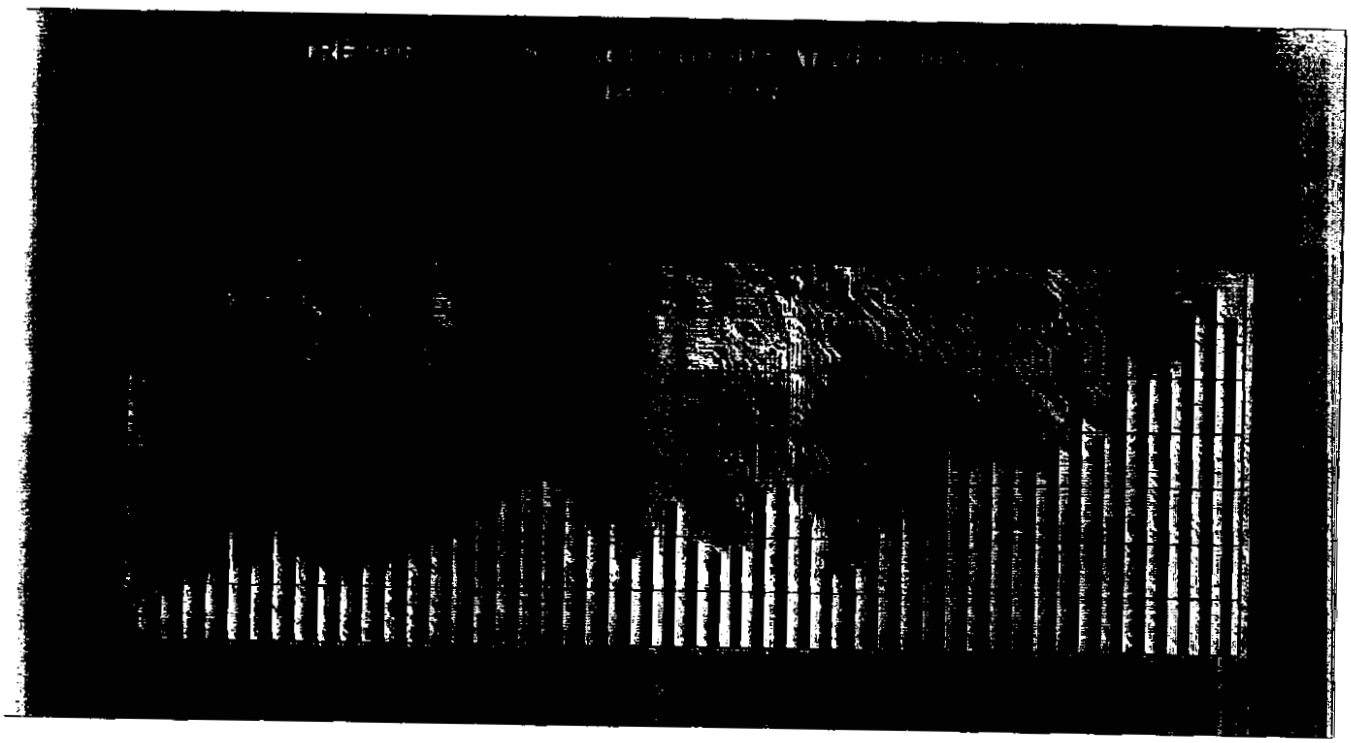
NCL IN CSIR (RESEARCH PUBLICATIONS)

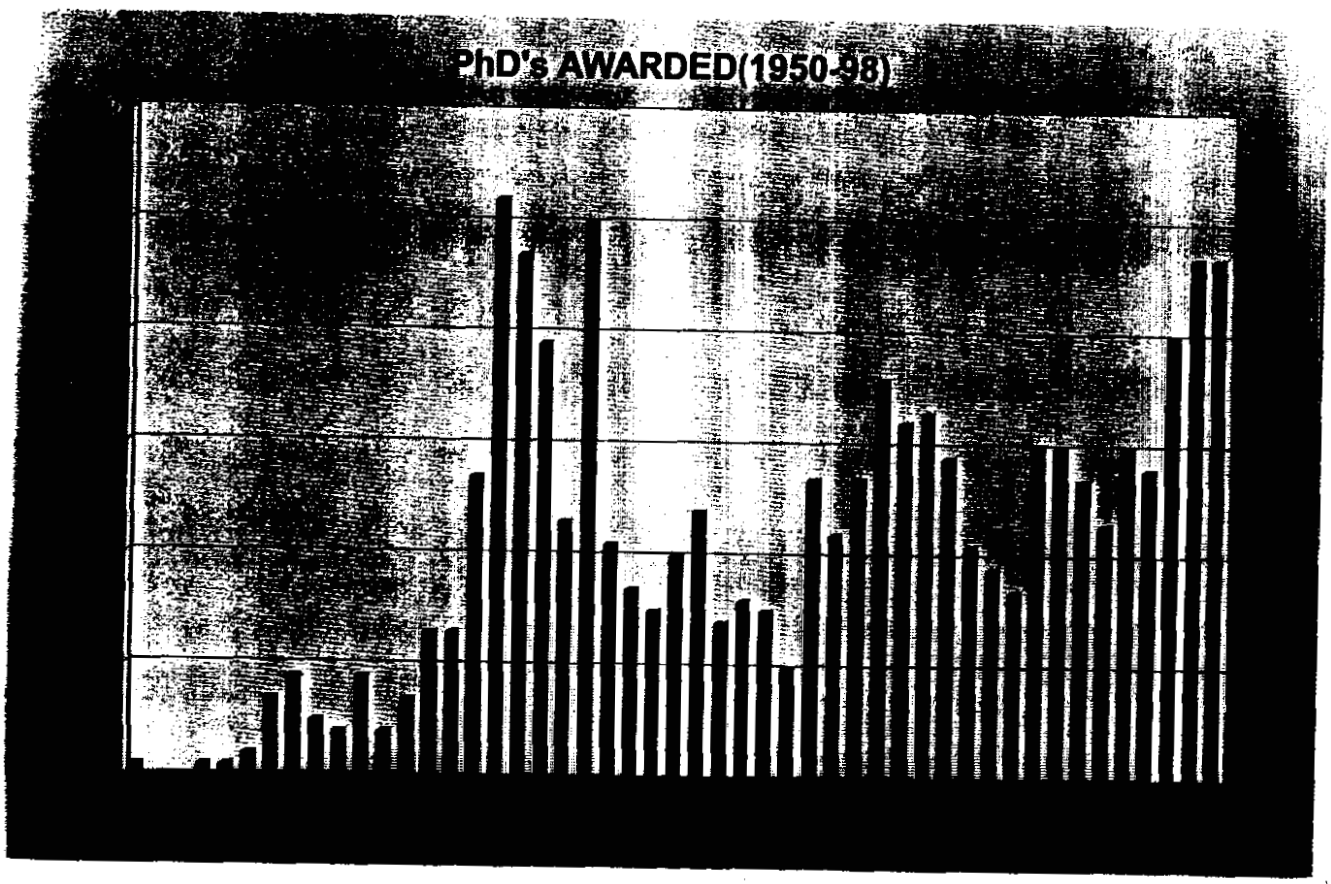


* Labs with minimum of 25 papers published

INDIAN PATENTS - FILED & GRANTED (1951-1999)






PhD's AWARDED(1950-98)

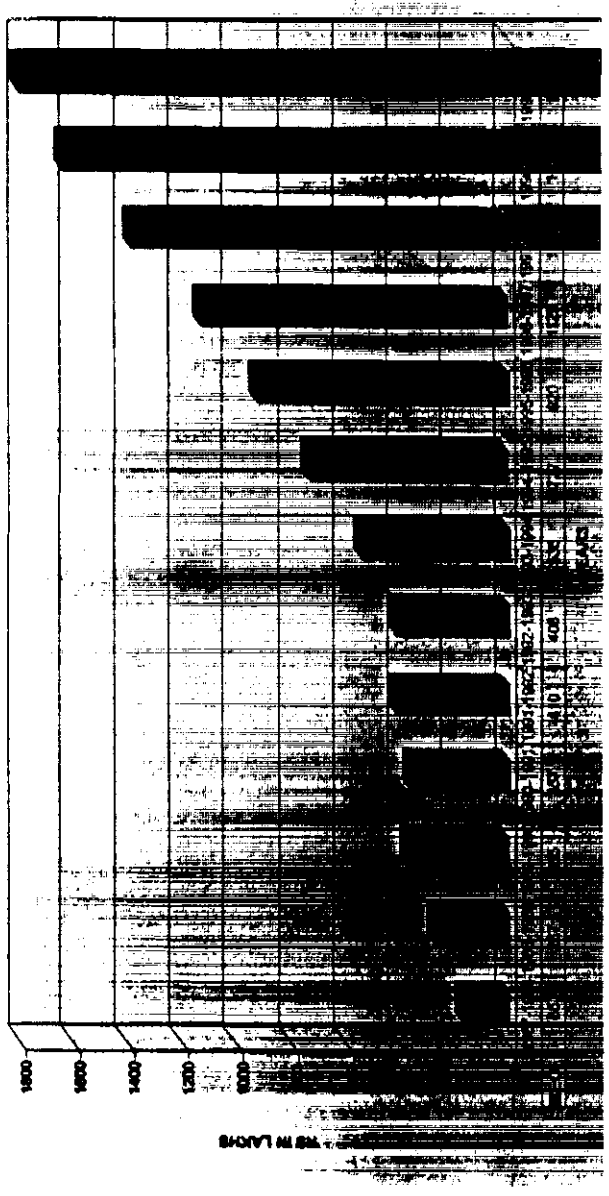
NCL IN CSIR (FOREIGN PATENTS)

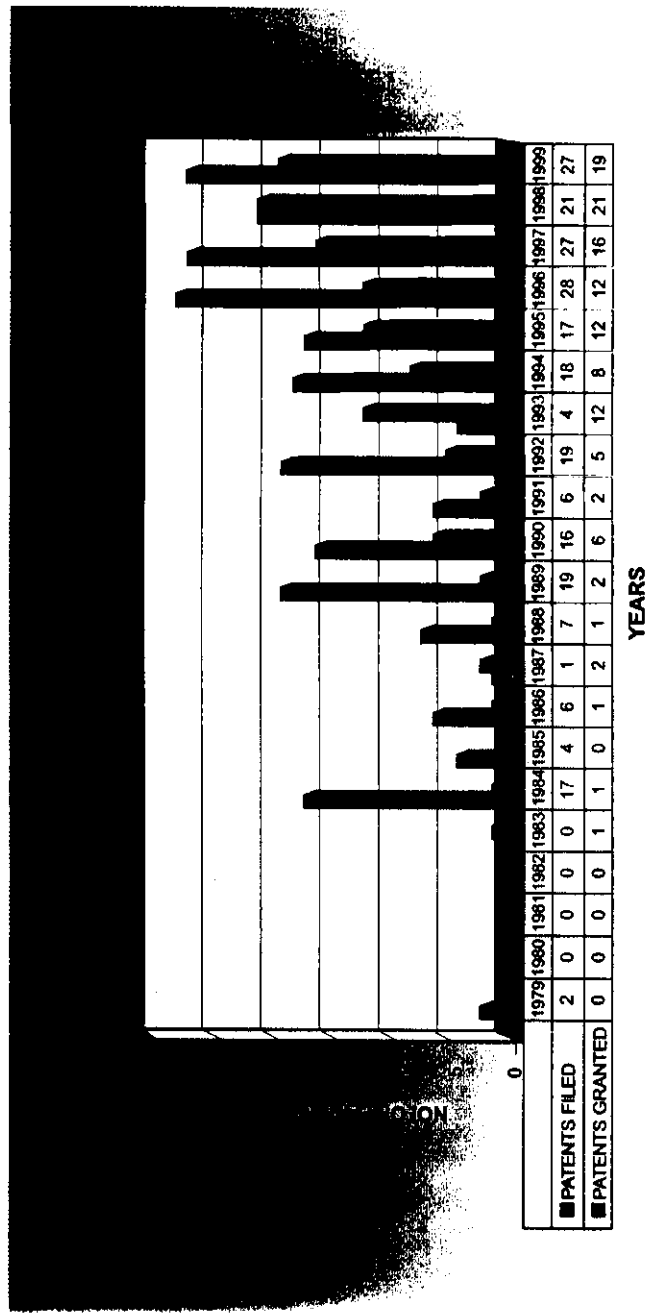
Year	90-91		91-92		92-93		93-94		94-95		95-96		96-97		97-98		98-99	
Laboratory	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G
CBRI	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	0
CBT	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	7	0
CCMB	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	5	1
CDRI	0	0	2	0	1	1	0	0	0	0	0	0	0	0	10	0	8	0
CECRI	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0	2	1
CEERI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1
CFTRI	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0
CGCRI	0	0	0	0	0	0	0	0	1	0	0	0	3	0	3	2	0	0
CIMAP	0	0	0	0	0	0	0	0	0	0	0	0	3	0	11	0	27	1
CLRI	0	0	0	0	0	0	0	0	0	0	5	0	2	0	5	1	0	1
CMRI	0	0	0	0	0	0	2	0	0	1	2	0	0	0	4	0	0	2
CSIR (SCH)	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0
CSMCRI	0	3	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
IHBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
IICB	0	0	0	0	0	0	0	0	0	0	3	0	9	0	8	2	3	2
IICT	0	1	0	0	0	0	0	0	3	0	2	0	8	1	8	1	13	4
IIP	0	0	0	0	0	0	0	0	6	0	1	0	2	1	0	1	0	0
IMT	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	1	3	0
NAL	1	0	0	2	0	0	0	1	2	0	2	0	0	1	0	0	0	1
NBRI	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0
NCL	[redacted]																	
NEERI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0
NPL	0	0	0	1	1	0	0	0	0	0	2	1	10	0	0	2	7	0
RRL(BHU)	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RRL(BP)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RRL(J)	2	0	0	0	1	0	2	1	0	0	2	2	0	0	2	1	0	0
RRL(JT)	0	0	0	0	0	0	0	0	0	0	7	0	3	0	2	0	0	3
RRL(T)	0	0	0	0	0	0	1	0	0	0	1	0	3	0	2	0	1	2
TOTAL	15	10	11	8	20	9	17	12	29	10	58	14	70	15	94	24	112	38

Source : IPMD, CSIR

Note : F-Filed, G-Granted

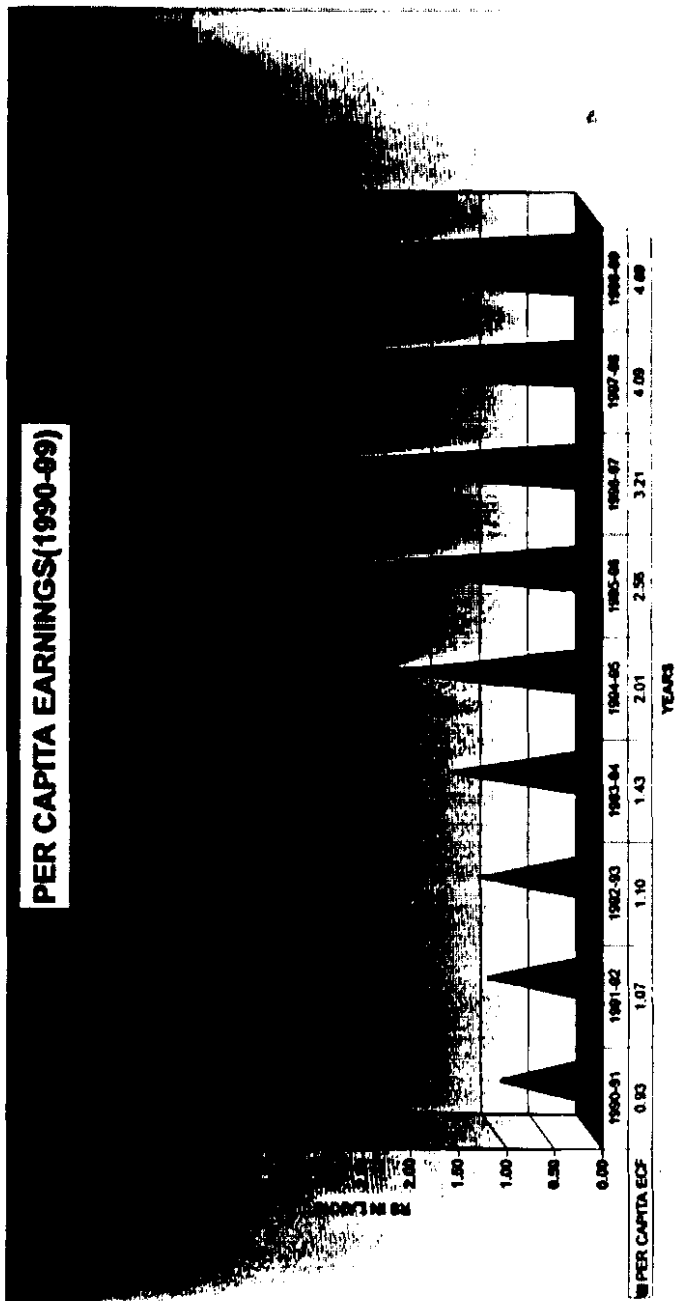
[redacted]





NCL IN CSIR (INDIAN PATENTS)

Year	90-91		91-92		92-93		93-94		94-95		95-96		96-97		97-98		98-99	
Laboratory	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G	F	G
CBRI	1	0	4	0	2	0	1	1	1	1	2	0	0	0	2	4	2	0
CBT	0	1	2	0	0	1	5	0	4	0	2	1	7	1	6	0	1	1
CCMB	0	0	0	0	0	0	0	0	0	1	1	0	1	0	1	0	2	0
CDRI	16	6	34	13	21	3	12	7	18	21	16	6	7	0	23	30	12	15
CECRI	20	5	23	4	33	2	10	4	15	5	11	12	7	4	4	9	10	8
CEERI	5	1	8	1	4	0	2	3	1	3	0	3	2	0	5	3	4	4
CFRI	4	1	3	2	4	1	3	1	4	0	2	2	0	7	3	5	0	2
CFTRI	5	0	0	2	3	3	3	0	11	2	13	1	6	0	8	5	35	5
CGCRI	3	1	1	13	7	1	5	6	7	1	9	3	7	8	11	2	14	3
CIMAP	2	0	2	0	2	0	2	1	3	4	5	0	10	1	11	0	20	2
CLRI	14	2	8	1	2	1	7	0	3	0	4	1	2	1	14	5	9	10
CMERI	0	0	4	2	1	0	1	0	1	1	3	1	1	1	1	0	1	0
CMRI	0	0	0	0	10	0	6	0	10	0	11	5	5	1	4	0	12	2
CRRI	0	1	0	0	2	2	1	1	0	1	0	3	1	1	0	2	0	0
CSIO	1	0	0	0	2	0	1	1	0	0	0	1	1	0	2	0	0	0
CSIR (SCH)	2	0	0	2	0	0	0	0	5	0	3	0	8	1	7	3	3	0
CSMCRI	5	2	6	1	7	7	3	4	2	4	1	5	2	0	2	8	3	3
IHBT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0
IICB	7	2	1	2	1	0	4	3	2	3	6	3	3	1	14	1	4	0
IICT	11	4	12	5	8	0	10	9	12	7	37	5	13	3	14	5	27	5
IIP	4	2	6	3	8	1	11	4	24	0	6	1	3	1	4	4	12	5
IMT	1	0	0	0	2	0	6	0	3	3	3	0	4	0	3	1	4	1
ITRC	5	0	0	0	2	0	0	0	0	0	2	0	1	0	1	3	1	1
MERADO(P)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
NAL	0	3	3	2	0	1	2	3	2	1	1	0	3	0	2	0	3	0
NBRI	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	1	0
NCL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	11	46	20	51	21	76	28	79	28	68	32
NEERI	2	3	1	2	0	0	8	1	12	0	1	1	2	2	2	0	4	2
NGRI	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1
NIO	0	0	2	0	2	0	0	0	0	1	1	2	1	3	0	1	11	0
NML	25	4	12	0	18	4	9	1	2	3	7	8	6	15	12	18	5	8
NPL	1	1	4	1	2	1	4	1	4	0	10	3	3	2	3	0	9	1
RRL(BH)	5	4	7	7	10	2	4	6	7	4	3	5	2	1	6	1	8	5
RRL(BP)	7	2	5	2	1	0	1	1	2	1	10	2	4	4	4	1	8	5
RRL(J)	0	0	4	0	6	0	13	0	11	6	8	0	5	1	9	7	2	3
RRL(JT)	8	2	12	5	21	2	10	10	20	5	20	8	7	3	4	2	10	7
RRL(T)	8	0	9	1	9	0	4	1	7	6	11	3	4	5	3	5	2	3
SERC(G)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
SERC(M)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
TOTAL	202	55	230	66	232	38	198	80	241	104	260	106	209	92	264	155	310	134



Hon'ble Prime Minister of India, Mrs. Indira Gandhi
addressing on NCL Silver Jubilee Celebration held on 1st Feb. 1975

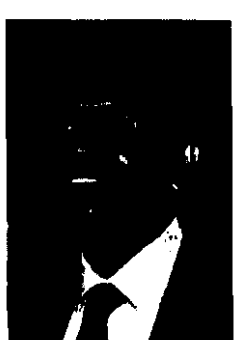
Prof. J. W. McBain
Ist Director (1949-52)

Prof. G. I. Finch
IInd Director (1952-57)

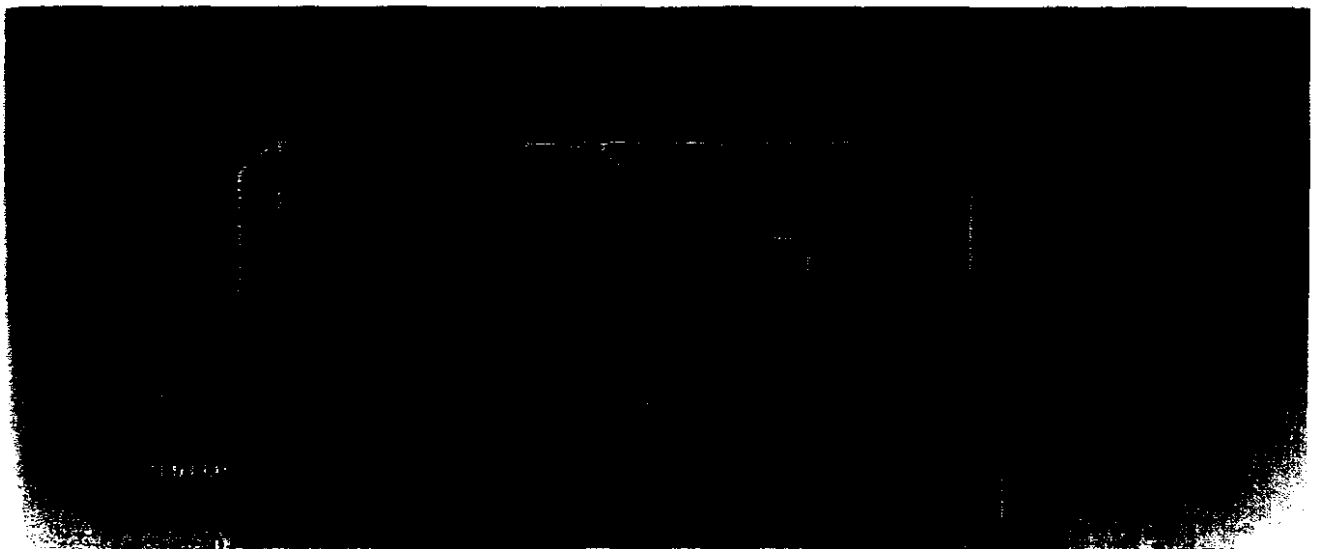
Prof. K. Venkataraman
IIIrd Director (1957-66)

Dr. B. D. Tilak
IVth Director (1966-78)

Dr. L. K. Doraiswamy
Vth Director (1978-89)

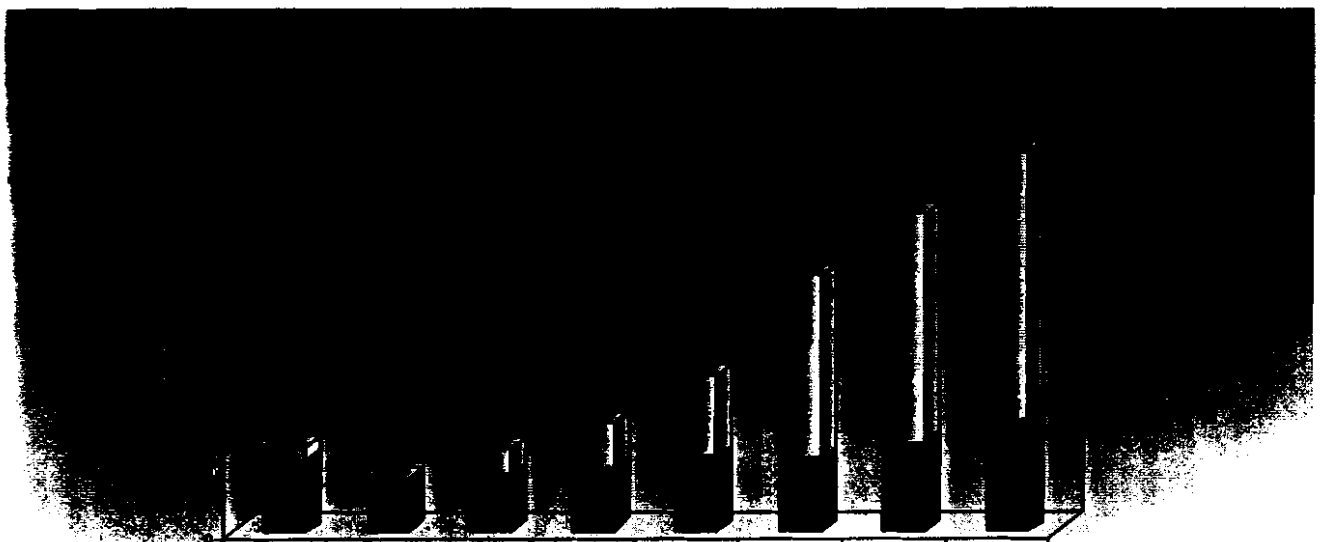


Dr. R. A. Mashelkar
VIth Director (1989-95)



	1991-1992	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999	1999-2000
DOLLAR EARNINGS	167,734	57,679	230,900	545,078	910,231	1,636,29	1,879,91	1,934,57	2,200,00

YEARS



	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99
FOREIGN	40	4	73	131	234	535	675	769
GOVT *	0	0	0	0	0	11	37	137
PUBLIC	32	27	29	34	7	24	27	20
PRIVATE	177	124	140	154	214	181	192	169

YEARS

National Chemical Laboratory, Pune

ABOUT US

National Chemical Laboratory (NCL) is a science and knowledge based research, development and consulting organization. Established in 1950, NCL is internationally known for its excellence in scientific research in basic and applied chemistry and for its outstanding track record of industrial research. NCL provides a unique global R&D platform with its client base today extending to several leading companies, both in India and abroad.

MISSION

"To advance knowledge and to apply chemical science for the good of the people."

VISION

- practice highest quality science
- provide highest degree of innovation in applied research
- effectively couple R&D goals to market needs
- forge national and global partnerships in R&D to deliver processes and products to the market place

ORGANISATION

The research activities at NCL are organized in terms of five business areas. These business areas are supported by specialist groups. The specialist groups provide high level scientific, computational and analytical inputs into the R&D programs of the business groups.

ORGANIZATIONAL STRUCTURE

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CLIMATE CHANGE IMPACT ISSUES RELATED ACTIVITES AT NCL

Considerable research work is carried out at NCL, Pune on alternatives to CFCs for refrigeration and air conditioning. Some areas are as follows:

- Alternative to CFCs for Air Conditioning and Refrigeration (AC&R) sector
- Clean Development Mechanism (CDM) simulation for hydrocarbon refrigerators
- Montreal Protocol – Kyoto Protocol cross cutting issues

NCL has been involved in various national and international activities. NCL was actively involved in the India's Country Program and its implementation. NCL is a member of ECOFRIG project since 1993 and HIDECOR project since1999 along with IIT, Delhi and other institutions. Both of these projects are sponsored by Swiss Agency for Development and Cooperation (SDC), New Delhi and INFRAS, Zurich.

Dr. Devotta is a member of the UNEP Technology Options Committee for Refrigeration and air conditioning under the Montreal Protocol and also a member of the IPCC WG III group for Special Report on Technology Transfer. Dr. Devotta is the National coordinator for the International Institute of Refrigeration. He is recipient of 1997 Stratospheric Ozone Protection Award of US-EPA for technical and scientific leadership to eliminate CFCs in the refrigeration sector.

Energy Conservation Activities at NCL

National Chemical Laboratory (NCL) established a heat pump and energy conservation group in 1980 with the objective of absorbing heat pump technology, establishing pilot plant units of heat pumps, transferring the technology to industry and incorporating energy recycling at the process design and development stage of the processes developed at NCL.

NCL, had a collaboration programme with Department of Chemical Engineering, University of Salford, UK for training of NCL scientists at their heat pump laboratory for the operation, design and development of heat pumps, for import of heat pump equipment to be installed at NCL for research and development activities and for demonstration to Indian industries, funded by Overseas Development Administration, UK.

LIST OF NCL PUBLICATIONS
ON
'ALTERNATIVES TO CFCs'

Devotta, S., 'CFCs vis-a-vis characteristics of refrigerants', Paper presented in CSIR workshop on 'Alternatives to CFCs', NCL, Pune, July, 1989.

Devotta, S., 'Alternatives to CFCs for air-conditioning and refrigeration', Paper presented in Indo-US (EPA) workshop on 'CFC Alternative Technologies and Substitutes', New Delhi, April,1990.

Devotta, S. and Gopichand, S., 'Theoretical assessment of R-134a and R-123 for heat pumps', Paper presented in 3rd International workshop on 'Research Activities on Advanced Heat Pumps', Graz, Austria, 24-26 Sept, 1990.

Devotta, S., 'Alternatives to CFC-12 for refrigeration - Needs of the developing countries', Invited paper presented in the US - National Academy of Engineers Workshop on 'Technology Transfer to Eliminate Ozone Depleting Chemicals', Irvine, California, April, 1991.

Devotta, S., 'Alternatives to CFCs for refrigeration and air-conditioning - Technology status and their implications', Invited paper presented in the UNEP workshop on 'The implementation of the Montreal Protocol for the protection of the ozone layer', Jomtien, Thailand, 26-29 November, 1991.

Devotta, S. and Gopichand, S., 'Comparative assessment of HFC-134a and some refrigerants as alternatives to CFC-12', International Journal of Refrigeration, 15(1), 112-118, January 1992.

Devotta, S. and Gopichand, S., 'Theoretical assessment of HFC-134a and alternatives as working fluids for heat pumps', Applied Energy, 41(4), 285-299, 1992.

Devotta, S. and Pendyala, V. R., 'Modified Joback group contribution method for normal boiling point of aliphatic halogenated compounds', Industrial Engineering Chemical Research, 31 (8), 2042 – 2046, 1992.

Devotta, S. and Gopichand, S., 'Comparative assessment of some flammable refrigerants as alternatives to CFC-12'. Proceedings of the '1992 International Conference - Energy Efficiency and New Refrigerants', Purdue University, USA, pp 249 – 257, 1992.

Devotta, S., Parande, M. G. and Patwardhan, V. R., 'Experimental comparative assessment of performance and heat transfer characteristics of HFC-134a and CFC-12 in a water chiller', Applied Thermal Engineering, 80-95 August, 1998.

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Devotta, S., Murthy, M. and Sawant, N. N., 'Performance of two door refrigerators retrofitted with a HC blend', Paper presented in IIR Conference on 'Emerging Trends in Refrigeration and Air conditioning', New Delhi, 18-20 March, 1998.

Devotta, S., Patil, P. A., Joshi, S. N., Sawant, N. N. and Sane, N. K., 'Compressor life tests with alternatives to CFC-12', Paper presented in IIR Conference on 'Emerging Trends in Refrigeration & Air conditioning', New Delhi, 18-20 March, 1998.

Devotta, S., Kulkarni, M. M., Sawant, N. N., Patil, P. A. and Sane, N. K., 'Compressor life tests with HC refrigerants', Paper presented in IIR Conference on 'Natural Working Fluids '98', Oslo, Norway, 2-4 June, 1998.

Devotta, S. and Sawant, N. N., Joshi, S. N., 'Life cycle testing of hermetic compressors with alternatives to CFC-12', Paper presented in 'Seminar in ODS Phase-out: Solution for the Refrigeration Sector', Kuta, Bali, Indonesia, 5-7 May, 1999.

Devotta, S., Sawant, N. N., Akalwadi, M. I. and Joshi, S. V., 'Performance of refrigerators retrofitted with R-401A and HC blend', Paper presented in '20th International Congress of Refrigeration', IIR/IIF, Sydney, September 1999.

Devotta, S., Sawant, N. N. and Joshi, S. N., 'Life tests on hermetic compressors with combination of oil and alternative refrigerants', Paper presented in '20th International Congress of Refrigeration', IIR/IIF, Sydney, September 1999.

Devotta, S., Kulkarni, J., Asthana, S., and Schwank, O., 'CDM simulation integrating Montreal and Kyoto Protocols: A case study on hydrocarbon technology for Indian domestic refrigerators', Paper presented in, 'The 11th Global Warming International Conference and Expo', Boston, USA, April 25-28, 2000.

Devotta, S., Padalkar, A. S., Joshi, S. N., Sawant, N. N., Sane, N. K., 'Comparative assessment of CO_2 for window air conditioners', Paper to be presented in '4th IIR- Gustav Lorentzen Conference on Natural Working Fluids 2000', Purdue University, USA, July 25-28, 2000.

Devotta, S., Sawant, N. N., 'Life testing of hermetic compressor with various hydrocarbon grades and other alternatives to CFC-12', Paper to be presented in '4th IIR-Gustav Lorentzen Conference on Natural Working Fluids 2000', Purdue University, USA, July 25-28, 2000.

NATIONAL INSTITUTE OF ADVANCED STUDIES

Bangalore, India

The Mission

The current aims of NIAS are:

To integrate the findings of scholarship in the natural and social sciences as well as technology and the arts through multi-disciplinary research on the complex issues that face Indian and global society,

and

To assist in the creation of new leadership with broad horizons in all sectors of society by disseminating the conclusions of such research through appropriate publications and courses as well as through dialogues with leaders and the public.

PURPOSE

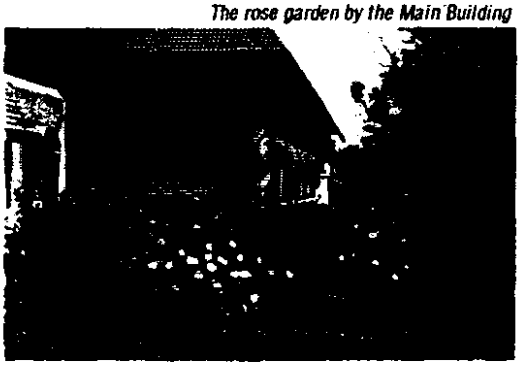
The National Institute of Advanced Studies (NIAS) was conceived and founded by the late Mr.J.R.D. Tata, who saw the great need in India for an institution that could conduct advanced multidisciplinary research and also serve as a forum to bring together administrators and managers from industry and government, leaders in public affairs, eminent individuals in different walks of life, and the academic community in the natural and social sciences. The Founder's vision was thus to nurture a broad base of scholars, managers and leaders who may contribute to tackling the complex problems facing contemporary India with intelligence, sensitivity, confidence and dedication.

The philosophy underlying NIAS is given shape by its research teams, which are drawn from a variety of disciplines in the natural and social sciences. The Institute is unique in its integrated approach to the study of intersections between science and technology, social issues and leadership.

MANAGEMENT

NIAS is a (private) society registered under the Karnataka Societies Registration Act, 1960. The Council of Management, the Academic Council and the Holding Trustees are the three authorities responsible for overall administration of the Institute. The Council is chaired by Dr. J. J. Bhabha (Sir Dorab Tata Trust, Chairman); Dr R. Ramanna M.P. is the Vice-Chairman.

The rose garden by the Main Building



Cover: The arcade, looking towards the Lecture Hall in the Main Building (Photograph by Dr. Sangeetha Menon)

[redacted]

RESEARCH PROGRAMMES

The multidisciplinary research at the interfaces between natural science and technology on the one hand, and the social sciences and humanities on the other, is being carried out presently in seven core units.

Environmental Studies [redacted]

Research undertaken in this Unit includes biodegradation of some of the widely used pesticides in Indian agriculture such as atrazine and endosulfan.

The Unit has also undertaken to create a database on use and misuse of pesticides in agriculture and other related areas in India, particularly in Andhra Pradesh, Karnataka, Tamil Nadu and Punjab.

The Unit is involved in pursuing various issues related to ecology and environment, particularly in agriculture, and has recently carried out studies of the ecological crisis in Bidar district, Karnataka, and the restoration of Bangalore lakes.

Epigraphy [redacted]

Areas of research include the development of software techniques for deciphering epigraphy texts, in particular inscriptions in the Brahmi scripts of 4th and 3rd century BCE, using image processing and pattern recognition techniques.

Gender Studies [redacted]

The main research work of this Unit is focussed on understanding of gender and gender relations, and on evolving strategies to work towards empowering women. The studies include attempts at a deeper understanding of the role of women in decentralised governance, facilitating women's participation in politics, violence against women, and literacy.

International and Strategic Studies [redacted]

Major research activities include a study of global perspectives on nuclear cooperation and technology transfer; a comprehensive analysis of the technical and political aspects of selected nuclear treaties and agreements; a study on gender and security; and issues related to energy security. The Unit has arranged rewarding dialogues on security issues with the Committee on International Security and Arms Control of the U.S. National Academy of Sciences.

Philosophy of Science [redacted]

Areas of research cover consciousness studies including scientific issues and interpretations in Indian thought; psycho-linguistic approaches to the mind and language; postmodernism and philosophy of the body; and cognitive mechanisms in non-human primates.

An attempt is being made to analyse the complicated problem of human consciousness through a multi-disciplinary approach based on the current status of neurological studies on the brain, physico-chemical mechanisms at the most fundamental levels and insight from oriental philosophies.

Sociology and Social Anthropology [redacted]

Major areas of work include changing cultures in societies in South Asia with emphasis on India, the role of media and consumerism, primary education issues, and the cultural bases of agriculture.

Science and Technology Policy Studies [redacted]

This new unit, created in January 2000, will initially focus on policies for the promotion of renewable energy, sustainable transport and the reform of the electricity sector. It will also study technology transfer and policy instruments for responding to global climate change and possible trade-offs with other policies undertaken to address for local concerns.

[redacted]

[redacted]

COURSES

NIAS conducts several residential courses every year. These courses are distinguished by their interdisciplinary character, and are taught by Institute faculty as well as by reputed guest lecturers from across the country. The earlier courses were based on the broad theme of 'An Integrated Approach to Knowledge and Information'. In recent years, these courses have been focussed on more specific themes, but retain a broad multi-disciplinary approach.

Senior Executives [redacted]

This residential course is conducted in the month of January every year for persons in senior positions in government, industry, the national science and technology agencies etc. The faculty for the course is drawn from NIAS but in addition includes well-known public figures, eminent scientists and technologists, distinguished men and women of letters, academics, humanists and sociologists, dynamic entrepreneurs and experienced administrators. The lectures are designed so as to allow for close interaction between faculty and participants. Special panel discussions are arranged in order to bring together speakers with divergent views, so that a more comprehensive and balanced understanding of the issues may emerge. In 1999 the course was devoted to the theme *Leadership and Society*, and in 2000 the theme was *Globalisation and Development*.

University and College Teachers [redacted]

The primary objective of this three-week residential course is to invite university and college teachers of different disciplines from all across the country and expose them to new advances in various fields of knowledge, make them aware of India's socio-cultural roots and engage them in discussions on major problems facing the country. This is achieved through lectures, panel discussions, participatory dialogues, group projects and educational tours. Six courses have been conducted so far. The 5th and 6th courses had the themes *Fifty years of India's Independence* and *The Education System in India* respectively.

Indian Foreign Service Probationers [redacted]

The thrust is to provide the probationer-diplomat with a broad outlook on India's cultural, economic, social and intellectual ethos, including in particular science and technology, to enable deeper appreciation of the issues peculiar to a transforming civilisation that is building new relations with the rest of the world. Two courses have been conducted so far. The last course was held between 19th and 24th July, 1999.

The Indian Administrative Service [redacted]

A course on *Issues in Sustainable Development* was organised in December 1999 for senior officers from the Indian Administrative Service drawn from across the country.

The Indian Space Research Organisation [redacted]

The first NIAS course for ISRO officers on *The Indian Space Enterprise: Foreseeing the Future* was conducted in October 1999. This course was aimed at a group of senior engineers and scientists from ISRO, identified as likely to be part of its future leadership. The purpose of the course was to help in shaping the orientation and planning skills needed by this group, and to offer a view of the broader horizons to which the goals of the Indian space programme may be set as the country enters the 21st century.

[redacted]

CONFERENCES AND SEMINARS

NIAS has an active programme of public lectures, conferences, seminars and workshops organized independently or jointly with other organisations. A wide spectrum of events is held ranging from major international meetings to informal discussion groups. NIAS has emerged as a key public policy forum in India contributing to informed national debate, and providing advice and consultancy on critical national issues.

Some of the more important meetings and seminars recently organised by NIAS have included the following.

Review Meeting on An Indo-US Programme on *Electric Power Technology Assessment*
17 March 2000
This project is a collaboration between NIAS and Carnegie Mellon University, USA.

Consultation on *Gender and Local Governance*
8 March 2000
This Consultation Meeting was held after the Gender Studies Unit carried out a study on *Gender and Local Governance* in the context of the recently held Panchayat Raj Elections.

Consultation Meeting on *Beijing Plus Five: Assessing the Impact of the Platform for action*
4 March 2000
The Gender Studies Unit of the Institute and the National Alliance of Women (NAWO) jointly organised a one-day Consultation Meeting to share views on the Beijing plus Five review scheduled for this year, and on the outcome of the initial reporting to the Convention for the Elimination of all forms of Discrimination Against Women (CEDAW) Committee in January 2000 by the Government of India as well as the NGO's.

Workshop on *Energy Towers*
29 February 2000
This Workshop, to discuss the feasibility of producing electric power by the Energy Tower concept, was organised at NIAS under the sponsorship of the Technology Information, Forecasting & Assessment Council (TIFAC), Department of Science and Technology, New Delhi.

International Conference on *Equity, Diversity and Information Technology*
3-4 December 1999.
Sessions at this Conference were focussed on technologies for reaching the non-affluent; developing local language access and local content; economic, political and cultural barriers to reach disempowered groups; and on-going or experimental projects that empower disadvantaged people

Workshop on the *Draft Indian Nuclear Doctrine*
26-27 November 1999
This Workshop was organised in collaboration with the Regional Centre for Strategic Studies, Colombo. 30 young participants from India and Sri Lanka deliberated on identified themes related to the doctrine.

Workshop on *Socio-Anthropological Approaches to Education Research*
31 October to 10 November 1999
This Workshop, part of a research project on primary education in India, was attended by field researchers from Andhra Pradesh, Tamil Nadu, Kerala, Karnataka, Madhya Pradesh, Uttar Pradesh and Rajasthan.

CONFERENCES...

International Symposium on *Science in Society: A New Social Contract*, Preparatory to the UNESCO World Conference on Science, 1999
27-29 January 1999
UNESCO sponsored this symposium as a meeting preparatory to the World Science Conference, held at Budapest, Hungary, from 26 June to 1 July 1999.

A Meeting on the *Status of Infrastructure in Karnataka: A Year After*
27-28 November 1998
NIAS, along with the Alumni Association of Jadavpur University, Bangalore Chapter, organised this seminar which was in continuation of one organised in 1997 on *Infrastructure in Karnataka: Key to Growth.*

Participants in the course for ISRO officers, October 1999.

ASSOCIATES' PROGRAMMES

NIAS maintains a strong outreach with its Associates' Programmes. NIAS Associates include distinguished persons from widely different backgrounds in industry, government, media, the arts and academia. Associates join the faculty at a monthly meeting, which always includes a lecture or some other important event. The Associates constitute a strong base of ongoing outside support and interaction.

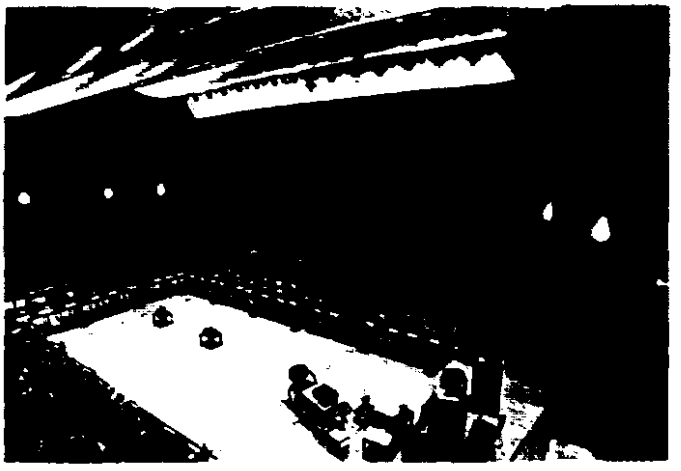
Some highlights of the programme during the year were lectures on 'Obituary on caste *as a system*' by the late Prof. M. N. Srinivas, 'Indo-US Relations at the Millennium' by Ambassador Dennis Kux, 'On wildlife through the lens' by Dr. Vivek R. Sinha and 'The *Saraswati* that vanished' by Prof. K. S. Valdiya

FACILITIES

NIAS is situated on 5 acres of land within the verdant campus of the Indian Institute of Science. The main building of NIAS has a strikingly distinctive architecture, pleasant with elegant lines, a bright-red tile facade and an arched corridor running the full length of the building. The building has spacious and cheerfully furnished rooms.

J.R.D. TATA AUDITORIUM

The architecture of the auditorium blends harmoniously with that of the main building. It has a capacity of 350, but with its excellent acoustics, flexible seat arrangement and long foyer, it is a distinguished venue as much for an international symposium as for a round table discussion, a performing arts event or an exhibition of paintings and sculptures.



The J R D Tata Auditorium with seating configured for the CISAC-NIAS Dialogue 1999

LECTURE HALL

The main building of NIAS has a lecture hall with a seating capacity of 70.

A guest room in the Main Building

ACCOMMODATION FOR PARTICIPANTS

The Institute has 30 fully equipped residential rooms along with a dining hall and lounge, capable of accommodating 60 people at a time.

LIBRARY

The library emphasises acquisitions in support of the Institute's research units. It has a small but carefully selected collection of current literature on sociology, psychology, history, philosophy and reviews in modern science. The present collection includes over 3500 books and 40 journal subscriptions. In addition the library has audio recordings of all lectures given at the Institute. It has plans to set up easy electronic access to libraries elsewhere in India and abroad

RECENT NIAS PUBLICATIONS

I. REPORTS

R1-99 Behavioural strategies adopted by wild bonnet macaques during natural foraging and provisioning
Sunitha Ram and Anindya Sinha

R2-99 Advocating for women's effective political participation
B.K. Anitha, Piush Antony and V. Gayathri

R3-99 Science, technology and society: a tale about rocket development during 1750-1850
Roddam Narasimha

R4-99 A biomass option for enhancing energy security
H.S. Mukunda
Aerospace Engineering, Bangalore

R5-99 Agrarian distress in Bidar
A.R. Vasavi

R6-99 Ecological crisis and agrarian distress in Bidar
P.K. Shetty

R7-99 Scientific explanations and consciousness
B.V. Sreekantan

R8-99 Advanced coal technologies for power generation
A.K. Kolar and V.M.K. Sastri
Department of Mechanical Engineering, IIT Chennai

R9-99 Distribution of electrical power
D.P. Sengupta

R1-00 Status of electric power transmission in India and possible technological developments
S. Parameswaran
Chairman, IEEE Bangalore Section

II. WORKING PAPERS

WP1-99 Fissile material cut-off treaty and options for India
S. Rajagopal

III. LECTURES

L1-99 Can the cultures of India survive the information age?
Kenneth Keniston
Massachusetts Institute of Technology Cambridge, USA

L2-99 Literatures in India
U.R. Ananthamurthy
Bangalore

L3-99 Political leaders of independent India
H.Y. Sharada Prasad
Vice President, Indian Council of Cultural Relations
New Delhi

L4-99 Understanding the 'what' and 'where' of consciousness: revisiting the *Bhagavad Gita* to ask a few more questions
Sangeetha Menon

L5-99 Understanding some misunderstandings of the role of intellectual property rights in technology transfers
V. Siddhartha
Officer on Special Duty at the Secretariat of the Scientific Advisor to the Defence Minister

L1-00 Recent trends in science and technology policy
J.-J. Salomon
Honorary Professor, Chair Technology and Society
Conservatoire National des Arts et Metiers, Paris, France

IV. BOOKS / SPECIAL PUBLICATIONS

1-99 The Bangalore Communiqué - adopted at the International Symposium on *Science in Society: A New Social Contract* 27-29 January 1999

2-99 International Symposium on *Science in Society: A New Social Contract*, 27-29 January 1999 - a report

3-99 The Bangalore Declaration on Information Technology for Developing Countries in the Global Village, November 4, 1998

4-99 Qualitative Methods in Mental Health Research
R.L. Kapur (ed.)

5-99 A CD-ROM of Selections from various manuscripts and description of the new digital technology developed at NIAS for the preservation of paper and palm leaf manuscripts
S. Menon and G. Williams

6-99 Scientific and philosophical studies on consciousness
S. Menon, M. G. Narasimhan, A. Sinha and B. V. Sreekantan (eds.)

7-99 Report on the Workshop on Information Technology Bill 1999

Entrance to the Main Building, looking through to the patio at the back.

RECENT FACULTY PUBLICATIONS

H.K. Anasuya Devi, 1999 Role of segmentation technique for sample epigraphy text: A case study. *Journal of the Epigraphical Society of India* 25: 40-50.

S. Sonpar and **R.L. Kapur**, 1999 Nonconventional indicators of gender disparities under structural reforms. *Gender Planning network project. Workshop 17-20 November 1999* (http://www.idrc.ca/mimap/papers.e.html)

A. Kumar, 1999 Peace through triangulation. *Himal South Asian* 12: 49.

A. Kumar, 1999 (Book review) *India's nuclear deterrent. Pokhran II and beyond* by Amitabh Mattoo (ed.). New Delhi: Har Anand. *South Asian Survey* 6.

S. Menon and **G. Williams**, 1999 Novel, cost-effective method of archiving manuscripts. *Current Science* 76: 1299-1301.

R. Narasimha, 1999. Rocketing from the Galaxy Bazaar. *Nature* (Millennium Essay) 400: 123.

R. Narasimha, 2000 E-governance: A blueprint for the future. *Parliamentary Affairs Millenium Special* 6: 13.

R. Narasimha and **M.K. Paul**, 2000 Rediscover railways (Bangalore-Mysore Corridor). *Deccan Herald*, 28th January.

S. V. Kulkarni and R. Narasimha, 2000 Quasi-cycles in monsoon rainfall by wavelet analysis. Current Science 78: 592-595.

M.G. Narasimhan, 1999 Model organisms in biology: Scientific and other uses. *Journal of Biosciences* 24: 141-142.

K. Ramachandra, 1999 On the future of Riemann Hypothesis. *Current Science* 77: 951-953.

K. Ramachandra, 1999 Notes on the Riemann zeta-function, II. *Acta Arithmetica xci*: 351-365.

R. Balasubramanian, **K. Ramachandra**, A. Sankaranarayanan and K. Srinivas, 1999 Notes on the Riemann zeta-function III. *Hardy-Ramanujan Journal* 22: 23-33.

R. Balasubramanian, **K. Ramachandra**, A. Sankaranarayanan and K. Srinivas, 1999 Notes on the Riemann zeta-function IV. *Hardy-Ramanujan Journal* 22: 34-41.

S. Sarukkai, 1999 Science, knowledge and society. *Economic and Political Weekly* 34: 779-784.

S. Sarukkai, 2000 Remembering M.N. Srinivas. *Economic and Political Weekly* 35: 431-432.

P.K. Shetty and **S.P. Magu**, 1999 Influence of metalaxyl on carbon dioxide evolution, dehydrogenase and phosphatase activities in the rhizosphere of wheat (*Triticum aestivum* (L.)). In: *Green Pesticides, Crop Protection and Safety Evaluation* (ed. Agnihotri, N.P., Walia, S. and Gajbhiye, V.T.). New Delhi: Society of Pesticide Science (India), pp 227-230.

U. Krishnamurthy, M.S. Roopkala, **A. Sinha**, P. Satishchandra and G.R. Ullal, 1999 Are there fast and slow handlers in hyperthermia-induced seizures? Abstract at the *First Annual Conference of the Indian Epilepsy Association*, Hyderabad, India, December 1999.

P. Satishchandra, G.R. Ullal, **A. Sinha** and S.K. Shankar, 1999 Pathophysiology and genetics of hot-water epilepsy. In: *Genetics of focal epilepsies: clinical aspects and molecular biology* (ed. S.F. Berkovic, P. Genton, E. Hirsch and F. Picard), 169-176. John Libbey and Company.

A. Sinha, 1999 Tactical deception in wild bonnet macaques: Evidence of intentionality. *Advances in Ethology* 34: 103. Abstract at the 26th International Ethological Conference, Bangalore, India, August 1999.

A. Sinha, G.R. Ullal, S.K. Shankar and P. Satishchandra, 1999 Genetics of hot water epilepsy: A preliminary analysis. *Current Science* 77: 1407-1410.

A. Sinha, 1999 Almost minds? The search for consciousness in nonhuman primates. In: *Scientific and Philosophical Studies on Consciousness* (eds. S. Menon, M.G. Narasimhan, A. Sinha and B.V. Sreekantan). National Institute of Advanced Studies, Bangalore. Special Publication 5-99, pp. 149-158.

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G.R. Ullal, P. Satishchandra, S.K. Shankar, **A. Sinha** and M. Panchal, 1999 Newer concepts in understanding hyperthermic handling in rats. Abstract at the *National Brain Research Centre Inaugural Colloquium*, New Delhi, India, October 1999.

K.A. Subramanian and **A. Sinha**, 1999 Social relationships influence decision-making during group fission in wild bonnet macaques. *Advances in Ethology* 34: 142. Abstract at the 26th International Ethological Conference, Bangalore, India, August 1999.

R. Cowsik and B.V. Sreekantan, 1999 A bound on violations of Lorentz invariance. *Physics Letters B* 449: 219-222.

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Rong He and **P.G. Vaidya**, 1999 Time delayed chaotic systems and their synchronization. *Physical Review E* 59(4): 4048-4051.

P.G. Vaidya, 1999 The geometry and nonlinear dynamics of pathogenesis. *Sadhana* 24: 53-71.

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A.R. Vasavi, 1999 Agricultural rituals: Rationality of rituals for regeneration. *Honeybee* 10: 6-7.

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NIAS FACULTY

Prof. Roddam Narasimha, Ph.D. (Caltech)

Director, National Institute of Advanced Studies

Prof. Narasimha is an aerospace scientist with a strong interest in atmospheric sciences and science and technology policy. He was on the faculty at the Indian Institute of Science from 1962 to 1998 and was Director of the National Aerospace Laboratories during 1984-1993. He currently also holds the position of Chairman, Fluid Dynamics Unit at the Jawaharlal Nehru Centre for Advanced Scientific Research. His most recent publications have been on the fluid dynamics of clouds and on rocket development in 18th century India. He is a Fellow of the Royal Society, London and Foreign Associate of the US National Academy of Engineering.

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Dr Raja Ramanna Ph.D. (London)

Honorary Professor

Dr Ramanna, the founder Director of NIAS, has worked on fission and particle physics, reactor physics, and theoretical aspects of music. Formerly Chairman of the Atomic Energy Commission, he is presently Chairman of the Council of the Indian Institute of Science and Vice-Chairman of the NIAS Council of Management. He was conferred the Padma Vibhushan in 1975, and nominated to the Rajya Sabha in 1997.

rr@nias.iisc.ernet.in

Prof Dilip Ahuja Ph.D. (Virginia)

ISRO Chair, Science and Technology Policy Studies

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May 2000

NATIONAL INSTITUTE OF ADVANCED STUDIES
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Prof Roddam NARASIMHA FRS, *Director*

24 July 2000

The Louis Berger Group Inc.
C-6/7, Safdarjung Development Area
New Delhi 110 016

Dear Sirs,

GEP-CCS Project: CLIN 04- Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above proposal. We are glad to confirm that we are willing in principle to host a forum for the research on climate change and its impact on economic development in India, subject to the associated terms and conditions being mutually acceptable. The topic(s) of research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing papers would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

Yours faithfully,

(RODDAM NARASIMHA)

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REPORT

A Biomass Option for Enhancing Energy Security

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Foreword

The National Institute of Advanced Studies has an energy studies programme whose objective is to look at the variety of different technology options that should be particularly relevant for India, where energy continues to be a serious problem. Part of this work is being carried out in collaboration with the Carnegie Mellon University.

The present report in this series looks at the potential of biomass as a source of energy. Technologies for biomass gasification have improved significantly over the last decade and now offer a serious option as a source of energy, particularly in a tropical country like India where sources of fossil fuel are either not plentiful or not sufficiently attractive economically; moreover from the energy security point of view biomass (with appropriate technologies and economic incentives) may be a very attractive proposition.

R Narasimha
Director, NIAS

Summary

This work is concerned with a strategy that simultaneously allows for complementing our centralized sources of energy in an economic way and, in the process, gaining global leadership in certain specific technologies. Explicitly stated, it envisages (a) an economic bioresidue-based power generation scheme in stand-alone as well as grid-interactive modes at power levels of 3 kWe to 3 MWe to augment the present centralized sources of electricity, (b) the possibility of bioresidue-based high grade clean heat for food-product and crop-drying applications, (c) providing a strong motivation for rural societies to preserve and even enhance biomass growth since such an act helps in bettering their quality of life through the availability of electricity under their own control, (d) the possibility of rural centres generating upgraded non-edible vegetable oils which can support both rural and urban transportation, and (e) pursuing strategies which provide far superior environmental-friendliness in terms of being near-CO_2 neutral and sulphur-free, objectives long sought in industrialised society, and very necessary now, thus

providing an opportunity for Indian technological effort to gain global leadership. This article describes the current status of the availability of bioresidues (both from agriculture and from plantations), methods to improve the available database, the techno-economic status of the biomass option, and different methods to advantageously deploy these resources for enhancing national energy security.

Introduction

India's power sector has a total installed capacity of approximately 89,000 MWe, over 70% of which is coal-based. The Government of India's Ninth Plan (1998/99-2003/04) envisages the need for an addition of some 57,000 MWe by 2003/04 to keep pace with demand. Coal is projected to continue to be the dominant fuel source for power generation in the country. While this target is unlikely to be met, it highlights the large requirement for new power generating capacity in the country.

Renewable energy for developed countries is considered as a strategy for the future. For oil-importing developing countries, particularly with widely distributed populations as in many South Asian countries including India, renewable energy from bioresidues could be the optimal solution. While fossil fuels are well-controlled by Government for their quality and availability, bioresidues are treated with scant respect. Powerful groups

control them for value addition, e.g. tree stocks by the timber, paper and related industries; but the rest is taken free by anyone who wants it and can lay hands on it first. This has distorted public perception and the true value of bioresidues has rarely been taken advantage of. A case in point is rice husk, a residue from paddy cultivation and rice production. Rice is the staple food of most of South-East Asia. The way rice husk is used for fuel in small establishments like hotels only about 60% of the available energy is utilized. Rice husk is composed of 60% volatiles, 20% fixed carbon and 20% ash. Conversion of the char residue is slow and cannot take place in the stepped grate stoves usually used for burning rice husk. The residue, with 50% char and about 40% of the heat value still unutilized, is simply disposed of in an unhealthy manner. Further, efficiencies of cook-stoves using rice husk are documented to be about 30% at best (ref. 1), so that the net energy efficiency is about 18%. The residue which is about 40% of the original mass contains nearly 50% ash, with about 95% silica, which if extracted economically could convert the present environmentally unsound method of using rice husk to an economically and environmentally benign strategy. What is more, carbon can be specifically extracted with its own contribution to the economic value of the process. Thus nearly every bit of rice husk can be used for electrical energy or for generating carbon or silica. Even a fraction of the 24 million tonnes of rice husk being utilised in this way (see Table 1) would be of mind-boggling economic value.

Table 1: Estimates of Biomass Produced in India

Crop	Production (10^6 tonnes)	Type of residue	Ratio of product to residue	Quantity (106 tonnes/y)	Typical uses
Rice	80	Straw	1.5	120	Cattle feed in sourtern and eastern India and for roof thatching all over the country. Generally burnt in the fields in the North.
		Husk	0.3	24	Mainly as a fuel by small industries
Wheat	65	Straw	1.5	98	Mainly in cattle feed
Bajra	7	Stalks	2.0	14	Domestic fuel
Jowar	11	Stalks	2.0	22	Cattle feed, domestic fuel
Maize	10	Cobs	0.3	3	Cattle feed
		Stalks	1.5	15	Cattle feed and domestic feed
Millets (all varieties)	35	Straws	1.2	42	Partly as domestic fuel
Sugarcane	270	Bagasse	0.3	81	Mainly as a captive fuel by sugar plants, partly as raw material for paper making
		Tops	0.05	14	Cattle feed
		Trash	0.10	27	Mostly burnt in the fields
Coconut	14 x 10^9 nut	Shell	0.1 kg/nut	0.2	Partly as domestic fuel
		Fibre	0.2 kg/nut	3.4	Partly for making mattresses, carpet etc.
		Pith	0.2 kg/nut	2.3	-
Groundnut	8.8	Shells	0.3	2.6	Industrial fuel
		Haulms	2.0	17.6	Partly as a fuel in households
Cotton	2.5	Stalks	3.0	7.5	Partly as domestic fuel
		Gin waste	0.1	0.3	Fuel for brick making and in other small industries
Mustard & rapessed	6.4	Stalks	1.8	11.5	Partly as domestic fuel
		Shells			Domestic fuel
All other seeds	9.0	Straws	2.0	18	Domestic fuel
		Shells			Partly as cattle feed
Pulses	14	Straws	1.3	18.2	Partly as domestic fuel
Tobacco	0.56	Stalks	1.0	0.6	Partly as fuel for processing tobacco leaves
Jute	1.4	Stalks	2.0	2.8	Partly as domestic fuel
Mestas	0.2	Stalks	2.0	0.4	Partly as a domestic fuel
Total				545.4	

Similarly, coconut shell is used in several parts of South India to produce char for subsequent generation of activated charcoal by the age-old 'pit method' (ref. 2), which is crude, energy-wasting and unhealthy. It is possible to conceive of modern, environmentally benign methods of generating electricity and also producing charcoal. The magnitude of this can cover a substantial segment of the 0.2 million tonnes of coconut shell produced annually. Neither of these approaches has been examined so far. Thus a whole range of opportunities for economical power generation remains to be exploited.

Thus renewable energy based on bioresidues or biomass to be generated through plantations can be obtained from three sources as below:

1. Agro-residue utilization for value-added products and power generation.
2. Plantation residues for power generation.
3. Waste land utilization for growing oil-seed bearing trees and extracting oil and bioresidues for power generation.

Agro-residue Resource Estimates

The biomass availability potential for generation of power in India is substantial. Based on the amount of the final product of agriculture, namely grains or food-crops, and the ratio of waste-to-product, estimates of the amount of residues are

obtained. These are illustrated in Table 1. This biomass is available in the form of straw, husk, stalks, bagasse, cane tops and trash, shells, fibre, pith, haulms, waste, etc. The ratios have mainly been taken from the report of the National Productivity Council entitled Survey of Biomass Availability in India, 1986 (these details can be found in the TERI Energy Data Directory Year Book, Ref. 3). The production values have been updated from various published data. Since the national grain output is known to reasonable accuracy, the errors involved in the estimate of the residues arise from the ratios. These could be uncertain to the extent of 10 to 15%. Thus the current estimates are expected to be no more inaccurate than this uncertainty. Since agro-wastes do not occupy a very high position on the energy ladder in terms of quality of fuels, strategies for their organized generation, preprocessing and commerce are virtually non-existent. The commerce that goes on now is on an as-is where-is basis born out of local necessity and lack of standardized forms of biofuels. This, in fact, makes it difficult to clearly assess the availability, current use and net material available, and, where used, to determine the end-use efficiency. One clear case where the bioresidue is totally wasted is with sugarcane trash, to the tune of at least 10 million tonnes of the total of 14 million tonnes available.

As can be seen noted from Table 1, about 23% of available bioresidue in the country is rice straw, 18% wheat straw, 16%

other straws, 15% bagasse, and 12% stalks of various plants; the remaining materials are distributed in smaller fractions between other residues. A typical distribution is shown in Table 1. An assessment of bioresidue which is likely to be available after use by the society as estimated from the present conditions is shown below. This estimate has been scaled from individual biomass assessment studies made in villages near Ungra by ASTRA and those initiated by MNES recently. A composite picture of the assessment studies carried out over 90 taluks in the country is still to be obtained. A brief review of the assessment studies is found in ref. 4. An estimate of the electricity that can be generated from the different wastes is presented in Table 2. The available residue amounts to an electricity generation capacity of 16000 to 18000 MWe at 6000 hours of utilization per year.

Table 2: Potential of Biomass for Power Generation

Source of biomass	Biomass generated (10^6T/Y)	Biomass utilised (10^6T/Y)	Biomass available (10^6T/Y)
Crop residues	414	280-300	114-134
Agro industrial residues (excluding bagasse)	50	50	-
Forest sources	35	-	35
Total (10^6T/Y)	499	280-350	149-169

The power generation capacity of the remaining bioresidue: 16,000 - 18,000 MW

Biomass Assessment Studies

It was indicated that the overall potential can meet the objectives of making an overall judgement. For these data to be useful, it is necessary that micro-studies be done to determine the actual mechanics of bioresidue generation and utilization in villages/taluks to help design bioresidue procurement plans for power generation plants. Towards this MNES launched biomass assessment studies all over the country at tehsil levels in the year 1995. As of today, 94 such assessment studies have been conducted in 2 phases in tehsils of 14 major biomass-producing states in the country. These include areas in Andhra Pradesh, Arunachal Pradesh, Assam, Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh, West Bengal, Kerala and Orissa. The studies were coordinated by the respective state nodal agencies for renewable energy development and conducted by select consultants/agencies.

These 94 studies have produced interesting results and the power potentials in these tehsils range from 1 MW to as high as 95 MW. The information generated from these studies is being compiled by the MNES into an on-line database, intended to be made available to investors/entrepreneurs, along with project notes/profiles for enabling them take a decision to go ahead with these projects.

MNES aims at covering assessment studies of 500 tehsils by the end of the Ninth Five-Year Plan period. The database being generated through this effort will be extremely useful for investors/entrepreneurs/financial institutions/related agencies for dissemination, focussing, R&D efforts and, finally, implementation of the projects.

Plantation residues

Agro-residues constitute an energy source which is generated at least once a year and, in some cases, with a the periodicity of three to six months. The other major energy route available is from plantation and forest residues. While it is true to say that it is not a publicly acceptable situation to design power packages based on solid woody bioresidues, since they are considered unsustainable, there are pockets like coffee and tea plantations, which are in the interior areas and are not well connected to highways where it is better to utilize these residues locally for heat and power generation. Considering the fact that the southern and north-eastern regions of our country abound in these plantations, substantial incursions are possible into bioresidue-based heat and power packages in these areas. The north-eastern region has also the benefit of the availability of natural gas in some pockets, and hence can be eliminated from consideration at present. The southern region, though having extensive tea and coffee plantations along the western hill slopes, does have serious problems with of the availability of fuel and

therefore constitutes one region which must be considered for the applications of bioresidue-to-energy strategies. These packages can be based largely on briquetted agro-residues.

Waste Lands and Their Utilization for Growing Biomass Including Oil-bearing Trees

The other major problem of India, namely, the waste lands (or, what has been termed more appropriately, the wasted lands), can be tackled in a win-win manner. The essential idea is to convert these waste lands into marginally green lands and then to good lands capable of normal biomass yield. Estimates of the extent measure of waste lands in the country vary according to varies between different investigative agencies. Table 3 taken from the book of Ravindranath and Hall (1994) provides some information on this subject.

Estimates of the extent of waste lands vary from 66 to 130 million hectares. Biomass yield from marginal lands is about 5 dry tonnes per hectare per year. From well-maintained land with proper selection of species and application of nutrients and water, one can reach productivity levels of 15 to 20 dry tonnes per hectare per year in a five-year cycle. The potential of waste lands can be gauged by the fact that even at the low yield of 5 tonnes per hectare per year the productivity of, say, 100 million hectares of land works out to 500 million tonnes per year. For annual use of 5000 hours of power generation,

Table 3: Estimates of Degraded Land Availability in India (Mha)

SPWD (1984); degraded (waste) land, quoted in PC (1992)	Degraded forest	36
	Degraded non-forest	94
	Total degraded land	130
Chambers *et al.* (1989); land available for tree planting	Cultivated land	13
	Strips and boundaries	2
	Uncultivated degraded land	33
	Degraded forest land	36
	Land for tree planting	84
Kapoor (1992); land available for tree planting	Agricultural land	45
	Forest land	28
	Pasture land	7
	Fallow (long)	10
	Fallow (short)	15
	Urban land	1
	Total land for tree planting	10
Ministry of Agricultural Sciences (1992); land use statistics	Forest land with < 10% tree crown cover	6 11
	Grazing land (pasture land)	12
	Tree groves (degraded)	3
	Cultivable waste	15
	Old fallow	11
	Total	52
	Current fallow	14
	Total degraded land	66

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the bioresidues from these amount to 60,000 MWe at a low conversion of 1.5 kg (dry biomass)/kWh. If the biomass productivity is increased by using known methods related to improvements in photosynthetic efficiency, the total power generation potential is a mind-boggling 100,000 MWe even without any other significant advance in new areas. It is entirely possible that in the new scenario when biomass growth rate is increased, newer uses of these for societal applications may arise and so alter the picture to some extent. But then, when things are in reasonably significant supply, the market forces of demand and supply will take over to reach a new equilibrium, which is much better than the current situation in terms of power availability.

A further point about waste-land utilization resides in the nature of the plantation to be grown. At typical biomass yields of 5 dry tonnes per hectare per year, the financial returns turn out to be about Rs. 6000 to 7000 per hectare (at Rs. 1200 to 1400 per dry tonne). *An alternate strategy is to grow oil-bearing plants or horticultural product-bearing trees so that bioresidue constitutes only the byproduct and the main product is oil-seeds or fruits.* Typical estimates indicate that biomass grown this way yields three products.: The first is Oil from oil-seeds to the extent of 0.5 to 4 tonnes per hectare per year. Oil yield being 10 to 50%, the amount of cake remaining is about 2 to 4 tonnes per hectare per year. This can be used in biogas plants to extract part of the hydrocarbons to generate

biogas (50% methane and the rest carbon-dioxide). Subsequently, the residue is a partial replacement for high quality fertilizer. The residue being natural and organic in nature has much less negative effect on soil quality in the long-term sense. Even as of now the cake is being marketed for its fertilizer value. The yield of solid bioresidue, which is lignaceous, is about 2 to 4 dry tonnes per hectare per year. Thus this route allows land and water to be used with much higher larger efficiency, and is environmentally friendly. The estimated financial productivity of the land estimated from the products obtained would thus be about Rs. 18,000 to 25,000 per hectare per year. Thus one can extract from the land and water resources thrice the productivity as compared to traditional and classical approaches. The oil so obtained from these plantations is capable of being upgraded through trans-esterification to obtain fuels which can burn in diesel engines with an efficiency only 7 to 10% lower than high speed diesel. It is also possible to use these fuels directly in rural transport vehicles like tractors and in power generation equipment in dual-fuel mode with producer gas from solid bioresidues and oil from the seeds.

To bring home the importance of these concepts, it is useful to recognize that the current use of high speed diesel amounts to 40 million tonnes (1997-1998) nationally (see ref. 3, p. 67). The productivity of the waste lands of 66 x 10^6 ha waste lands if fully used is between 33 and 240 million tonnes. Thus all

our oil demand can in fact be sustained from this source alone, even if the oils need further purification to match diesel fuels in terms of operational friendliness.

Thus utilisation of waste lands offers an important national alternative for generating useful biofuels to manage our societal needs.

Biomass Conversion Technologies via Gasification

Biomass gasification is basically conversion of solid biomass (i.e wood/wood waste, agricultural residues etc.) into a combustible gas mixture normally called Producer Gas or low BTU gas. The general composition of the producer gas is – CO: 20%, H_2: 15-18%, CO_2: 9-11%, CH_4: 1-2%, N_2: the remainder.

The process, developed earlier for woody biomass, was extended recently to include agro-residues by using briquetting technology to convert loose agro-and plantation residues to solid biomass of high density, and involves partial combustion of this biomass. Given that any biomass contains carbon, hydrogen and oxygen molecules, complete combustion would produce carbon dioxide and water vapour. Partial combustion produces carbon monoxide as well as hydrogen both of which are combustible gases. Solid biomass fuels, which are usually inconvenient and have low efficiencies of utilization, can thus

be converted into a high quality gaseous fuel with its associated convenience.

While there are different types of gasifiers such as fixed bed downdraft, updraft and cross-draft gasifiers discussed in the literature (see for instance, ref. 5), the most extensive work done till date in India and elsewhere for small electricity generation via reciprocating engines, has been on the fixed bed downdraft gasifier. While research studies have been conducted on fluidised bed gasifiers, it has been concluded that these would not be suitable for producing the low tar gas required for reciprocating engines.

Bioresidue Gasifier IC Engine Systems

The biomass gasification activity in India is about 16-17 years old. It started around the same time at the Karnataka State Council of Science & Technology (KSCST), based at the Indian Institute of Science (IISc), and M/s Jyothi's (Baroda). The initial motivation was diesel replacement for agricultural pump sets (about 2.5 million in number at that time and about 6 million in 1998). At IISc, the challenge of building an efficient small gasifier, then considered very difficult if not impossible, was alluring and therefore taken up.

By 1986, successful open top downdraft reburn gasifiers with extraordinary test performances (85 to 90% diesel replacement

even at 3.7 kWe) were built and demonstrated. M/s Ankur Technologies had just then started with a closed top design.

In the last ten years not only have a large number of systems been built by M/s Ankur Technologies, but several other manufacturers – AEW, Tanaku, and Cosmo Enterprises, Raipur have entered the field. Centres for scientific support were established at IISc, Bangalore, IIT/Bombay, IIT/New Delhi and Madurai Kamaraj University. Approximately Rs. 18 crores have been spent on these projects over the last 12 years. Of this about Rs. 4 crores was towards R&D. The rest was for demonstration purposes. Vigorous development and information exchange took place at national meetings organized under Ministry of Non-Conventional Energy Sources (MNES) patronage till 1993. There have been no major meetings thereafter.

It is important to discuss one aspect of small gasifiers which is relevant to the Indian context. Because there were large numbers of small power level pump sets, it was thought expedient to develop small gasifiers. However, this also became a tool for experimenting on small-scale designs, to enable better understanding of the processes involved, with minimal expenditure on research and development and then, of course, one scale-up to larger power level systems. The question of developing a good small gasifier has cropped up in the literature and at many discussion meetings. Solar Energy Research

Institute's (SERI, the present NREL) original document, which is the translation of the Swedish experience, states that building a lower power level system which runs reliably is more involved when compared to large power level systems because the volume to surface area is unfavorable for small systems and the heat loss issues cause difficulties in ensuring reliability. This statement is technically correct and has also been experienced by us in the early stages of the development of the gasifier.

Therefore it was assumed that if one could make a small gasifier that is efficient and emitting "minimum tar" as assessed by standard tests, then the concepts involved are worth preserving for larger gasifiers and the scalability of gasifiers based on these concepts becomes a strong point of these technologies. It is worth noting that in classical chemical engineering approaches, it is considered only appropriate to do model studies, build prototypes and examine issues of scaling, and this is exactly what is being followed systematically in the current approach through scientific and engineering studies on systems at increasing power levels.

The earlier international development in this area shows that only large lower level systems were addressed, due more to historical than scientific reasons. It is therefore meaningful to conclude that the development of small-scale gasifiers has given insights into what needs to be done at larger power

levels, much in the same way as what happens in several other engineering fields.

During 1988 to 1992, MNES had a vigorous demonstration programme for gasifiers for water-pumping applications. About a thousand gasifiers were put up in three stages under this programme by at least three manufacturers, and the performance of the systems was monitored as follows. (a) Designers went round all by themselves to determine the usage pattern and problems if any in running the system. They also suggested changes needed to make the system more user friendly, (b) The state nodal agencies utilized a separate team of three technical personnel to monitor all the gasifiers in the field. (c) MNES utilized a separate national agency to monitor the performance and provide inputs to the Government on the design, operation, training and related aspects. The agency submitted its report directly to MNES. The duration of run on one of the designs is in Table 4, which includes the hours run on each system and the total run period, which indicates the experience accumulated. When all the gasifiers were deployed in the field, there were three levels of monitoring teams.

Table 4: Sample of IISc Gasification System Performance – Duration

Years	Capacity (kW)	Min-Max h/ System/Y	Number of Systems	Hours accumulated
1987 to 1990	3.7 kWe (pump)	100 to 500	120-450	40,000
1988 to 1995	3.7 kWe (Hosahalli)	1400	2	8,000
1995 +	20 kWe	2800	1	2800 (Hosahalli)
1990 to 1996	70 kWe (Port Blair)	1200	1	4000
1992 +	20 kWe	400	1	800 (Ungra)
1995 +	40 + 40 kWe	1800	1	1800 (Orchha)
1996 +	400 kWh	600	1	600 (Coonoor, tea drying)

Subsequent to the early efforts, 25 to 100 kVA systems were also permitted under the demonstration program. Further the technology developers gained confidence and started building larger gasifiers both for thermal and electrical applications. In 1994, because of an interesting development and connection with Swiss scientists through Dr. Hari Sharan of DASAG, Switzerland, the 75 kg/h (100 kVA) IISc system went through rigorous testing and evaluation in India and in Switzerland. In both places, tests were conducted with different bioresidues and loads for a total of 100 hours each. *This system is perhaps the only gasifier in the world which has undergone such rigorous testings.* The test results are presented in ref. 6, and have been presented at two major international meetings (refs. 7 and 8). Subsequent to these tests, Swiss scientists have used the system to check other subsidiary elements like the cooling

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and cleaning units rather extensively. It has also undergone a long-duration test of 150 hours continuously, as well as several intermittent ones after coupling the gasifier to a gas engine.

Subsequent developments at Bangalore involving other manufacturers in the country have resulted in gasifiers with capacities ranging from 100 kg/h to 500 kg/h, both for thermal applications and electricity generation. The quality of gas required for drying food products like tea posed difficulties which could be dealt with by cleaning the gas adequately. The class of engines used for power levels less than 100 kWe are mostly naturally aspirated and for those beyond 150 kWe are turbo-supercharged. The problems on gas cooling and cleaning for *larger sized engines* are more demanding *than for the lower power level systems.* These have been very inadequately explored in earlier work on gasifier applications for electricity generation.

The investment cost of the gasification technologies in comparison to coal-based power plants is as follows. For power generation systems of a couple of megawatts and above, the cost varies between Rs. 35 and 45 million per MWe (US $ 1000 per kWe). Bioresidue-based systems also have similar costing since all these power plants are generally based on combustion–steam power generation cycles.

The cost of small gasifier-based diesel engine generator systems at power levels of 100 to 500 kWe varies between Rs. 25 and 35 million per MWe (US $ 700 to 800 per kWe). In most of the applications, the cooling water clean-up and cooling for recycling applications is absent. When these are included, the unit cost is comparable to large power level system unit costs (US $ 1000 to 1200/kWe). The cost of electricity generated from small gasifiers is between Rs. 2.5 and 3.0 per kWh and in the case of large power level systems, it is between Rs. 2.2 and 2.5 per kWh. The simple pay-back period on investment in the gasifier for a retro-fit application works out to 15 to 24 months depending on the cost of bioresidue, which is taken as between Rs.1000 and 1500 Rs per tonne, and 24 to 30 months, if the electricity generation package consists of gasifier–gas engine-generator set, and 30 to 40 months if it is based on gasifier–diesel-generator (DG) set operating in dual-fuel mode with 75% diesel replacement. In all cases it is taken that the power package is used for 5000 hours per year.

A problem that is somewhat special to India in this scenario is that the market is almost entirely driven by diesel engines. Because stand-by power is an absolute necessity for industries, a large number of industries have DG sets. The total stand-by capacity all over the country is about 17000 MWe. This magnitude of power is used to the extent of about 500 hours over a year, essentially to take care of scheduled and unscheduled power cuts, due to a number of factors like grid

stability, low quality of power (in terms of voltage and frequency), excessive peak demand, and non-availability of fuel at times. In some states and specific locations, the amount of electricity generated in-house in comparison to that from the grid is as high as 30%. Also the tariffs payable to the State (Rs. 3.50 to 4 per kWh) are higher than the cost of in-house generation of electricity (Rs. 2.75 to 3.15 per kWh).

These aspects have created the demand for cheaper processes of electricity generation in many instances and using the existing investment on diesel-generator sets more effectively. While most industrialists can easily appreciate the economics and the possible benefits, their problem is usually about examining a few working systems, for none of them wishes to risk being the first to venture into the field. The current MNES schemes do not have provision by which risk is initially taken by governmental agencies with subsequent transfer of financial liability to the industrialist. Laboratory testing and proving has been performed to a substantial extent in India through Swiss cooperation, up to a power level of 100 kWe. For power levels larger than this, industrial participation becomes essential. Industrial participation however can begin only when they can see a few successful systems in the field as already explained. Hence, it is extremely important to demonstrate a few systems under different conditions – largely industrial but also both in semi-rural and urban settings so that user misconceptions can be eliminated. Even under these

unfavorable circumstances, some aggressive entrepreneurs have gone in for high power gasifiers. These are of course in the initial stages of demonstration and users still handle gasifiers with kid gloves. Also the developers are not in a position to provide guarantees which can be trusted at present. If no attempt is made to catalyse the process with financial, technical and monitoring inputs, the field will take a long time to grow. This is also because peer groups from overseas have largely been under the impression that the systems are not reliable, or are not economical, even if they are reliable. To erase wrong public impressions by documentation is even more difficult; however, this is taking place slowly by systematic dissemination by which technical questions are being responded to, joint testing conducted and third party verification of most of the task elements being done.

Gasifier-Based Power Generation Strategy

All these imply that utilizing the incentive driver in terms of lower cost of electricity generation for propagating the bioresidue-based renewable energy technology exists even today. However, it is necessary to overcome (through demonstration plants) the barriers created by (a) inadequate experience with large power level systems, certainly above 300 kVA, and (b) non- availability of gas engines to demonstrate the true potential of bioresidue-to-energy conversion.

It is therefore important to mould this programme so that a number of projects of reasonable power levels – 4 x 300 kVA, 2 x 600 kVA, and 1 x 1 MVA – evolve, being handled with proper cooperation between technology holder, client, monitoring scientific group and project initiator. Intermediate reviews and documentation, dissemination to peer groups through various means, such as referred journals and vetted reports (so that a common platform of understanding of all the issues involved develop), are also of paramount importance.

In these tasks it is important to generate appropriate fuel linkages. The issue is by no means small and is addressed in the next section.

Standard Gasifier Fuel (SGF)

One of the serious problems that besets gasifier users as well as technology suppliers who have to stand guarantee for performance is the nature of the fuel used in the gasifiers. The general quality of fuel to be used in solid bioresidue gasifier is as follows. Bioresidue chips of smaller than a certain size (typically 30 to 70 mm for power levels less than 500 kWe), with density greater than 200 kg/m^3 and moisture content less than 15%, are required; they should not contain inorganic material like sand, grit and mud. The major problem in the field is non-compliance with the requirement given in the manual. Sometimes users have used larger sized chips with

resultant reduction in diesel replacement. The second non-compliance concerns moisture in the wood chips. Surprise checks also indicated the generation of tar. Investigation showed that the moisture content exceeded 30% and, in some cases, was around 50% (virtually green wood). Reprimanding the operating personnel resulted in improvement to the expected level. The third non-conformity discussed earlier, namely, the inclusion of inorganic matter in the form of sand and mud, these being picked up from the area where the biomass is harvested, results in the formation of a hard fused ash-like matter inside the reactor, and in some cases, on the ceramic reactor walls. What happens is that the ceramic wall of the container also reacts and fuses with the impurities and this results in the loss of the parent material as well. Resolution of these problems lies in generating standard gasifier fuel and supplying it through depots/banks.

We should recall that when fuels are to be used in reciprocating engines, the quality of the fossil fuel has to be controlled to a very good degree, and should be much superior to what is obtained from bioresidues. For the same reciprocating engine, if we have to supply gas of consistent quality, we should maintain minimum quality of the feed stock. In the current environment of bioresidue utilization, almost every household deploys it with poor end-use efficiency, with not much concern about the emissions which are a serious health hazard. This problem faced by solid fuels has remained unresolved because

of inadequate attention paid to the science of their conversion process. Therefore, there is a strong case at the national level to upgrade the quality of bioresidue-based fuels which suffer from the common misconception (national or, perhaps, even universal) that they can be emission-friendly fuels. While there are technological interventions for better use of bioresidue fuels, even these can work more economically provided attention is paid to the preparation of these fuels at costs acceptable to the market. We should recognize that the density of fuels, their shapes and sizes and their moisture contents vary widely. The density of sundry fuels is 50-60 kg/m^3 for sugarcane trash, bagasse pith and coconut coir pith, about 100 kg/m^3 for rice husk and groundnut shell, about 175 to 200 kg/m^3 for cotton stock, *Ipomoea* (a weed) and coffee husk, about 500 to 600 kg/m^3 for causarina, eucalyptus and similar stocks, and about 1000 to 1200 kg/m^3 for padauk and briquetted fuels based on light agro-residues as mentioned above. Thus one can see that the density variation is a factor of 20. A typical truck with a storage space of 6 x 2 x 3 = 36m^3 can at best carry 1.5 to 2 tonnes of the light agro-residues or the standard 10 tonnes of the higher density solid stock or briquetted fuels (in the latter the carrying capacity being decided by weight and not volume). Thus it is important to think of densifying the light agro-residues through briquetting at the location of the material or perhaps within a kilometer of its availability and then transporting it as needed. The cost of transportation works out to about Rs.10 to Rs.12 per kilometer

for a full 10-tonne truck. This amounts to Rs. 300 even at distances of 25 km and, therefore, the incremental cost of transportation works out to Rs. 30 per tonne over 25 km. This is an economically meaningful incremental cost which the society should be able to sustain for the benefits that can accrue from bioresidues, electricity for various uses and, to a smaller extent, charred solid fuel for cooking. The strategy of local bioresidue collection is suggested because of the small land holdings that lead to distributed bioresidue availability and control. Thus it is important to develop bioresidue-based "Standard Gasifier Fuel" (SGF) banks. Such banks are expected to have tractor-trailer mounted equipment, including chaff-cutter, waste heat drier-pulveriser and briquetting machine, all powered by an diesel-engine alternator system which can move from place to place and generate briquetted fuels. At the field site, the farmer who is involved in providing the fuel resource can be paid on the basis of the dry weight of the fuel he supplies. Typically this can be about Rs. at 300 to Rs. 400 per tonne of the raw bioresidue, so that the final cost of the processed bioresidue works out to about Rs. 1000 to 1200 per tonne.

It is necessary that the projects discussed earlier be coupled with the "Standard Gasifier Fuel" (SGF) strategy discussed above so that one has a complete package for power generation.

Oil Strategy

Oil and HSD consumption

The use of high speed diesel (HSD), which constitutes about 75% of the middle distillate output, and about 50% of the sum of the middle and light distillates and about 40% of all the refined petroleum products, is the backbone of the economy as reflected by the transportation of goods across the country. In the year 1995-1996 its consumption amounted to 33 million tonnes and its annual growth in its consumption is about 4 million tonnes. About 10% of the amount consumed is used by the rural sector for water pumping, transport-tractors etc. The diesel consumption in the agricultural sector is for six million, 5 hp pump sets which use one 1litre per hour of diesel for an average of 500 hours every year. In addition, there are about 2 million tractors which consume about 1 million tonnes of HSD. Thus, of the total HSD used per year which is 40 million tonnes (1997-1998), the amount used in the farm sector is 4 million tonnes.

One strategy to attempt to alleviate energy shortages is to allow the rural sector to generate oil for its own needs by various means as discussed earlier. It was brought that a better way of using waste lands is to grow oil-seed or horticulturally useful product-bearing trees so that bioresidues constitutes only the byproducts and the main produce is oil-seed or a fruits. Also it was brought out that oil yield from oil

seeds is to the extent of 0.5 to 4 tonnes per hectare per year. In the total waste land area of at least 66 million hectares the oil that can be generated is 33 to 264 million tonnes per year. This range is obviously large, but unfortunately, inadequate data make closer estimates difficult. This is a mind-boggling figure, a fact not recognized by the planners as yet. At the least, a part of these lands must be used to meet the principal requirement of oil for water-pumping applications. This will need only 1 to 8 million hectares of waste land. This field is unfortunately only weakly appreciated and coordinated in the country today. As is further evident in the discussion presented in Annexure I, considerable potential exists for the development of theise areas.

The Overall Strategy

The overall plan is to set up a national level board/centre/ commission with the participation of membership coming from different ministries – MoEF, MNES, MoA, and Waste Land Board – with the idea of (a) encouraging the growing of trees bearing oil-seeds and streamlining related activities by providing various kinds of incentives; (b) promoting R&D to reduce the gestation period for the achievement of these objectives; (c) encouraging industries to adopt surrounding localities by planting such trees; (d) framing policy for investing in these oil cakes to meet the local energy demands; (e) orienting the whole programme so as to offer employment

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opportunities to the local labour force, incidentally discouraging needless migration to urban areas.

A number of bioresidue-based projects at the power level of 250 kVA, 600 kVA and 1200 kVA should be located near industries and chosen to meet the following criteria. (a) A sustainable supply of bioresidues for the foreseeable future – at least about 5 years (about twice the period for return on investment), (b) industrial operations that can permit generation of a minimum number of units of electricity, and (c) availability of different classes of bioresidues – solid stock, and standard gasifier fuels (SGF) along with the demonstration of the production of these fuels. Typical investments in the total package will be about Rs. 100 million including technical costs of monitoring and documentation.

Annexure I

(Constructed from the articles published in BUN – India newsletter, volume 2.3. The authors whose articles are used here are Dr. P Radhakrishna, MNES, Chennai, Drs. A Das and T B Reed of Colarado School of Mines, Colarado, USA, Sri. Vinayak Patil and Sri. Kanwarjit Singh, and Prof. U Shrinivasa and H S Mukunda, IISc, Bangalore)

(Summary drawn from articles published in BUN – India, v. 2.3, 1998 – ref. [10])

Vegetable oil as a source of energy has been known for a long time. Perhaps the presently administered affordable prices, international attention and convenience associated with petro-oils, have not promoted the required R&D for exploring the use of vegetable oils as future liquid fuels. Basically vegetable oils are either edible or non-edible and the plants bearing them are annual or perennial. Both these categories also have other applications in various other areas, apart from cooking, such as medicines, food preservatives, base for soaps, illuminants, lubricants, paints, drying agents, for curing of leather products and the like. Edible oils like coconut, sesame, castor, rape, mustard, safflower, niger, and linseed have the pride of place in Indian history, dating way back to the Rigvedic Age. Other edible oil-plants introduced later on include groundnut (introduced approximately in 1800 AD), soybean (1910), sunflower (1940) and oil palm (1966). Of all these oil-seeds, castor (introduced around 1000 BC) oil and cakes are not edible. In the category there are at least 150 species, mainly trees or shrubs, yielding oils that are not consumed directly by man or animal. The main uses of these oils in India are in soap-making and in ayurvedic medicines. Other activities associated with these oils are not documented to the satisfaction of researchers. In recent studies, some of the oils like *Mahua*, *Sal* and *Kokum* are introduced in proportional quantities in making *Vanaspathi* (hydrogenated fats) and chocolates respectively. In fact, many of these trees produce valuable chemical substances in s from their leaves, flowers, stems and roots portions, whose importance has been known from Yajurvedic times. Other economic activities associated with these oilseeds such as harvesting, collection, crushing, marketing etc. however are not well-organized like that of other edible oil products. The available potential is also not yet estimated since the collection of seeds is not a regular occupation. It is estimated that 76 lakh tonnes per year, and 2 lakh tonnes of seeds are collected from 7 other tree species in minor quantities.

Table A: Production of non-edible oil seeds and bio-residues in India

Species	Oil fraction (%)	Seed current estimates (10^6 tonnes/y)	Oil (tonnes/ha/y)
Castor	45–50	0.25	0.5–10
Jatropha	50–60	0.20	2.0–3.0
Mahua	35–40	0.20	1.0–4.0
Sal	10–12	0.20	1.0–2.0
Linseed	35–45	0.15	0.5–1.0
Neem	20–30	0.10	2.0–3.0
Pongamia	30–40	0.06	2.0–4.0
Others•	10–50	0.50	0.5–2.0

•*"Others" refers to seeds from a whole range of seed-kernels species: Jute plant, mango kernel, flame of the forest, Indian Coral, kokum butter tree, ink-nut, soap nut, milk weed, waternelon, yellow oleander, tamane oil-tree, crotan oil tree, palm, prickly poppy, wild walnut, almond, kamal, tung oil-tree tree, silk cotton, bullet wood tree, ironwood tree, bastard sandal, pilu, foon etc.Oil production depends on a number of agro-climatic factors and the choice of the species.*

Data on the availability and use of these oils for power generation are not as extensive as for fossil fuels. The limited information available in the literature is put together here. One of the biofuels considered by Das and Reed is hemp. Historically hemp (*Cannabis sativa L.*) has been a very high yielding plant (Haney 1975). Assuming that hemp produces up to 4 tonnes/acre of seed plus 10 tonnes/acre stalks, Table 1 shows how many gallons of liquid fuel import could be saved by each of the following proven conversion routes.

The hemp plant is a promising high yielding biomass fuel crop cultivator and both its production and utilization should be included in the DOE/TVA and regional biomass screening programmes. One hopes that DOE regional biomass programme contractors have no difficulty qualifying for the necessary permits. Most of the conversion technologies in Table 1 are well-known. Biodiesel from hemp is the newest conversion technology. Recently, at the Biomass Conference of the Americas (Biomass, 1993), nearly a dozen papers were presented on biodiesel fuel. It was recommended that farmers in Northwest America achieve

self sufficiency to provide enough fuel for tractors, irrigation and combines in energy by planting oil-seed crops like sunflower or safflower on 10% percent of their acreage. Sunflower and safflower yield typically 60 gallons per acre of vegetable oil. Hemp-seed yields up to 300 gallons of oil per acre have been reported (Haney 1975), yet there was not one single mention of this promising fuel oil-seed crop anywhere in the Conference.

Table B: Conversion technologies for hemp stalks and hemp oil

Conversion technology	Conversion efficiency (%)	Gasoline equivalent (Gal/acre)
STALKS@10 tonnes as stalks/acre		
Ethanol from fermentation of hydrolyzed cellulose	20	200
Digestion of whole stalks to methane	50	500
Producer gas from thermal gasification of stalks	85	1000
Methanol from syngas from gasification of stalks	65	750
Wood oil from fast pyrolysis of stalks	60	700
Oilseeds@4 tonnes seed /acre		
Hemp seed oil from seeds, no conversion	100	300
Biodiesel-premium diesel fuel from hemp seed oil	90	270

The cost of oilseed fuels is linearly related to yield and farming cost. The cost of farming and pressing sunflower oil, yielding 116 gallons/acre, is $2/gallon (Peterson 1981). Assuming that hemp will cost the same as sunflower to grow, a hemp seed yield of 4 tonnes/acre (Haney 1975) can produce 300 gallons of hemp seed oil at a cost of $0.77/ /gallon. This may make domestic hemp seed oil economically viable today. [See also (Biomass, 1993)] *Biomass Conference of the Americas*, Burlington, Vermont; Haney 1975: "An ecological study of naturalized hemp (*Cannabis Sativa* L.) in East-Central Illinois"; Alan Haney and Benjamin B. Kutscheid: *The American Midland Naturalist* Vol 93, No 1, January 1975, 1-24; Peterson 1981: Vegetable oil as an agricultural fuel for the Pacific Northwest, C. L. Peterson, *et al*, Idaho Agricultural Experiment Station Bulletin No. 598, Moscow, ID 83843].

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One area in which scientific work has led to clear conclusions of practical relevance is the use of bio-oils like rapeseed oil in some western countries and the possible use of non-edible oils in India. There has been a serious thrust on the production of pyrolitic oils from biomass in many countries such as Canada, Spain and Italy, to enable their use in reciprocating engines. Several studies have shown that pyrolitic oils have problems related to their acid content and water on ignition and performance in reciprocating engines. Gas turbine engines using this oils seem to have fewer problems of ignition and combustion, as these are continuous combustion devices.

One serious question to be debated is the relative importance given to the two routes –

(a) pyrolitic oils and their refinement, and
(b) non-edible oils and their refinement to enable use in reciprocating engines (the main focus of developing-country alternatives for small power generation will be reciprocating engines).

It appears that for India, the route involving the use of non-edible oils can be economically meaningful and can be used as the incentive a driver for restoring the environmental balance. Some experience has been obtained on the use of liquid fuels like *Pongamia pinnata* (Honge) oil as a substitute for diesel engine by Prof. U Shrinivasa under the project called SuTRA (Sustainable Transformation of Rural Areas) at the Indian Institute of Science, Bangalore. This has been done in seven villages located about 100 km from Bangalore for varying lengths of time, from 40 days to over 100 days. The number of hours of run accumulated over the period exceeds 4000. The following observations have been made based on this experience. (a) The oil as obtained from the expeller requires thorough cleaning, (b) the engine can be both started and run on Honge oil continuously whenever the engine itself is in good condition, (c) the engine exhaust appears clean during visual inspection, (d) engine fuel consumption increases by 10 percent by volume as compared to diesel. While more work needs to done in this area, it is obvious that this need not limit the expansion of the use of such oils for power generation.

Initial estimates and assessments suggest that at least in the semi-arid regions, enough Honge trees can be grown to enable most villages to operate local power stations using this oil, at the rate of about 0.5 kW per capita. This will allow villages to feed surplus power to the grid instead of being consumers of grid power as is the situation at present. It will also provide to the villages, electricity in sufficient quantities from one of the most inexpensive of the renewable energy options. The experience that has been gained in the country on growing oil-bearing trees and their utilization is significant with respect to a plant called *Jatropha curcas*, which is a wild dwarf bushy tree that is very hardy and grows in most climatic and soil condition. It is not browsed by

animals, including sheep and goats. Its present use is in the soap industry and this interest is dwindling due to the availability of cheaper oils from overseas.

Some experience has been gained by Mr. Vinayak Patil and Kanwarjit Singh, through systematic studies in Maharashtra, on the subject of cultivation and marketing of *Jatropha curcas* through agro-forestry co-operatives. They have made a strong plea in this regard – "It is now increasingly being realised that co-operative agro-forestry can be used as an effective medium to fight the battle against environmental degradation. By motivating the farmers to adopt agro-forestry crops like *Jatropha curcas* as an alternative cropping pattern the energy and economic scenario in the rural areas can be drastically improved. Agro-forestry is the only effective means to enhance the area under actual tree cover for achieving the national goal of bringing 33% of the total land area under effective tree cover required for maintaining the environmental balance and for greening the country. Co-operative agro-forestry is a productive programme which holds immense potential to generate a sustainable source of self-employment, renewable source of energy and contribute to complete socio-economic and ecological development through the active participation of the people for their own welfare. The concept of co-operative agro-forestry was conceived in Maharastra State in 1993 with the formation of "Nashik District Eucalyptus Growers' Co-operative Society" at Nashik. Taking a cue and technical guidance from this pioneering co-operative agro-forestry venture initiated at Nashik more than twenty-five similar agro-forestry co-operatives have already been formed in Maharastra State and many more are in the process of formation. This process has finally culminated in the formation of the state level federation agro-forestry co-operatives in Maharastra State in November, 1990, which is the first state-level federation of its kind in India."

The chief aims and objectives of the agro-forestry federation are: to organize supply of the requisite propagation material, to guide the farmers regarding cultivation practices of agro-forestry crops; to help and guide the farmers in procurement of loans and to stand guarantee for repayment of loans; to organize harvesting and marketing of the agro-forestry produce and to organize setting up of suitable processing units based on agro-forestry produce.

Experience in agro-forestry in Maharastra shows that the willingness of the individual farmers to accept agro-forestry as an alternative cropping pattern is governed by the following factors, viz. availability and type of land, availability and quantity of water, distance of the farm from the residence of the landowner, exposure to cultivation practices of a particular crop, availability of trained labour and basic training instincts of the farmer. It has been observed that even if one of these factors is unfavourable, agro-forestry makes an ideal alternative.

The Eucalyptus Growers' Co-operative Society of Nashik has been campaigning for the cultivation *Jatropha curcas*, a dwarf bushy tree, which is very hardy and grows in most of monsoon and soil conditions and yet offers handsome returns to the grower. The soap manufacturing units in the country had been looking for an alternative to edible oil for the manufacture of soap for the past seven to eight years. Since some of these units showed interest in buying *Jatropha* seeds for extraction of oil, the agro-forestry co-operative at Nashik motivated 1450 farmers. In 1988-89, 3000 hectares, in 1990-91 another 3000 hectares and in 1991-92 4000 hectares of land have been covered under *Jatropha* plantation. Agro-forestry federation will organize marketing with buy-back guarantee for the seeds and provide technical guidance to the farmers regarding cultivation of *Jatropha curcas*.

The by-product from Jatropha seeds, in the form of oil-cake after extracting of oil, is an excellent organic manure, even superior to cow-manure. This pioneering effort of introduction of a systematic plantation programmme of *Jatropha curcas* in Maharastra State will prove to be a new trend setter which, hopefully, can lead to a revolutionary transformation of the gloomy economic and energy scenario into an era of economic boom and prosperity of all sections of the society including the rural poor. It will ensure optimal and harmonious utilization of our land, water, manpower and financial resources. The bio-crude oil of *Jatropha curcas* can save foreign exchange worth several thousand million dollars by the year 2000 AD and onwards. The water requirements are much less as compared to other agro-forestry crops. It comes to full fruition within 4 to 5 years and has a long productive period of around 50 years yielding handsome returns annually. These traits make it a low-cost model ideal for small farmers and a safe investment model both from the banker's and the farmer's point of view. Some basic research on cultivation has been carried out at Bharatiya Agro-Industrial Research Centre, Pune in Maharastra by Shri Ashok Raina. Research and development activity has also been undertaken by Godrej Soaps and Hindustran Lever who are major users of *Jatropha* oil in India. Preliminary experiments carried out by the authors at Nashik have successfully established that *Jatropha* oil could be used as an alternative to diesel as furnace fuel and also as an alternative to kerosene in specially designed stoves. Shri Kannighanti Chandrashekhar, an automobile engineer from Hyderabad has also conducted experiments on preparing 2T stroke oil from the *Jatropha* oil – a lubricating mixture used in mopeds, scooters and motor cycles. The future of *Jatropha* oil seems to be promising and the time is ripe for expanding the *Jatropha* oil base to enhance the availability of this useful oil as a raw material for industrial use and for generation of electric power in a decentralized manner.

The forest development corporations of Maharastra and Gujarat have also initiated introduction of *Jatropha curcas* in their afforestation programme for revegetation of denuded and degraded forest lands as a commercially important and hardy species for quick greening of public waste lands. Collection of *Jatropha* seed can provide a regular source of income to the local people and reduce pressure on forests. Tribal populations will also get an alternate source of livelihood and energy and the illicit cutting of forest trees and encroachments on forest lands will considerably relieved."

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REPORT

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being built at coal pitheads. Since hydro power resources and pithead thermal stations are located in areas far removed from load centres, exploitation of these resources and building these power stations is essentially attendant with the requirement of long distance transmission of bulk power. It is to be emphasised that addition of generation without adequate network strengthening for evacuating bulk power and transmitting it over long distances, with minimum loss, to load centres is meaningless. For this purpose, new and effective methods of transmission have to be evolved.

Status of Transmission in India

Transmission system planning so far has been more or less on the basis of regional self-sufficiency. The strategy for transmission system development is to achieve fully integrated operation of the regional grid systems and to connect such systems through inter-regional interconnections of appropriate power transfer capabilities. Inter-regional ties are expected to improve the reliability of the connected regional grids and facilitate emergency exchanges of power and optimum utilisation of available generation facilities particularly the transfer of surplus energy available in one region to another with a deficit. In course of time, the scope of the regional plans might be required to be widened to cover the option of bulk power transfer from one region to another on economic considerations. This approach would eventually lead to integrated planning at the national level.

As in so many aspects of its culture and development, electrification in India is a study in contrast. On the one hand, in a small period of 43 years, generation capacity has grown from a scant 2300 MW to the present level of 90,000 MW. The country's power transmission system includes a 250 MW back-to-back direct current link,and a couple of long distance point-to-point HVDC transmission systems. An experimental 200 km, 200 MW DC system built almost entirely with indigenously developed and built technologies – right down to thyristors in the convertor stations – is in operation.

On the other hand, annual per-capita energy use in India is roughly 300 kWh, about 10% of global average. Furthermore, the reliability of the bulk power supply is very poor and its quality is alarmingly below the standards of the developed world. Plant availability figures – an indication of how well plants are run – are low. The average generating plant load factor (the ratio of a plant's average output to its rated maximum, capacity) is about 57%. For comparison, plant load factors in developed countries are normally higher than 70 %. Low frequency operation is routine throughout India and harms generating units and load alike.

In addition, more than two decades after regional power grids were formed, there is still no adequate tariff structure for power interchanges between Indian states. Inter-connected operation is therefore usually blocked, leaving each state system

to operate in isolation. Crisis management has become the order of the day, and load shedding – both scheduled and unscheduled – has become common. Customers have also gotten used to periodic brownouts and blackouts.

Keenly aware of this serious obstruction to future development, the Government of India has made generating capacity and transmission-system additions a priority in its five-year economic plans.

Shifting the Mix

At present, India derives about 67 % of its electricity from coal, 8 % from oil, 23 % from hydro electricity, and about 2% from nuclear power. In coming years, however, this mix is likely to shift, with nuclear and renewable energy sources accounting for more of the mix and fossil fuels for less. By the end of the 10th Economic Plan in 2007, nuclear power is expected to expand to 10000 MW, or roughly 8 % of the total generation mix.

Capacity additions are of course pointless without commensurate expansion of transmission systems. Unfortunately, this idea has not always guided electrification in India, and growth in transmission systems of late has not kept pace with additions to capacity. Underlying this mismatch are several causes, including right-of-way clearance difficulties

and very long waiting periods associated with the building of transmission lines, which are often more onerous than securing the environmental clearances for a large base load thermal power station.

Along with growth in generation and transmission capacities have come greater complexity and the need for closely interconnected and integrated operations. At present, India is divided into five independent grids, each with a Regional Electricity Board (REB) to coordinate load dispatch operations within the grid. However, the facilities available to these boards are far from adequate for controlling the interconnected operation of a complex power system. At the very minimum, modern, computer-based data acquisition systems and effective, reliable communications would be needed before the five grids could be combined into a national system.

The engineering expertise for designing such advanced systems and the trained workforce to operate them are both on hand in India. Nonetheless, serious problems are often encountered in maintaining the stability of the conventional power systems that are already in place. Peak demands on power have always exceeded the available capacity, and the gap yawns wider every year. Furthermore, transmission and distribution systems are grossly lacking in reactive compensation. Line losses are also a problem - transmission and distribution losses average about 21% of all power generated.

Not all problems are technical, however. To promote rural electrification and agriculture, power is provided to farmers at an average of only 13% of actual cost. On top of this, power losses due to pilferage exacerbate an already acute shortage of financial resources. Other problems contributing to far-from-satisfactory performance of electric utilities include an antiquated, unremunerative tariff structure and inadequacies in automated controls.

Such straits are forcing reexamination of our strategies in power development. Besides reducing transmission and distribution losses, improving plant load factors, and implementing strictly disciplined intra- and inter-regional power transfers, we must seriously consider an extensive program of energy conservation. Even marginal attempts at conservation could result in savings of at least 10% as recent studies have shown.

One of the paramount rules in interconnected operations is grid discipline with regard to voltage and frequency; but in the face of shortages and increasing demand, this discipline has been hard to maintain. Some state boards take unfair advantage of the interconnection, rather than behaving in a cooperative manner. Overdrawing of energy, especially during times of peak demand, has become common. For lack of statutory power, the regional boards cannot enforce discipline. The problem has become so severe that, in order to keep their

systems in operation, some of the state boards frequently have to turn to ad-hoc measures on almost an hour-by-hour basis.

Governmental Policies

Transmission system development is an evolutionary process. Unlike generating stations that are confined to specific locations, transmission systems comprise a number of system elements covering EHV transmission, sub-transmission and distribution networks at various voltage levels, substations, switching stations, load despatch and communication facilities etc., spread over a vast area. The quality of supply to the ultimate consumers is dependent on the total effect of performance of all the system elements constituting the transmission systems. Adoption of a regional concept for power system development and multiple ownership of transmission systems call for a joint effort by the various states of the region owning the state systems and also the central agencies engaged in development of centrally owned generation projects, in maintaining the system parameters in a dynamic situation for ensuring quality of supply to the ultimate consumers.

As it is neither feasible nor economical to develop discrete transmission facilities associated with each generation project, a transmission system is planned and optimised on a regional basis without regard to ownership. The location of regional power stations at pitheads in the case of coal-based stations

and at appropriate locations in the case of hydroelectric stations has necessitated bulk transfer of power over long distances, transcending state boundaries. For meeting these transmission needs, a transmission system at 400 kV has already been developed which can be further supplemented by new technological options such as HVDC transmission, higher voltage AC transmission at 800 kV etc.

For efficient management of the regional grid systems covering appropriate monitoring and control of the system parameters, requisite load despatch and communication facilities on modern lines are also being established.

Major Constraints

System development being a complex task, a number of problems are faced in its execution. The important ones among them are given below.

- Inadequacy of investment for Transmission and Distribution (T&D) works,
- Problems in obtaining forest clearance for construction of transmission lines,
- Problems in obtaining right-of-way through agricultural land,
- Problems of execution,
- Problems of multiple ownership and sharing of transmission cost,

Thrust Areas in Transmission

Action is necessary on a number of areas in order to give a further thrust to promote grid development. The most important among them are mentioned below.

The first and foremost is the simplification of the procedure for according clearance for transmission lines from the forest and environmental angles. Unless this is done, a number of critical transmission lines which are currently under implementation may get unduly delayed besides affecting the programme for further expansion of the transmission system in future.

Yet another area requiring attention is the programme for installation of capacitors. The problem is required to be tackled on a war footing as the backlog in the area is very severely endangering the security of the regional grids besides contributing to the increased system losses etc. As the resource position of the SEBs is coming in the way of speedy implementation of capacitor installation programme, it would be necessary to arrange for special financial assistance earmarked for the purpose to the SEBs.

The last but not the least important matter requiring urgent attention is the creation of an appropriate organisation at the national level for removing the deficiencies in establishment

of power transmission projects by taking up construction of inter-state and inter-regional transmission links and other trunk lines for strengthening the regional grids which might not receive the attention of the existing Central or State sector organisation.

The Central organisation could be vested also with the responsibility for construction of the National Load Despatch Centre and for coordinating the activities of the Regional Load Despatch Centres which would be in charge of regional operations. The national level organisations and the regional boards should be vested with statutory powers for exercising effective control in day-to-day grid operation. The present problems of indiscipline by the constituents in not adhering to schedules etc., of the REBs could be overcome only through implementation of this proposal.

Technological Upgradation

Side-by-side with the action taken for overcoming the difficulties in grid development, technology upgradation is being undertaken in all areas of transmission for increasing efficiency and improving the economy. Most important among them are:

- Use of Static VAR Compensation (SVC) Systems
- Application of series capacitors
- Use of Gas-insulated Substations (GIS)

- Use of Guyed-type Towers
- Use of latest technologies in substation equipment such as circuit breakers, surge arrestors, insulators, capacitors and relays.

Status of Technology Upgradation in Design and Engineering

i) Circuit breakers

The circuit breakers most commonly used untill recently at EHV substations have been of the minimum oil and air-blast types. Operating experience has shown that the minimum oil circuit breakers require frequent maintenance on account of deterioration of quality of oil and wearing out of contacts. In air-blast type also, there has been deterioration of contacts during operation in addition to mechanical problems. SF6 breakers are now being used in all EHV substations where a high degree of reliability is essential. These breakers practically do not require any frequent maintenance and are free from fire hazards. The technology for manufacture and operation of SF6 breakers for all voltage levels is available in the country.

ii) Surge Arrestors

Another technological advance is the use of metal oxide arrestors in place of conventional surge arrestors. These arrestors have much higher discharge capability and ensure

better protection to the equipment, thereby making it possible to reduce switching surge overvoltages. Metal oxide arrestors are now being manufactured indigenously and thus can be used extensively for future EHV systems.

iii) **Toughened Glass and Composite Long Rod Insulators**

The most commonly used insulators for transmission lines at present are disc type ceramic or glass insulators. In India, generally porcelain type insulators have been used in the form of strings to support the transmission lines. Toughened glass insulators could be used on some of the 400 kV lines under construction. Toughened glass insulators are helpful in achieving more uniform distribution of voltages across insulator strings. Interest is now directed towards use of composite long rod insulators using materials like resin-bonded glass fibre cores with shed shells of organic or inorganic materials. Such insulators have been developed abroad and their field performance is under study.

iv) **Gas-Insulated Substations**

EHV substations in this country are generally of the open-air design. However, metal-enclosed gas-insulated substations using SF6 gas as insulating medium are now getting established in developed countries. These substations occupy considerably smaller area and volume as compared to conventional substations and require little

maintenance. In India a beginning has recently been made for setting up of gas-insulated substations in Mumabi (by M/s Tata and M/s BEST) and in Delhi (by DESU). Kerala State Electricity Board is also going in for such stations at Trivandrum, Cochin and Kozhikode in Kerala State, where the pressure on land compels economy in land use for substations. The equipment required for these gas-insulated stations has to be imported. In future more such substations may find application, especially in the metropolitan cities where space is a major constraint and upgradation in distribution systems require installation of higher capacity switchgear at same locations. Indigenous development of this technology merits consideration.

Trends in Design of Transmission Towers

Design of transmission towers has undergone many improvements over the years. In India, self-supporting broad-based lattice towers are being traditionally used for EHV lines. As an alternative, guyed towers are being considered which have been extensively used in USA, Canada and Russia. These towers are light in weight, easy to construct and have simpler foundation designs. These advantages are, however, offset to some extent by greater interference in areas of intense agricultural activities, increased vulnerability to sabotage etc. In India, the use of these types of towers is to be examined for long distance transmission in appropriate locations (e.g. hilly terrain

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where plain land of required area for conventional towers may not be available etc.). However, guyed towers have been adopted on an experimental basis on a 10 km stretch of the Agra-Ballabgarh 400 kV line, a part of the Auraiya transmission system.

Other developments that are gaining interest are the use of high tensile steel in the place of mild steel, upgradation of existing transmission lines etc., which are being examined. There have also been improvements in the methodologies used for the design of towers. Digital computers are now extensively used for the design calculations. Necessary software is also available to analyse the towers as space frames.

v) Use of Electronic Systems for Protection and Instrumentation

Considerable development has taken place in the field of protection and instrumentation also. Electronic instruments and equipment, capable of meeting the stringent needs of power system operation and control, are increasingly being used for this purpose. The need for special relay characteristics, which ensure better discrimination and faster response, has resulted in the phasing out of conventional electromagnetic relays and their gradual replacement by static relays. Microprocessor-based relays are likely to find application in future. Electronic systems

like event loggers and disturbance recorders are also finding extensive application in the substations. Microprocessor-based technology is also promising application in energy metering.

vi) Capacitors

Mixed dielectric non-peb was hitherto being used for the manufacture of capacitors. There had been a number of failures of such capacitors. The losses in such capacitors are also high. All film non-peb liquid impregnated dielectric technology has now been introduced in the country. This technology requires special techniques for achieving proper impregnation. Capacitors using all film non-peb liquid impregnated dielectric have very low losses. There is only one manufacturer of this dielectric film in the country. It is believed that the quality of the film being manufactured is not up to the mark.

vii) Modern Communication Systems

The use of geo-stationary satellites for communication purpose is also gaining attraction, especially with the advent of low cost terminals (LCT's) for earth stations. Yet another development of interest is the use of optical fibre systems. These are completely immune to electro-magnetic interference and offer extra high capacity and reliability for data transmission. Since signals travel in the form of light rays, frequency allocation and coordination

problems are completely avoided. At the national level, CEA has drawn up a communication perspective for the next few years, which envisages the coordinated use of these facilities.

New Concepts in Power Transmission

In the world scenario, unprecedented technological, environmental, social, economic and political changes are being witnessed, all of which will have a bearing on power development. The technological evolutions in power, communication and transportation systems have to exist in close proximity to each other. Increasing public sensitivity to environmental issues, often combined with the difficulty in obtaining new transmission corridors is becoming an important factor while considering transmission facilities.

Under these handicaps, coupled with severe constraints in financial resources, attention must be paid to strengthen the existing transmission networks. Ways and means to utilize them in an optimal manner have to be evolved. Losses have to be reduced to the minimum and the power transmission capacities of existing lines have to be enhanced. New technologies for adopting these have to be evolved. In this context, it becomes necessary to focus attention on the following aspects of power transmission.

i) EHV and UHV AC Transmission
ii) HVDC Transmission
iii) Very Long Distance Transmission
iv) Higher Phase Order Power Transmission
v) Compact Transmission Lines
vi) Flexible AC Transmission systems
vii) Automated Control of Reactive Power

EHV AC Transmission

Transmission systems link power generating stations with the load centres and thus provide a path for electrical energy to flow from the generating stations to the load centres. In the early stages of system development in India, the load centres were confined to urban areas, the requirements of which were met from small capacity generating stations over radial low voltage transmission links. However, with the growth of the State systems after independence, large capacity generating stations were established with corresponding expansion of the transmission network within each state. As the transmission distances increased, higher transmission voltages were adopted and generating stations within each state were interconnected over high voltage links to form state systems. With the adoption of the concept of regional planning for power development, the State systems were gradually interconnected to form regional grids in all the five regions of the country. Correspondingly, the complexity of the transmission systems grew with adoption of still higher transmission voltages for

transmission of large blocks of power over long distances, cutting across state boundaries. In this manner, transmission systems at various voltages have come into existence. Till the mid seventies, the highest transmission voltage was 220 kV. For meeting the requirements of power transmission from large thermal complexes located in pitheads and remote hydro stations to the load centres, 400 kV transmission systems were introduced after the seventies. The first 400 kV transmission line was commissioned in 1977. The principal voltages for transmission are hence 220 kV and 400 kV. These lines are capable of transmitting power in the range of 150-200 MW over 100-200 km in the case of 220 kV and 400-500 MW over 300-500 km in the case of 400 kV. In certain cases the transmission distances exceed even 1000 km. These trunk transmission lines along with the underlying network at voltages of 132 kV/110 kV/66 kV serve to deliver power to the ultimate consumers. Barring heavy industries which are supplied at high voltage, other categories of consumers are served over the low voltage distribution networks which receive supply from the high voltage system.

HVDC Transmission

HVDC transmission has definite economic benefits when large blocks of power have to be transmitted over long distances. The following table gives the capability of HVDC systems for transmitting power over various distances as compared to the EHV AC system at different transmission voltages:

Distance km	Capability of + 400 kV HVDC (MW)	Capability of		EHV AC Transmission	
		400 kV MW	750 kV MW	1000 kV MW	1200 kV MW
500	2250	405	1665	3680	5790
700	1690	313	1250	2770	4340
900	1460	261	1080	2400	3770
1100	1360	210	900	1987	3125

It has to be understood that the HVDC provides a link between two AC systems. This being the case, what is essentially required for a DC system is easily seen to be a rectifier at one and an inverter at the other, with a DC transmission line in the case of a point-to-point transmission system. In the case of a back-to-back link, providing mainly an asynchronous tie between two AC systems operating at different frequencies, the DC line length is virtually zero.

A few of the advantages of HVDC power transmissions are:

1. interconnection of AC systems operating at different frequencies,
2. great flexibility in the control of magnitude and direction of power flow,
3. damping out oscillations and improvement of stability margin when embedded in weak AC systems,
4. reduction in right of way requirements,
5. reduction in structural requirements of transmissions lines,
6. reduction in line losses,
7. reduction in conductor size due to absence of reactive currents,

8. lower insulation levels,
9. reduction in corona and radio interference.

In the world scenario, HVDC transmission schemes are becoming more and more popular and as of now over 60 schemes are in operation. In the Indian scene, this is an emerging technology. Positive steps are being taken to develop indigenous know-how through R&D schemes being sponsored at the national level to look into special aspects of HVDC. The first major step in this direction is the establishment of an experimental line linking the Madhya Pradesh and the Andhra Pradesh electricity systems. The project presently uses one circuit of the existing 220 kV double-circuit AC lines between Barsoor in Madhya Pradesh and lower Sileru in Andhra Pradesh for DC power transmission. The entire scheme has been conceived with the basic idea of development of indigenous technology and indigenous manufacture of equipment. The project has less than 5% import content. The scheme is in operation now, and the transmission system is transferring power to the extent of 100 MW in the mono-polar mode. The commissioning of the project has proved that the technology can be indigenously developed and has also infused a sense of confidence amongst the HVDC personnel involved in its design, manufacture, operation and maintenance. In the second phase of the project, which is under execution, it is proposed to enhance the power transmission capacity to 200 MW at 200 kV.

The experimental line apart, a couple of commercial HVDC schemes are also in operation. One of these is the back-to-back DC tie at Vindhyachal, transferring 500 MW of power from the western to the northern region. This scheme has provided a good inter-regional balance between generation and demand. The other commercial scheme is the Rihand-Delhi point-to-point transmission system handling power of 1000 MW over a distance of 910 km. at ±500 kV. Both these commercial schemes have been executed on a turnkey basis with foreign collaboration. A few more HVDC projects like the Chandrapur-Padhke point-to-point and the Chandrapur-Ramagundam back-to-back schemes are under execution.

The experimental HVDC pilot project between Barsoor and Lower Sileru has served as a very good role model in the development of indigenous technology. In the field of HVDC power transmission, through this exercise, indigenous expertise and know-how has already been developed in our country. Despite this, it has not been possible for us to commercialize these successes. The reasons for this, need detailed analysis.

Very long Distance AC Transmission

Very long distance AC transmission schemes are not presently in operation, except may be in Russia. However, keen interest is being evoked in this area in various parts of the world. The major aspects to be considered in long distance AC transmission systems are: (a) transmission of bulk power with

suitable stability margins and (b) maintaining a uniform voltage profile all along the line. The aspects to be analysed are:

i) the feasibility of half-wave length transmission,
ii) performance of series-compensated transmission system, and
iii) performance of static VAR compensated transmission system with supplementary controls.

The main factor impeding the implementation of the long distance AC transmission lines is the high cost of the compensating equipment. Instability precludes the transmission of power from a remote generating source if the angle between the generator terminal voltage and the receiving end bus voltages is between 90 and 180 electrical degrees. To provide a sufficiently stable margin of safety, a criterion used for preliminary studies is 30 electrical degrees of phase shift over the line. At 50 Hz, a 400 kV line of 500 km length at surge impedance loading (SIL) has an angle of approximately 30 degrees.

To maintain an angle of 30 degrees of Extra Long Distance (ELD) lines at SIL, 100% compensation is required for all lengths in excess of 500 km. Hence, as the line length increases, the cost per unit length (including compensation) also increases. Apart from high capital investment, ELD lines present operational problems such as surplus VAR during light load

conditions, Ferranti effect and generator self-excitation. Instead of shortening, if the line is electrically lengthened so that its effective electrical length is between 180 and 270 degrees, an interesting phenomenon occurs. The system is stable as one operating in the first quadrant (0-90 degrees). For example, if the generator terminal voltage is 190 degrees leading, with respect to the load voltage, the stability margin of the system is the same as if the generator were operating at 10 degrees from the load. The salient features of an exact half-wave line are:

i) the general line constants are such that a 3000 km. lossless line will represent zero series impedance and zero shunt admittance,
ii) the voltages at both ends are extremely stable,
iii) the line will not act as either a sink or a source of reactive power,
iv) there is no Ferranti effect when the line is opened at the far end,
v) surplus reactive power and possibility of self-excitation are absent under light and no load conditions,
vi) the mid-point voltage and current are proportional to the current and voltage respectively at the receiving end of the line.

It may be worthwhile taking up a project on very long distance AC transmission for transmission of power from the power-rich eastern region down to the southern region along the

eastern coast – a distance of about 2000 km. If implemented successfully, the transmission losses would be reduced to a minimum and the voltage profile along the line will be flat.

Higher Phase Order Transmission

Recently, High Phase Order transmission (HPO) systems are being considered as a viable alternative to UHV 3-phase transmission to achieve efficient utilization of Right-of-Way (ROW) and increased transmission capability to meet the growing demand for electric power. However, it is necessary to establish the basic feasibility before adopting HPO transmission systems depending on several steady-state performance indices such as SIL, thermal loading, electric fields and the related noise levels. On the other hand, obtaining completely new designs for multiphase transmission lines offer significant advantages in addition to increased power transmission capability such as:

- efficient utilisation of ROW,
- reduced electrical gradients and noise levels,
- compact structures,
- reduced insulation requirements,
- reduced overall cost.

As a result, a multiphase line with smaller dimensions can transmit a large amount of power covering the entire range of transmission voltages.

It would be worthwhile taking up the conversion of some existing 3-phase 220 kV lines in operation to 6-phase systems.

Compact Transmission Lines

Environmental and economic pressures have encouraged utilities to seek improved design approaches to make transmission lines more environmentally acceptable and cost-effective. The need for most efficient use of the ROW is being felt more keenly than ever. Compaction of a transmission line means reduction in the dimensions of the line, both in the horizontal and vertical directions. By horizontal compaction, power density over available corridors is increased by more efficient use of the land and ROW. Vertical compaction reduces the height of the support structures, making them smaller, lighter and less expensive. In general, compaction reduces the total profile of the line. Other means of optimally utilising the existing transmission lines without the need for increasing ROW requirements lie in the upgradation of the operating voltage to the next higher level by suitably changing the conductors, towers, cross-arms, insulators etc., and by adopting multi-circuits on the same towers.

It is necessary to take up some projects for compaction and upgradation of voltage levels of some existing HV power transmission lines.

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Flexible AC Transmission

The most recent advance in transmission technology and one ideally suited to Indian conditions is the Flexible AC transmission, popularly known as FACTS. The way in which FACTS is to be realized is through the application of thyristor-controlled series devices which are capable of rapid adjustment of network impedance. FACTS can be used to control power flow in parallel lines in such a way that the network losses are minimised under steady-state conditions.

Under transient conditions, FACTS can substantially enhance emergency power carrying capacity of the line. FACTS concept involves the use of the following thyristor-based controllers, which also form the part of planning tools for FACTS.

- SSR damping
- Series reactance
- Static VAR Compensator
- Fault Current Limiter
- Series Capacitor (Fixed & Controlled)
- Load Tap Changer
- Phase Angle Regulator
- Ferro-Resonance Damper
- Static Condenser
- Dynamic Load Brake
- Dynamic Voltage Limiter

The power flow over an AC line is a function of the phase angle, and voltage at the two ends of the line and the line impedance. In order to control the power flow, any one of these three parameters has to be controlled. With presently employed mechanical controls on the power system, phase angle control is by means of slow mechanical phase shifters; the voltage control is by means of transformer tap changers, reactors and capacitors which are mechanically switched and slow acting; there is essentially no control over line impedance. Hence, with mechanical controllers, there is very little scope for high speed control over any of the three parameters and control cannot be exercised frequently because mechanical devices tend to wear out quickly.

So, with present day mechanical devices, power system operators arrive at the required steady-state power flow through generation scheduling, transformer tap changing and switching of shunt reactors and capacitors. This is done to maintain voltage and phase angles within safe operating limits. The flexibility of an AC line or any part of an AC system can be improved, if the control over one or more of the base parameters, namely, voltage, current phase angle and line impedance is improved. This can be achieved by employing the concept of FACTS.

Advanced Static VAR Compensation (STATCOM)

The shunt-connected static VAR compensator, using conventional thryristor switches, is already a firmly established device for transmission line compensation. The static VAR compensator (SVC) is usually composed of thyristor-switched capacitors and thyristor-controlled reactors. With proper coordination of the capacitor switching and reactor control, the var output can be varied continuously and rapidly between the capacitive and inductive rating of the equipment. The compensator is normally operated to regulate the voltage of the transmission system at a selected terminal, often with a priority option to provide damping if power oscillation is detected. A totally different, advanced static VAR compensator using a particular type of solid-state switching converter, called voltage-sourced inverter, is feasible.

Unified Power Flow Controller

It has long been realized that an all solid-state or advanced static VAR compensator, which is the true equivalent of an ideal synchronous condenser, is technically feasible and, with the use of Gate-Turn-Off (GTO) thyristors, is also economically viable. The Unified Power Flow Controller (UPFC) was proposed for real-time control and dynamic compensation of AC transmission systems, providing the necessary functional flexibility required to solve many of the problems facing the utility industry. The UPFC consists of two switching converters, which are voltage-sourced inverters using gate turn-off thyristor

valves. These inverters are operated from a common DC link provided by a DC storage capacitor. This arrangement functions as an ideal AC to AC power converter in which the real power can freely flow in either direction between the AC terminals of the two inverters and each inverter can independently generate (or absorb) reactive power at its own AC output terminal.

Viewing the operation of the UPFC from the standpoint of conventional power transmission based on reactive shunt compensation, series compensation and phase shifting, the UPFC can fulfill all these functions and thereby meet multiple control objectives by adding the injected voltage with appropriate amplitude and phase angle to the terminal voltage.

Conclusion

The paper briefly describes the most recent advances in electric power transmission, and traces the history of power development in the country. Most of the advances have taken place keeping pace with the developments that have emerged in advanced countries. The historical development has been mainly due to the changing environment and technical requirements for more and more efficient power transmission. Considering all the factors, it can be concluded that, under the prevailing power situation in our country, the best option available is FACTS.

Under the existing shortages and generation not being able to meet the growing demand, coupled with the lack of financial resources to add to the generating capacity or to build more transmission lines, employment of FACTS devices in our systems appears to be the best immediate solution. It is imperative that a pilot project be taken up on the development of this technology on the lines of the HVDC transmission pilot project.

It is also essential that prototype pilot projects on all modern transmission technologies be taken up at the earliest.

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LECTURE

Recent Trends in Science & Technology Poli

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Let me say how pleased and honoured I feel to speak in your renowned Institute. And before starting my lecture, let me share a confidence with you. Bangalore's many historical and cultural features and the reputation of your Institute are such that, although I am here for the first time (but not the first time in India), you can't imagine how many things the simple name of your city and region did evoke in me. But there is one thing more recent that Bangalore and NIAS have meant for me. In the preparation of the UNESCO Conference on Science, which took place last June in Budapest, I was asked to re-write entirely the draft "Agenda for Action" whose first version was as bad as possible. I was then in the South of France and I received a fax containing a long paper whose title was the "Bangalore Declaration" – and instructions to take into account its main themes which were elaborated

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in your Institute.[1] Well, let me say that I had not much to add to what I had already written: the gender issue was already there, as well as the need to associate more closely the Western concept of science and the rationality, if not the wisdom, of traditional knowledge and practices. Even the notion and title of "a new social contract for science" was there, because I was writing at the same time a book, published last month in France, whose first chapter has precisely this title.[2]

I do not say this to appear as fighting for some priority nor even originality, since such a notion has been touched on by various authors in the last decade, but to introduce my lecture by underlining that neither the Bangalore Declaration nor the conclusions of the UNESCO Conference can be taken for granted. It will indeed require a long lapse of time and perhaps several generations before we will be able to witness scientists and concerned policy-makers fulfilling all the objectives and changes endorsed in Budapest. It is like the Test Ban Treaty: it would be better for mankind that all countries (especially the United States and Russia!) adhere to it, yet one is far from seeing such an all-out ban being implemented. You are as aware as I am of this gap between what we wish or want and the realities and constraints of the nation-states and world politics, since this is also the first day of the workshop your organise on the Draft Indian Nuclear Doctrine – to

which you kindly invited me to participate.[3] Let me add that such a public discussion on such a subject is not simply another illustration of the democratic roots of your country, but a real exception in the world: where else has moving towards the "triad" of a nuclear weapons system ever been discussed publicly?

When I heard that I would have to speak about recent trends in science and technology policy, I decided to re-read one of the first books published on the subject, a book edited in 1965 by my friend (the late) Norman Kaplan, *Science and Society*.[4] What he wrote in his Introduction is still valid and relevant today: "It has been only in the last decades that it became so clear that studies on the relations of science and society could no longer be neglected. Even so, there is still no generally accepted label identifying studies of science and society. There is still no single identifiable academic discipline specializing in such studies. Sociologists, political scientists, economists, historians and perhaps not so strangely, the 'hard' scientists themselves have all shown some concern". And he added: "Who now needs to know something of the relations of science and society? The answer, especially in a democratic society, is that it is difficult to think of anyone who does not need to know".

This has not changed since: the field is still without an accepted label and there are more and more people in our

societies who want to know more about this relationship. However, something is new: the knowledge and literature about the subject has increased to the point that it is difficult, indeed impossible, to keep up with the number of books, journals, articles and conferences that deal with it. In relation in particular to science policy, Norman Kaplan paid tribute to OECD for having organized the first meeting of ministers and others concerned with questions of national science policy. "This received", he wrote, "only a few inches of space, at most, in the newspapers, but it is quite likely that historians of the future may accord it considerably more importance. This was probably the first meeting of this kind and it is most likely not the last". Norman Kaplan was right: many other meetings of this kind did follow and I know, having been interviewed several times by historians about the very beginnings of this field within and outside OECD.

I don't mention that in order to point out my age, I mean to face the fact that I myself may be becoming a historical topic, but to stress that there is now almost half a century of institutionalised science policy. And since the 1960s there have already been so many important changes in the international economic and political context that many commentators have tried to divide them into "ages", "epochs", "periods", "stages" or – more commonly – "phases" of science policy. An author even spoke of a "paradigm of science policy" showing, in spite of national

variations, a high degree of congruence in the core of views and instruments used.[5] This proves at least that, in spite of the fact that the domain has no generally accepted label, there is now around the world a science policy community within academia as well as within the national and international policy-making bodies, which functions like any other scientific community in the Kuhnian sense, spreading information, publications, memory and culture on views and instruments in the field. Science policy studies, social studies of science, science, technology and society, even science of science as it was called in the former communist countries – whatever the label, there can be no doubt that the field exists today and has both an intellectual and policy-oriented legacy. The research and publications of your own Institute illustrate this legacy perfectly.

Four factors of change

I would need much more than the time available for this talk to mention all the phases that science policy has witnessed since the first ministerial meeting on science held at OECD in 1963 – if one takes this event as the beginning of its irreversible institutionalisation. Rather than doing so I will discuss four major changes which have affected the relations between science, technology and society since World War II in order to illustrate not the past, but the current and even future landscape of science policy issues.

The first factor of change is indeed the end of the Cold War, the implosion of the communist system, the economic collapse of the former Soviet Union which no longer counts today among the great actors in the technological competition – except in space research in close co-operation with the West. For some of the most industrialised countries, those in particular which were involved in the challenges of the tensions between the East and the West, resources dedicated to defence research during this period represented two-thirds of the public research and development (R&D) expenditure – expenses worthy of the Pharaohs.

The relative decrease in investment in military R&D plus the economic difficulties, cuts in public spending and social pressures resulting from unemployment in most countries lead to efforts concentrated on competitiveness and innovation and to the restriction of the financial support allocated to fundamental research. This doesn't mean that military threats have disappeared, as we continue to see even in Europe. It just means that the strategic and ideological impetus that justified the state's unlimited support for scientific ventures has vanished. When discussing recent trends in contemporary science policy and science funding, the plural is really unnecessary. There is only one major overall trend: the increasing priority given to industrial research and innovation at the possible expense of curiosity-driven enquiry. This trend started

earlier, but the end of the bipolar nuclear arms race inevitably meant that defence R&D investments would be cut and that market-oriented research would alter the direction of national science and technology policies.

The second factor is of course the scientific and technological revolution which we witness at the end of the century and whose effects will extend far beyond the next decade in all activities, whether civil or military. Revolutions in new information and communication technologies, biotechnology and the materials sciences have triggered momentous changes, analogous to those provoked by the printing revolution: an intellectual, economic and social metamorphosis of civilisation and culture. I would in fact call it a *single* revolution whose changes and applications indeed have the same characteristics: upstream, they are all related to knowledge – and capital-based industries, closely dependent upon multidisciplinary research, know-how and technologies that result from work undertaken both in universities and industry; downstream, they all contribute to the same phenomenon of "dematerialsation" which defines post-industrial societies in that they rely less and less on natural resources but are increasingly dependent on the intangible capital they are able to accumulate and diffuse.

lack of rain in some areas, ecological disasters, and the worldwide spectres of water shortage and the greenhouse effect. Environment starts with settlement: 40% of the world's population are doomed to live in cities, out of a total of between 8 and 11 billion people. This gigantic process of accelerated urbanisation will have a two-fold result: on the one hand, megacities whose infrastructure will never match the needs of such a concentration of human beings, with problems of management, unemployment or underemployment, and violence that cannot be overcome; on the other, whole regions whose natural resources will lie fallow, so that the feeding of the megacities in most developing countries will be more and more closely dependent upon imports from industrialised countries, and thus their own growth will be jeopardised.

In this connection, something has happened that Norman Kaplan's book could not foresee, namely that the ethical facet of scientific advance is growing in importance. Nowadays the ethical implications of the use of scientific knowledge have become so profound and of so much concern to individuals and society at large, that any research or application of its results has to comply with ethical standards and principles. Scientists themselves have started to play an active role in defining and shouldering their responsibilities. Leaving aside all the circumstances of World War II which led to the decision to bomb Hiroshima and

Nagasaki, we can recall here how entering the atomic age meant, as Oppenheimer said, "the discovery of sin" or "the loss of innocence" for science. But this is not only related to the new links forged by the Second World War and its aftermath without peace between science, politics and the military establishment.

More importantly it is related to the disturbing consequences which science makes possible in other fields as well, for instance the risks of eugenics and abuses involved in the progress of the most advanced bio-medical research. Remember that already in 1975, when the biologists discussed at the Asilomar Conference the possible adverse consequences of genetic engineering, some were speaking in favour of a moratorium on research. In 1994, in his inaugural lecture at the Collége de France, Professor Pierre Chambon argued that a world moratorium for fifty years would seem to him an extremely wise decision. And more recently an international convention has been adopted within UNESCO which institutes a worldwide ban on human cloning. "How far is too far?" is the question confronting the scientific community in a political, intergovernmental framework which has little to do with the traditional arena of scientific debates. Actually, these are the issues that the book I published just a month ago in France is dealing with under a title which may appear provocative to the "traditional" scientists who believe that one can dissociate

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scientific research from its repercussions: *Can we survive science? – A certain idea of the future*. This title reproduces the title of the paper published by John von Neumann two years before his death: *Can we survive technology?* The fact is that what could so easily be said of technology earlier is now applicable to science itself.[6]

Nothing is more revealing of the change in the social image and function of science than this case, namely that the current pursuit of knowledge calls for barriers that are requested not only by people or institutions outside the scientific community, but within the scientific community itself. These were problems that Norman Kaplan had not foreseen because they couldn't be foreseen at the very beginning of the institutionalisation of science policy. And even less of course could their social consequences be foreseen. For instance, a salient feature of our times is the emergence of organised sectors of society demanding to take part in the debates and decision-making concerning scientific and technological issues. Alongside traditional actors such as trade unions and political parties, strong new lobby groups are coming to the fore, including industrialists, entrepreneurs, the media and a variety of non-governmental organizations as well as laymen or women. Many of these are concerned with the environmental and other issues that science and technology are addressing or are expected to address. All this is new, especially if

one thinks of the predicament of the Charter of the Royal Society, which was given the objective of "perfecting the knowledge of natural things", while at the same time "not meddling with Metaphysicks, Moralls and Politics".

The demand for public participation and more transparency arises from two phenomena, both connected with the increasingly scientific nature of modern industrial societies: first, technical systems have become so complex that they have to be operated by experts, and secondly, people feel that they are being excluded from any democratic oversight of these activities.[7] The result is the paradox that although these societies have the means of acquiring, processing and sharing information which may give individuals far greater knowledge of the world they live in, this huge growth in the amount of information available is not matched by a similar degree of transparency of society vis-à-vis itself. On the country, the more the media provide instant coverage of world events as they happen and call on "experts" for comments, the more the information creates a vast blur, if not outright faking of "events", as we could all see for ourselves during the Gulf War or more recently during the Kososvo crisis.

The use of experts – turned into technocrats, strategists, prophets or gurus – is sometimes the best way of getting round conflicts and muddling the debate. While the public

may be more eager to be informed, as levels of education rise and the middle class grows, public suspicion is far from being reduced when institutions with specialised knowledge – as we have seen in the case of nuclear power – make efforts to anticipate the public's questions. And thus while the public expectations of science may be high, there is also a widespread disenchantment and disregard for science, and fears as to the unforeseen or unknown consequences of technical change. The question one might raise today is the following: do these changes lead to the end of science policy? Let me now try to answer this question.

From one model to another

The paradox of the West, the cradle of modern science, of its accumulation of discoveries and industrial applications, is that there is now a questioning of the social cost of the achievements of science, the major risks involved, the mismatch between the strength that humanity now enjoys and the wisdom (or lack of it) brought to bear on its use. It is true that the experience of this century, whose barbarity owes so much to science, tends to raise doubts about the link between the progress of knowledge and the progress of morality postulated by the thinkers of the Enlightenment. The present "malaise of civilisation" is obvious; actually it is not new for those who read Husserl

or Freud, but it has never before generated so much pessimistic debate.

After the Second World War, the rivalry between the superpowers and the arms race brought public and private interests closer together, to the point where systems of research and education were "socialised" even in the countries that considered themselves to be most liberal. Whatever was good for science was good for society – an article of faith first proclaimed in 1945 in the report by Vannevar Bush, then scientific adviser to the President of the United States, which was entitled *Science the Endless Frontier*, the next frontier after the conquest of the American West and industrialisation.[8] This report not only provided a justification for federal intervention in the private sector (in industry and the universities), but was also the source of accepted notions of the "linear" nature of innovation: it held that science *in itself* is the driving force of technical progress, and that science is therefore crucial to achieving national objectives in all areas of governmental competence.

This model, which was as simplistic as it was attractive in arguing the case in favour of science with governments, offered an idyllic vision of a process that led straight from basic research to production and the market. The more laboratories, staff and equipment allocated to those engaged in basic research, the better would the increasing number

In this flood of technical changes, it is from now on impossible to dissociate what belongs strictly to an intellectual venture from what answers to the interests of firms in their battles for competitiveness. There are at least three reasons for this. First, there is the increased association and even cross-fertilisation between science and technology: the frontiers between science and technology are becoming so blurred that it is more and more difficult to find a part of science that does not nurture or is not nurtured by technology; the reverse is just as true: technology depends more and more upon scientific research. The second reason is that few scientific activities as such can be dissociated from the support given by the state or by industry: the traditional autonomous status of science within the academic framework is more and more challenged by its growing dependence upon institutions that do not belong to academia. The third reason is that the great majority of researchers are now outside the university framework: today, most of them belong indeed to industrial or military laboratories.

The third factor of change, closely linked to the scientific and technical changes and to the industrialisation process which they stimulate around the world, is the globalisation of the economies and markets, which goes with the liberalisation of trade and privatisation of firms, the

increasing role exerted by multinational firms and the declining functions exerted up to now by governments in regulating economic activities and their social repercussions. However, just as globalisation gives an illusion of convergence without global integration, the trend towards "innovation" leads to common challenges, without creating identical opportunities to respond. National economies are becoming more interdependent, and technical knowledge is becoming the common property of a worldwide technical community. But the dominant political concept still remains that of the nation state, which struggles to ensure that the production and exploitation of innovation remains largely circumscribed within its borders. And yet, there is at the same time a move towards greater cooperation (if not integration) of scientific and technological activities, as illustrated in particular by the European Union. I will come back later on this point.

Finally the fourth factor, which is as conditioned as the previous one by the current industrialisation process, is the multiplication of the environmental problems that affect the future of our planet. Beyond the phenomenon of increasing urbanisation, the nature and level of industrial and agricultural activity are bringing about changes in the biological, chemical and geophysical cycles that play havoc with nature's system. The results are extinction of species, pollution of air and water, new epidemics, ozone depletion,

of discoveries guarantee an ever greater number of new products and processes for the economy. The mobilisation of brains and laboratories that had been so successful during the War was therefore set to carry on in peacetime, and all the major programmes involving defence, atomic energy, space and electronics could point to science as one of the top priorities pursued by the state.

In fact, the work of economists on R&D and innovation (C. Freeman, R. Nelson, P. David, N. Rosenberg, etc.) has gradually made people appreciate that the process is much more complex, since it involves many factors that have nothing to do with science or even research – such as market forces, the nature of the demand, social need, the contribution of design or marketing, and so on. At the same time their work has shown that it is important not to rely exclusively on the "market-pull" model, which is set up as the exact opposite of its rival "science or technology-push" in theological debates: neither demand nor supply alone explains everything.

The linear model prevailed for years and propagated the experience of the United States by convincing all the industrialised countries, and then what used to be called the Third World, that science was the royal road to economic growth, whereas in fact basic research provided an excuse – if not an alibi – for pursuing major programmes in the

name of national defence and prestige. Here, the linear model did a great disservice to most developing countries because it encouraged them to mimic the wealthy countries and invest very heavily in higher education before they had adequate general secondary, or sometimes even primary education. As a result, they produced well-qualified scientists who tended to be cut off from the rest of their societies, all the more so because their countries lacked the institutional means to transform their knowledge into economically useful know-how. In doing so the poor countries forgot the lessons of the Industrial Revolution in Europe or, more recently, of the newly industrialising countries, since *all* of them began by aiming to expand general education rather than scientific research. The key people needed to achieve take-off are not so much researchers as engineers, middle managers and skilled manual workers who can master the knowledge and know-how required to establish the basis of industrialisation.[9]

The "market-pull" model, best illustrated by the Japanese example, became increasingly popular from the 1970s onward as it became clear that the competitive strength of firms and nations was closely linked to their capacity for innovation in the civil field. Whereas the United States had made national security the top priority of its science and technology policy, Japan had done the exact opposite – its science and technology policy had been its main

means of ensuring national security. For years, the US (as well as France and Britain, which adopted similar priorities) boasted of the spin-offs for the civil economy that resulted from military research. Nevertheless, some observers kept insisting that the countries that invested most in defence-related research tended to have lower or little productivity growth.[10] Furthermore, military research led to the development of "esoteric", high-performance products which by definition are produced in small numbers at enormous cost, so that the spin-offs are less easily exploited in the civilian market.

The model favoured now is the Japanese MITI, which from the outset links technological advances with exports, rather than the American model emanating from the Bush Report, with its emphasis on the production of new knowledge. In short, it is no longer enough to have a solid infrastructure of basic research and to notch up Nobel Prizes in order to be the leaders in productivity and innovation. In spite of their current financial crisis, the example of Japan and the newly industrialising countries in South-East Asia show that a huge investment in basic research is neither a sufficient nor even a necessary condition for ensuring that innovations are successful in world markets. In other words, science is heading for hard times – with the exception of Japan, whose science policy, as Helga Nowotny argues, "has repeatedly been counter-cyclical". In the US, the idea

of science as "an endless resource" is replacing that of science as "an endless frontier" in what Helga Nowotny called rightly the "rhetoric" of science policy – "a share of symbolic politics" which shows how strongly the orientation and management of the research system is dependent upon belief.[11]

Science "the endless resource" now inspires and justifies innovation policies in the same way that science "the endless frontier" inspired and justified science policy: utility and productivity have replaced science as a system of values and culture. This new catchphrase is very revealing of the present change of attitudes, reflected in the 1994 presidential report called *Science in the National Interest*.[12] This issue now is not so much to push back the boundaries of knowledge, in the hopes that society will derive some benefit at some time in the distant future, but instead as quickly as possible to use existing knowledge to solve the most urgent economic, industrial, commercial and social problems. The book recently edited by Lewis Branscomb, *Investing in Innovation*, proposes a variety of guidelines to create and foster "a research and innovation policy that works", which means that technological infrastructure, rather than science as such, appears as the foundation for the engine of economic growth in the current context of growing globalisation and competition.[13]

The linear model is by definition the credo of university researchers, whereas the market-driven model is the credo of industrial managers. The former assumes that the state will subsidise basic research without worrying about seeing results in the short or even medium term, nor about precisely how the money is allocated among the various projects. The latter requires priorities to be established for the short term based on demand and a concern to keep a close watch on returns on investment. In a period when budgets are tight, the temptation is great not only to impose on the universities the same systems of evaluation and management that apply to industrial laboratories, but to attach values to basic research other than those that pure scientists would claim for it.

This is where we are now, and the situation revives the debate that goes back to the end of the 1930s between Michael Polanyi, a great supporter of independence and self-governance for science, and J.D. Bernal, who advocated detailed planning of research activities to match social needs.[14] Paradoxically, however, in the present debate the roles seem to have been swapped. Polanyi was a free marketeer, Bernal a Marxist. The experience of the Second World War led to the adoption everywhere of Bernal's model, though the notion of the independence of university research *à la* Polanyi was preserved, at least in the West. Yet since the planned economies have collapsed, the

freedom of university research has been under constant attack in the market economies.

As long as the Cold War ensured that funds flowed freely, Polanyi's model continued to be preserved, especially since the interests of the state and of science converged. I wrote long ago that "the scientific society is not just one in which science is one of the goals of the society, but in which scientists want their own goals to be those of society".[15] Scientists were mobilised under an "alliance" whereby the state agreed to support science for its own sake but had to refrain from interfering in the *modus operandi* of the scientists: how they were hired, their choice of research topics, their methods of evaluation, etc. But as soon as the strategic imperatives lost their urgency and economic considerations became paramount, the alliance was broken: the goals of society had priority over those of the scientific establishment.

At the same time, the relationship between the two extremes of science policy was reversed: the state withdrew from the scene, hoping that the private sector would take over its role, and simultaneously put pressure on the universities with the aim of forcing the researchers to leave their ivory towers and work to shorter deadlines. The criteria henceforth are to be "need-driven" not "opportunity-driven". Some, not without irony, have been tempted to see in this reversal

the homage of vice to virtue: liberalism with a touch of Marxism. I am reminded rather of Saint-Simon's *Catechism for Industrialists*, in which savants were given a share of power provided they satisfied the demands of the industrial system. "Scientists", Saint-Simon said, "render important services to the industrial class, but they receive from it services that are even more important, they receive their very *existence*. . . . Thus it has the right to say to the scientists: we are ready to feed, house, clothe you and satisfy your physical tastes only on certain conditions".[16]

How far the "economic war" will lead private firms and laboratories to replace the state in taking on what now are public investments remains a question that is still open. These investments grew constantly during the Cold War as each of the superpowers tried desperately to keep ahead of the other in technology. As Galbraith realised early on, "Although spending of all kinds – whether on weapons, old age pensions or air pollution – boosts demand, they do not all have the same impact on technology".[17] The question to day is: will trade and international competition be as powerful a stimulant as the real or imagined threat of nuclear war? And since many major industrial firms are now suffering from cuts in the public subsidy that they once enjoyed, will they be more careful in their R&D expenditures?

The challenges still ahead

Unless there are new world crises on the same scale as those earlier this century, it is obvious that the research system will never again enjoy the same level of government support. This is clear in space research: the success of the Apollo mission gave hope of further manned flights to the moon and other planets. NASA even dreamed of space cruises in the 21st century. But now research efforts are being concentrated on perfecting unmanned flights, retrieving launchers and developing multipurpose satellites. In the year 2000 NASA is supposed to cut almost 4,000 jobs as well as 25,000 jobs connected with its contracts (31% of its labour force). Daniel Goldin, NASA's director, did not hesitate to announce very prematurely that his scientists had identified traces of fossilised life in a meteorite lying forgotten in a geological museum, because missions to Mars are less and less likely to be funded. Needs must: "smaller, faster, cheaper" has become the motto of the space industry, and is being applied to more and more of the entire national R&D effort.

And yet, even if the future isn't what it used to be, as Paul Valéry said, this does not mean there is no longer any future. A new generation is taking the place of the scientists (many physicists) and decision-makers who were responsible for science policy from the Second Word War to the Cold

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War – a generation with other concerns than the arms race and an apocalyptic struggle between capitalism and communism. Nonetheless there is unlikely to be a return to the "laissez-faire" relationship between the state and the scientific establishment that prevailed in the pre-war period. That is impossible because the two have become dependent on each other in ways that cannot now be reversed.

For one thing, neither can now survive without the other: government needs the *advice, methods, proof, results* or simply *promises* of science in order to govern, while research cannot hope to make progress without support from government, since the private sector cannot be expected to take on all the costs and risks of basic research. From this standpoint, Saint-Simon was wrong: there is a feedback connection between what he called the industrial class and the scientists, by which the former owes as much its very existence to the latter. Science, having demonstrated in war its usefulness to industry and the state, will continue to demonstrate it in peace as part of the same business of the control, domination and innovation race of the "post-industrial" economic and social process.

For another thing, there are so many problems that scientific research can help to solve – including those that it has helped to create. Neither the number nor the significance

of these problems was reduced as if by waving a magic wand when the Berlin War fell, and while the shambles of "real socialism" restrain any dreams of utopia in that direction, it is equally unthinkable to rely on capitalism as a panacea. On the contrary, there is daily evidence that market forces are not going to deliver full employment and assured prosperity nor reduce inequalities, and that the market could give rise to new disasters. The need for international regulation is more and more obvious, and the kind of negotiations that will soon take place in Seattle within the WTO are certainly not, as they have up to now been prepared, the answer to the most pressing world economic challenges.

In any case, the emphasis on competitiveness means that short-term economic interests alone determine the search for and spread of innovations while neglecting the risks that science itself constantly creates for the medium or longer term. These risks affect the future in the same way as natural disasters, with the difference that little can be done about the natural disasters, whereas we could act to reduce or prevent the man-made ones. Scientific research has a key role in solving these urgent problems, all the more so given that so many are the direct result of scientific "progress": destroying nuclear arsenals, processing nuclear waste, risks linked to genetic engineering, or eugenics or misuse of computers, etc. To this list of threats one can

add all the problems that proliferate as a consequence of the type of industrialisation favoured in the 20th century and which carry risks for the whole planet. As I already said, the nature and scale of economic activities cause changes in systems of all kinds: biological, chemical, geological. It is no longer possible to deny that global warming exists as a result of gas emissions and the greenhouse effect; the Intergovernmental Panel on Climate Change produced a report, based on the work of 2,000 experts from around the world, which showed that global warming is not simply occurring, it is speeding up.[18] The commitments made at the Earth Summit in Rio and Kyoto – which not one country has respected up to now – are already outdated compared with a pace of development that is likely to be less and less "sustainable". Science could have a role here too, in identifying the precise nature of the problems, assessing the facts and highlighting the long-term costs of failure to act now.

Lastly, it is impossible not to mention the challenge of poverty and hunger in developing countries. Climate change can only exacerbate the imbalances that, together with the population explosion, already cause such suffering to their inhabitants. As scientists have been telling us for years, if only a tiny fraction of R&D spending were switched to concerted efforts to tackle the specific problems of these countries, the situation would improve. However,

given that their population growth is likely to speed up in the next century, the poorer countries are the ones most at risk of suffering not just from the industrial fall-out of the rich countries, but from the increase in their own energy requirements. They will therefore need to acquire, with the help of the industrialised countries, a domestic capability in science and technology that will allow them to study, measure, give due warning of and, if possible, control the damage resulting from progress.[19]

It is far from certain that these problems will elicit the mobilisation of science and technology that they deserve. Other choices, other priorities would be possible for the policies whose subject is science. If this is a dream, we must confess that industrial societies leave little room for dreams. Men may well ask what scientific and technical progress will make of them, while they have forgotten what they could make of scientific and technical progress. On the other hand, it cannot be ruled out that the pressure of global problems will be such as to force the most advanced countries – not out of philanthropy but out of sheer self-interest – to devote a larger proportion of their R&D spending to these issues. Much of the malaise, of the worries about the future, would thereby be reduced since science "the endless resource", perceived by untrammelled capitalism as a good like any others, is a major element in the *fin-de-siècle* disillusion.

In any case, two things are certain. First, the context of innovation policies will increasingly affect university research, forcing it into ever closer links with private industry. A new balance must be worked out between the opportunity-driven criteria based on what scientists want and the needs-driven criteria of society. University research is condemned to operate against a background of the need for innovation, for a range of programmes that transcend traditional boundaries between disciplines, a "market for knowledge" shaped by social demand, closer ties between "hard" and social sciences in dealing with problems that the essentially social ones (from the environment to megacities and poor neighbourhoods) that all societies, industrialised and developing, will have to face in the 21st century.

It will take more than a generation of researchers for these changes to achieve their full impact on the institutions, funding and methods of university research. At the same time as the traditional role of the universities is being drastically altered by having to cope with mass education, and they are urged increasingly to offer short, vocational courses, other pressures are forcing changes in the conception, practice, hiring and direction of university research. The book edited by Michael Gibbons, *The New Production of Knowledge: The Dynamic of Science and Research in Contemporary Societies*, shows how these changes

are already affecting research institutions.[20] The domination of technology requires multidisciplinary research and a new kind of cooperation with industry that lead to a new scientific environment where engineering becomes much more important than the advancement of knowledge. There is no more striking illustration of this trend than the way Berkeley is now bringing together fields ranging from physics to molecular biology in new research buildings involving 100 million dollars, or how Harvard, Stanford and Princeton are attempting to break age-old departmental and disciplinary barriers to take advantage of the new opportunities in genomics, biophysics and nanotechnology. The pressure of industrial competition is such that new university "entrepreneurial" postures are required. For instance the new Berkeley "effort formally known as the Health Sciences Initiative will cut a wide swathe through the campus, involving some 400 scientists from at least 8 departments".[21]

Secondly, although technological competition between nations, with state support for their industries, is likely to become increasingly intense, it will not prevent an expansion of multinational co-operation in research. The prime reason will be financial: today even the United States, once little interested in joining international research projects, is following closely the OECD Magascience Forum discussions; soon the US will be participating more and more in

international programmes to build and develop major facilities. They have already joined CERN in Geneva and their space station programme depends upon the co-operation of Europe as much as that of Russia. Another revealing example is that of the European Union where, even if its R&D spending as such seems tiny (5 to 6%) compared with the total expenditures of the individual member states, links are being forged between scientists and laboratories through common projects as national programmes become more dependent on the European research system. Progress towards union is perhaps greater in science and technology, through the network of programmes linking universities and industry, than on the political level. As a student of mine has recently demonstrated in a brillant doctoral thesis, since national R&D budgets have been slashed, support from the EU is no longer just a little encouragement, it is a major contribution to national efforts without which national research institutions would suffer.[22]

All the issues I referred to, far from challenging the need for a science policy, imply that governments must increasingly make basic decisions regarding the size, organization and orientation of the national research effort. The task ahead is difficult, since priorities will be much more diffuse, complex and harder to define and implement than in the past. The scale of the scientific effort will be

in question – but so will other public investments – during this time of economic crisis, unemployment, public debt and international competition. These changes will require both demonstrated excellence and relevance, which means rethinking the distribution of resources and research programmes relative to the overall social context.

Let me now conclude: all these changes lead us to conceive of a new social contract of science which is precisely the major theme that was discussed during the UNESCO Science Conference held last June in Budapest. The next century will tell us how far this new social contract will be more or less beneficial to the progress of our knowledge and understanding of nature and ourselves than the former "alliance" between science and politics conditioned by World War II and the Cold War's intense strategic, ideological and economic competition. How far also it may be more beneficial to mankind is another question that the future will answer. Let us simply hope that it will.

Notes

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2. *Survivre à la science — Une certaine idée du futur*, Albin Michel, Paris, 1999
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4. N. Kaplan, *Science and Society*. Rand McNally Company, Chicago, 1965
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6. John von Neumann, Can we Survive Technology?. *Fortune Magazine*, 1955
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8. V. Bush, *Science the Endless Frontier: A Report to the President on a Program for Postwar Scientific Research* (1945). Reprinted by the National Science Foundation, Washington, 1960
9. J.-J. Salomon and A. Lebeau, *Mirages of Development: Science and Technology for the Third Worlds*. Lynne Rienner, Boulder-London, 1993. Also J.-J. Salomon et alii, *The Uncertain Quest: Science Technology, Development*. United Nations University, Tokyo, 1994
10. R. A. Solow was the first to call attention on the lack of links between the amount of defense R&D investments and the acceleration of economic growth: "Gearing Military R&D to Economic Growth", *Harvard Business Review*, November-December 1962. On the same theme, see in particular N. Rosenberg, "Civilian 'Spillovers' from Military R&D Spending: The US Experience since World War II", in *Strategy, Defense and the Western Alliance*, (S. Lakoff and R. Willoughby, eds), Lexington Books, Lexington, Mass., 1987. For the case of France, see J.-J. Salomon, *Le Gaulois, le Cow Boy et le Samourai: La politique française de la technologie*, Economica, Paris, 1986, and Elie Cohen, *Le Colbertisme High Tech.*, Paris, Hachette, 1992.
11. H. Nowotny, "Phases or Paradigms of Science Policy? A Response", *Science and Public Policy*, vol.21, no.6, December 1994. Actually, Nowotny dealt with the content of certain research developments terminated or altered in the western world which Japan has taken up. I would like to stress the fact that in Japan the whole academic and basic research is now receiving a big boost, whereas the same area is getting fewer resources in the western world: a counter-cyclical choice of investment already obvious at the end of the 80s (see Y. Okubo, *Regard sur la science et la technologie japonoises*, Paris, 1997, and D. Normile, "Basic Science Spending to Jump in 1997", *Science*, vol. 275, 3 January 1997.)
12. W. J. Clinton and A. Gore Jr., *Science in the National Interest*, Executive Office of the President, OSTP, Washington, 1994, p p. 1-2
13. L. Branscomb and J. H. Keller (eds), *Investing in Innovation – Creating a Research and Innovation Policy that Works*, MIT Press, 1998. See also, less recent, R. J. Samuel, *Rich Nation, Strong Army: National Security and the Technical Transformation of Japan*, Cornell University Press, 1994; and

Errata

1. Page 4, end of paragraph 1: Add after '...outside OECD' 'that it has become an historical topic'.
2. Page 13, paragraph 2, line 13: Replace 'On the country,' by 'On the contrary'.

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15. J.-J. Salomon, *Science and Politics*, MacMillan and M.I.T Press, London, Cambridge, 1973, p.64
16. H. de Saint-Simon, *Catéchisme des industriels, Oeuvres*, vol.V, Anthropos, Paris, 1967, p. 25 (author's italics)
17. J. Galbraith, *The New Industrial State*, Houghton Mifflin, Boston, 1967, p.339, note 9
18. Reports published in 1997 by Cambridge University Press, summarised in French in *Les Cahiers de Global Change*, no.7, July 1996, available at the IPCC Secretariat, WMO, Geneva, Switzerland
19. E. B. Sokolnikoff, *The Elusive Transformation: Science and Technology and the Evolution of International Politics*, Princeton University Press, 1993, and "New International Trends Affecting Science and Technology", *Science and Public Policy*, vol. 20, no. 1, April 1993
20. M. Gibbons et al, *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, Sage, London, 1994
21. See R.F. Service, "Berkeley Puts All its Eggs in Two Baskets", *Science*, vol. 286, 8 October 1999; pp. 226-227
22. Regina Pinto de Gusmao, *L'engagement français dans l'Europe de la recherche*, Economica, Paris, 1997. From 1988 to 1993, the European Union financed almost 3000 European research consortia which mobilised more than 5200 French participations (teams involved in a project) and with which were associated more than a thousand French research institutions, private and public. The average annual amount of the EEC spending is estimated to be 2.5 billion francs, that must be compared with the 2 billion francs of the "crédits incitatifs" spent from the French State budget during the same period.

As Head of the Science Policy Division at OECD, Paris during 1963 to 1983, Prof. J.-J. Salomon was one of the main architects of the restructuring of science and technology policies in Europe. As Head of the International Council for Science Policy Studies for UNESCO, he promoted many programmes in developing countries. He initiated the first post-graduate programme in Science, Technology and Society at the Conservatoire National des Arts et Metiers at Paris. He is the author of several books, including Mirages of Development – Science and Technology for the Third Worlds. *His new book,* Survivre a la science – un certaine idee du futur, *is currently under publication.*

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summary of work experience

1999–present	ISRO Professor of Science and Technology Policy, National Institute of Advanced Studies, Indian Institute of Science Campus, Bangalore.
1994-99	Senior Environmental Specialist, Climate Change, Global Environment Facility, Washington, D.C.
1993-94	Associate Research Scholar, Centre for Global Change, University of Maryland, College Park, Maryland
1993-94	Adjunct Associate Professor of Systems, University of Pennsylvania, Philadelphia.
1988-93	Senior Analyst, The Bruce Company; providing scientific and policy analytical support to the Climate Change Division, Office of Policy Analysis, U.S. Environmental Protection Agency, Washington, D.C.
1991-92	Visiting Associate Professor, Department of Management Studies, Indian Institute of Science, Bangalore.
1982-88	Fellow, Tata Energy Research Institute New Delhi; Convenor, Energy Environment Interface Group; In-charge, ENVIS (Environmental Information System) Centre on Energy.
1979-81	IPH Research Fellow, Interdisciplinary Programs in Health, Harvard University School of Public Health, Boston.
1978-79	Guest Investigator, Unit for Research on Behavioral Systems, National Institute of Mental Health, Poolesville, Maryland.
1973-78	Graduate Research Assistant, Division of Biomedical Engineering, The University of Virginia at Charlottesville, Virginia.
1977	Visiting Researcher, Study Group for International analysis, Vienna, Austria.

education

1980	Executive Program in Environmental Policy and Management, Harvard University School of Public Health, Boston, Massachusetts
1978	Ph.D., Biomedical Engineering (Health Care Systems Analysis), The University of Virginia at Charlottesville, Virginia
1972	B. Tech., Electrical Engineering, Indian Institute of Technology, Bombay, India

distinctions

2000 Review Editor, Chapter 6, *Policies, Measures and Instruments*, IPCC Third Assessment Report. Working Group III.

1998 Lead Author, IPCC Special Report on *Methodological and Technological Issues in Technology Transfer*.

1993 Co-Editor, Special Issue of the *Journal of Resource Management and Technology 21*(1) on Waste Management in Developing Countries.

1993 Co-chair, IPCC-OECD Expert Subgroup on Methane Emissions from Biomass Burning.

1992 Member, Ad-hoc Working Group on Global Warming of the Scientific and Technical Advisory Panel of the Global Environment Facility.

1991 Member, Ad-hoc Working Group on Global Warming and Energy, Scientific and Technical Advisory Panel, Global Environment Facility.

1987 Chair, Session on Developing Country Issues at the 4th International Conference on Indoor Air Quality and Climate, August, West Berlin.

1990-99 Editorial Advisory Board, *Global Environment Review, Energy Environment Monitor*, TERI Information Service on Global Warming.

1986-87 Thermal Power Appraisal Committee, Government of India.

1985-83 Formal peer reviews of publications for *Annual Reviews of Energy and the Environment, Chemosphere, Climatic Change, Indian Academy of Sciences, Energy Environment Monitor*, and *Fertilizer Research*.

meetings organized

1990 Workshop on the Scientific Basis for Global Warming Potential Indices, Boulder, Colorado, November 14-16

1989 Options for Improving Biofuel Cookstoves Technologies, Washington, DC, July 27

1988 Training Program on Energy and Environment for Officers of the Indian Administrative Service, New Delhi, September 5-10

1985 National Workshop on Environmental Management of Thermal Power Stations, New Delhi, November

1983 Workshop on Environmental Guidelines for Coal Transportation, New Delhi, November

consulting

1993-94 Global Environment Facility, Washington, DC
1991-93 United Nations Development Program, New York
1991-92 United National Environment Program, Nairobi
1984-92 East West Centre, Honolulu
1983 World Health Organization, Geneva
1981 National Institute of Mental Health, Maryland

dissertations

1978 *Analysis of Socio-Economic Correlates of National Health Indicators* (Doctoral)
1972 *Simulation of Physiological Systems* (Undergraduate)

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"Developing an Operational Program for Sustainable Transport" presented at the FFEM-GEF Workshop in Paris, May 4-5, 2000 and at the NIAS Course for IAS Officers, 16 December, 1999.

"Global Environmental Treaties" presented at the XIVth NIAS Course for Senior Executives on Globalization and Development, Bangalore, 21 January, 2000.

"Renewable Energy Development in Nicha" presented at the GEF Familiarization Seminars in Washington, D.C., 6 December, 1999.

"Restructured GEF and its Operational Strategy", the *Int. GEF Workshop*, New Delhi, April 1966.

"Discussion on "Political Issues", the workshop on *Attaining Sustainable Culture-enabling Norms of Development*, Center for the Advanced Study of India, Univ. of Pennsylvania, Philadelphia, Nov 1995.

"Estimating Incremental Costs for the Global Environment", IGIDR, Bombay, October 1994; TERI, New Delhi, September 1994; LBL, Berkeley, June 1994.

"Global Warming Potentials of Greenhouse Gas Emissions" at the Dept of Systems, University of Pennsylvania, Philadelphia, October 5, 1992.

"Global Warming Potentials of Greenhouse Gas Emissions: How Science and Policy get intertwined when the stakes are high", CAOS, I.I.Sc., Bangalore, April 1991; and IGIDR, Bombay, November 1991.

"Global Warming", All India Radio, March 8, 1991; Training Programme on *Management of Environment* for IAS Officers, Bangalore, February 1991.

"Estimating Contributions to Global Warming", I.I.Sc., Bangalore and TERI New Delhi, October 1989.

"India's Contribution to Emissions of Greenhouse Gases", and "Improving the Efficiency of Biofuel Cookstoves", *International Workshop on Global Climate Change*, LBL, Berkeley, June 1989.

"Social and Environmental Effects of Hydroelectric and Coal-fired Power Stations", Training Program on Energy and Environment for IAS Officers, New Delhi: Sept 1988 and Oct 1987.

"Relative Impacts of Large Scale Methods for Generating Electricity", M.P. State Electricity Board, August 1988, Jabalpur and at Bhabha Atomic Research Centre, July 1988, Bombay.

"Thermal Power: Contribution to India's Energy Requirements and Environmental Degradation", August 1987, Jawaharlal Nehru University, New Delhi; NTPC Seminar, Kanha, Feb 1987.

"Energy Environment Interface in Rural Areas", IAS Courses on Rural Energy Planning and Technology, May 1987, Nainital; and Sept 1986, Shimla.

"Environmental Considerations in Energy Planing and in the Power Sector", Course on Energy Planning and Demand Management, October 1986, Nainital; Training Programs on Planning for the Power Sector, April 1987, Ooty; April 1986, Shimla; and April 1985, Ranikhet.

"Energy Environment Interface", APDC-ENERPLAN National Courses on Integrated Energy Planning, Islamabad, October 1986 and Colombo, December 1985.

"Environmental Management of Thermal Power Station", National Workshop on Environmental Management of Thermal Power Stations, New Delhi, November 1985.

"Energy Training in India" World Bank (EDI) Seminar for Trainers in the Energy Sector, Bangkok, June 1985.

This Update: 24 July 2000

INDIAN INSTITUTE OF MANAGEMENT, AHMEDABAD

About the Institute

Indian Institute of Management Ahmedabad (IIM-A) was established in 1961 as an autonomous Institution by the Government of India in collaboration with the Government of Gujarat and the Indian Industry. IIM-A was registered as a society with a Board of Governors to oversee the functioning of the Institute. The Board has representatives from the Governments of India and Gujarat, the Industry, the IIM-A Society, the IIM-A faculty, etc.

IIM-A was conceived not to be purely a business school, but a school of management. Its mission is to professionalise Indian management through teaching, research, training, institution building and consulting. It also aims to professionalise some of the vital sectors of India's economy such as agriculture, education, health, transportation, population control, energy, and public administration. In its formative years, IIM-A collaborated with the Harvard Business School (HBS). Largely as a consequence of this collaboration, IIM-A pioneered the case method of teaching in India.

Academics lies at the core of IIMA. There are many avenues for the all round development of a student at IIMA, but it is the emphasis laid on academics which is responsible for the institute's position as a top Asian business school. IIMA offers four programs for the development of management in the country - three are teaching programs and one is a series of refresher courses for mid and top level management. Admissions to the postgraduate program - PGP (equivalent to an MBA) are extremely competitive attracting many applicants every year. IIMA maintains its standards with the help of a large and distinguished faculty.

The faculty is organized into areas or groups or centers and keeps itself up to date with the outside world by engaging in research and consulting. Another distinguishing feature of the academic landscape is the large variety of courses offered, a majority of which are taught using the case method.

Profile

IIMA has possibly the largest faculty of any of the management institutions in the developing nations. Its distinguished faculty conducts the developing countries' most prestigious MBA and Ph.D. level programs in management, trains around a thousand managers and administrators every year, contributes expertise not only to industry but to a number of other strategic sectors and produces perhaps a third of all the management research done in India. The counsels of the faculty are heard with respect by those in government, by heads of corporations, and by managers of financial institutions, cooperative societies, voluntary organizations, academic institutions, and international agencies.

The total strength of the faculty in the eighties has been around 80. A build up is likely in view of the expansion of several areas and groups, and the setting up of new thrust groups. In the following pages brief profiles are presented of primary members of each area and group of the Institute.

Significant research has been done by members of the Area on efficiency of public enterprises, financing of public sector undertakings, taxation, deficit financing and fiscal policy in India, economics of housing, sources of economic growth in India, monetary policy in India, comparative rates of growth in developing countries, managerial economics, marketing of fish in India, regional disparity in growth in India, planning for rural development and employment, decision analysis, game theory, entrepreneurship development, business concentration in India, industrial licensing policy in India, and Indian anti-monopoly policy.

Consulting at IIMA has been guided by several norms:

Consultancy is an academic activity. Projects are taken up only if they have a definite learning value. Faculty members do not solicit consultancy projects. The total time spent on consulting is voluntarily restricted, so that other academic responsibilities are met. On an average, IIMA faculty members undertake about 60 new consultancy projects on varied themes a year. Some involve giving advice to clients on specific problems; others involve training interventions. Still others require evaluation of specific projects or programs.

IIMA faculty caters to a wide range of clients. These include public and private sector corporations, financial institutions, government agencies and departments, cooperative societies, not-for-profit institutions, and international agencies like the World Bank and FAO.

International Support

IIMA has set up a number of academic centers/groups to pioneer research in thrust areas of high social relevance. Among the international organizations which have sponsored research at the Institute are the Ford Foundation, UN Agencies, and the World Bank. Central and state government ministries, departments, Planning Commission, financial institutions, and industrial agencies have also funded research work at IIM-A.

Climate Change Research

The Public Systems Group (PSG) undertakes research, training, and organizational work on management of various public systems. The objective of PSG is to promote research, which will generate concepts and theory for effective management of public systems and provide opportunities to managers of public systems for developing managerial skills and techniques. PSG's domain can be grouped into three categories:

- Work on organizations such as hospitals, universities, electricity boards, public works departments, state transport corporations, and municipalities.
- Work on programs such as health and family planning, education, housing, etc.
- Work on government departments concerned with developmental tasks such as education, industries, energy, housing and urban development, transport systems, etc.

Prof. P. R. Shukla, of the PSG is the focal point of the research work on Climate Change activities at IIM-A. He specializes in energy, energy efficiency and environment modeling, renewable technologies, decentralized planning, integrated assessment modeling and climate change policy analysis. He has worked extensively with government organizations, international agencies, NGOs and private organizations. He has been a Lead Author of IPCC Second Assessment Report and Technical Papers 1 and 4, Co-author of six books on energy and environment policies and has published extensively in reputed journals. The curriculum vitae of Prof. Shukla is enclosed for further reference. Prof. Shukla would continue to be the center of research as a part of the forum under GEP-CCS.

CURRICULUM VITAE

PRIYADARSHI R. SHUKLA

Address:	Indian Institute of Management, Vastrapur, Ahmedabad 380015, India Phone: 91 79 407241, Fax: 91 79 6427896 EMAIL: Shukla@iimahd.ernet.in
Birth:	[redacted]
Nationality:	Indian

ACADEMIC QUALIFICATIONS

1979	Ph.D., Stanford University, U.S.A. Awarded *Prize for Outstanding Student at Graduate Level* (1979)
1976	M.S., Stanford University, U.S.A. [redacted]

WORK EXPERIENCE

Since Oct. 79	Professor, Public Systems Group Indian Institute of Management, Ahmedabad, India
June - Sept 79	Research Fellow, Stanford University, California, U.S.A.
June 73 - Sept 75	Faculty, National Institute of Design, Ahmedabad, India

RECENT INTERNATIONAL VISITING ASSIGNMENTS

June 1996	Center for International Research in Environment and Development (CIRED), Paris
February 96	National Institute of Environment Studies (NIES), Tsukuba, Japan
July -Aug 93	IEPE, Grenoble, France
June - July 93	Battelle, PNNL, Washington DC
Apr -June 93	Faculty of Management, McGill University, Montreal, Canada
Oct 92 - Apr 93	Advanced International Studies Program, Battelle, PNNL, Washington DC
Oct - Nov 91	CIRED, Paris
Aug - Sep 90	Folkecenter for Renewable Energy, Denmark

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TEACHING AND TRAINING

Masters and Doctoral level courses in the area of Environment Management, Energy and Environment Policy, Electric Power Economics and Policy, Risk Analysis and Public Policy, Decision Models, Manufacturing Strategy, Technology Policy, Multiple Criteria Decision Making, Electric Power Economics and Policy etc. Training programs in the areas of Energy and Environment Policy, Integrated Assessment Modelling and Policy Analysis, Sustainable Development, Energy Conservation, Renewable Energy Policy, Decentralized Planning, Manufacturing Policy, Technology Policy and Project Management, Climate Change Policy, Development and Financing of Climate Change Mitigation Projects, Macro-Economic Modelling for Developing Countries etc.

DOCTORAL THESIS SUPERVISION AND ASSESSMENT

Supervised and guided several doctoral students in the areas such as energy and environment policy modelling and analysis, renewable energy policy, climate change policy, technology and manufacturing strategy. Recognized as doctoral examiner and thesis guide by several national and international universities and academic institutions.

RESEARCH AND CONSULTATION

Undertaken numerous Research and Consultation assignments for national and international organizations on global climate change modelling, energy demand forecasting, energy and environment modelling and policy Analysis, environment management, environment impact assessment, sustainable development, operations management, project management, logistics, and technology strategy. Clients for research and consultation work for include Government of India, State Government Agencies, corporate sector, NGOs and international organizations. Have provided frequent inputs and advice to government of India on policies in the areas of energy, environment, climate change and technology.

RECENT INTERNATIONAL INVITATIONS

Invitations for seminars and collaborative work from international organizations:

Battelle, Pacific Northwest National Laboratories (Washington DC); University of Twente (The Netherlands); RISO National Laboratories (Denmark); Folkecenter for Renewable Energy (Denmark); McGill University (Montreal); University of Virginia (USA); University of Aalbourg (Denmark); CIRED (Paris, France); University of Oldenberg (Germany), IEPE (Grenoble, France); World Resources Institute (USA); GERAD (Montreal); University Corporation for Atmospheric Research (Boulder, USA); National Institute of Environment Studies (Tsukuba, Japan); COPPE/UFRJ (Brazil); Korean Energy Economics Research Institute (Seoul); Fondazione Eni Enrico Mattei (Milan); Modern Asia Research Center (Geneva); Energy Research Institute (Beijing); Asian Institute of Technology (Bangkok), Pew Center on Global Climate Change (Washington DC); Hagler Bailly Services Ltd. (Washington DC); Environmental Defense Fund (EDF), Stanford University; Resources for the Future (RFF); PEW Center on Global Climate Change (Washington DC, USA); Institute for Global Environmental Strategies – IGES (Japan), International Institute for Education (Washington DC); etc.

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Invitations from UN Organizations, Development Agencies, Institutions and Corporations:

FAO; Intergovernmental Panel on Climate Change (IPCC); UNEP; UNDP; UNU; UNFCCC; GEF; IEA; The World Bank; USAID; CIDA; GTZ; Indo-Dutch Project for Alternatives in Development (IDPAD), Environment Agency (Government of Japan); UPME (Colombia); British Petroleum, Shell International etc.

EDITORIAL BOARD OF INTERNATIONAL JOURNALS

Environmental Modelling and Assessment, Baltzer Science Publishers, Amsterdam

International Journal of Operations and Quantitative Management, U.S.A.

INVITED MEMBERSHIP OF COMMITTEES

Member, Rural Energy Pricing Committee, Planning Commission, Government of India

Member, The Indian Man and Biosphere Research Committee, Ministry of Environment and Forests, Government of India.

Member, Ecosystems Research Committee, Ministry of Environment and Forests, Government of India.

Member, Expert Committees on Environmental Pollution, Appointed by the Hon'ble High Court of Gujarat State, India

Member, Working Group on Framework Convention on Climate Change, Ministry of Environment and Forests, Government of India

Member, Global Energy Technology Strategy Project, An International Public and Private Partnership, Coordinated by Battelle Memorial Institute, Washington DC

Member, Group for Integrated Assessment Modelling - A Research Group of Indian Institutions Developing *Regionally Sensitive Integrated Assessment Model*

Member, Core Group, Integrated Assessment Modelling in Developing and Transitional Economies, An initiative by START and IPCC

Member, Editorial Committee, Research Publications, Centre Social Humaine, New Delhi

Member, Energy Task Force, Confederation of Indian Industries, Gujarat State

Member, Expert Group on Greenhouse Gas Inventories, Scenarios and National Communication, Ministry of Environment and Forests, Government of India (1999)

Member, Expert Group on Kyoto Protocol Mechanisms, Ministry of Environment and Forests, Government of India (1999)

Member, Expert Group on Impacts of Climate Change, Ministry of Environment and Forests, Government of India (1999)

WORK ON ENERGY AND ENVIRONMENT POLICY

Consultant over past two decades to different Ministries and Organizations of Government of India such as the Advisory Board on Energy, Planning Commission, Ministry of Environment and Forests and Ministry of Non-Conventional Resources

Collaborative Research on Strategies for Energy Conservation and Environmental Pollution, with *University of Twente*, Netherlands

Consultant on Energy Conservation to several Industries in India

Invited Expert: Biomass Energy Workshop, International Energy Agency, Paris.

Invited Expert: Non-Commercial Energy Planning, Bogota, Colombia

Invited Expert: Biomass Energy Future, Rio de Janeiro, Brazil

Consultant to Regional Wood Energy Development Programme, FAO, Bangkok on study of *Biomass Electricity Generation Technologies*

Consultant for Rural Energy Planning to Central and State Government Ministries and Nodal Agencies

International Expert and Lead Author, *Renewable Energy on the World Market: A Policy Study*, International Energy Agency (IEA), Prepared by Advanced International Studies Unit, Battelle, Pacific Northwest National Laboratories, Washington DC

Project Director, Project on ***Strategies and Instruments for Sustainable Growth - Energy Management and Environmental Protection in India***, Sponsored by Indo-Dutch Programme for Alternatives in Development.

Co-ordinator, Least Cost Power Sector Planning, Project Sponsored by the Pew Center on Global Climate Change, Washington D.C., U.S.A.

WORK ON CLIMATE CHANGE POLICY

Convening Lead Author, IPCC Third Assessment Report (TAR) on Climate Change, Chapter 8 - *Global and Regional Costs and Ancillary Benefits*, Working Group III (Under Preparation)

Lead Author, IPCC Special Report: *Emissions Scenarios* (Under Preparation)

Lead Author, IPCC Special Report on Methodological and Technological Issues in Technology Transfer, Chapter 10 (Energy Supply), Forthcoming.

Co-ordinator, International Workshop on Integrated Assessment Models for Climate Change Policy for Asia, Sponsored by Asia Pacific Network for Global Change Research, 1998

Co-ordinator, Training Workshop for Integrated Assessment Models for Climate Change Policy Analysis, Sponsored by Asia Pacific Network for Global Change Research, 1998

Lead Author, IPCC Technical Paper IV: *Implications of Proposed CO_2 Emissions Limitations (1997)*

Lead Author, IPCC Technical Paper I: *Technology, Policies and Measures (1996)*

Lead Author, UNEP/IPCC discussion paper: *Mitigation and Adaptation Cost Assessment: Concepts, Methods and Appropriate Use (1997-98)*

Contributing Author, *Human Choice and Climate Change*, Pacific Northwest National Laboratory, U.S.A.

Lead Author, *Climate Change 1995 - Economic and Social Dimensions of Climate Change, Second Assessment Report of the IPCC (Chapters 8,9 and 10)*, Working Group III

National Consultant for Global Environment Facility (GEF) Projects

Invited Expert at the *Global Climate Change Institute*, Organized by UCAR/OIES at Snowmass, Colorado, USA, July 1994

Invited Expert: Third IEA Modelling Seminar on Uncertainty and Energy Policy Choices to meet UNFCCC Objectives, International Energy Agency, Paris

Invited expert to US Country Studies Program on *Greenhouse Gas Mitigation*

Invited Expert, *First IPCC Asia-Pacific Workshop on Integrated Assessment Models*, Tokyo, March 10-12, 1997

Invited Expert, Asia Least-Cost Greenhouse Gas Abatement Strategies (ALGAS) Project Sponsored by Asian Development Bank.

Invited Expert, International Workshop on the Technology Strategy, February 1998, Tokyo, Japan

Invited Expert, *International Workshop on Integrated Assessment Modelling (IAM)* - Organized by Energy Research Institute and State Development Planning Commissions Beijing, China, October 11 - 13, 1998

Invited Expert, *Second IPCC Workshop on Integrated Assessment in Africa*, Kadoma, Zimbabwe, November 22-25, 1998

Collaborative Research with *Battelle, Pacific Northwest National Laboratories*, Washington DC on Climate Change Modelling

Consultant to *Government of India* on Energy-Environment Modelling and Policy Analysis

Collaborative Research on Energy and Greenhouse Gas Policy for India using MARKAL Model, with *McGill University and GERAD*, Montreal (1994-96)

Collaborative work on the IMACLIM-NEXUS model with *Centrè for International Research in Environment and Development*, Paris (ongoing)

Collaborative Research with *National Institute of Environment Studies*, Tsukuba, Japan, on the Asia-Pacific Integrated Model (AIM) for Evaluating Policy Options to Reduce GHG Emissions and Global Warming impacts (ongoing)

Consultant, Climate Change Awareness and Outreach (CCAO) Project, USAID (1999 – 2000)

Consultant, Clean Technology Initiative (CTI), USAID (1999 - 2002)

Expert and consultant to GEF Secretariat for preparing "Case Study on India" for the GEF Review of Enabling Activities.

CONTRIBUTIONS TO INTERNATIONAL REPORTS (as co-author/ co-editor)

Lead Author, *Developing Countries and Global Climate Change: Electric Power Choices for India*, Report, Published by The Pew Center on Global Climate Change (Forthcoming – 1999)

Lead Author, *IPCC Special Report on Methodological and Technological Issues in Technology Transfer: Chapter 11 (Energy Supply)*, Forthcoming in 2000.

Lead Author, *IPCC Special Report on Emissions Scenarios*, Forthcoming in 2000.

Principal Author, *Biomass Based Power Generation and Wood Fuel Production Systems - Economic Analysis and Implementation Strategies*, Report, FAO, Regional Wood Energy Development Programme in Asia, Bangkok, Thailand, Forthcoming 1998.

Lead Author, *Mitigation and Adaptation Cost Assessment: Concepts, Methods and Appropriate Use*, Report, United Nations Environment Programme (UNEP), October 1998.

Editor, Proceedings of Regional Conference on *Climate Change Mitigation in Asia and Financing Mechanisms*, Sponsored by UNEP/GEF and The World Bank, Goa, India, 4 To 6 May 1998.

Contributing Author, *Human Choice and Climate Change - Rayner, S and Malone, E (Eds.)*, Battelle Press, 1998.

Lead Author, *Implications of Proposed CO_2 Emissions Limitations - IPCC Technical Paper IV*, Intergovernmental Panel on Climate Change, Geneva, October 1997.

Lead Author, *Technologies, Policies and Measures for Mitigating Climate Change - IPCC Technical Paper I*, Intergovernmental Panel on Climate Change, Geneva, November 1996.

Lead Author, *Chapter 8 - Estimating the Costs of Mitigating Greenhouse Gases*, Climate Change 1995 - Social and Economic Dimensions of Climate Change, Contributions of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) - Eds. J.P. Bruce, H. Lee and E. Haites, Cambridge University Press - 1996.

Principal Lead Author, *Chapter 9 - A Review of Mitigation Costs Studies*, Climate Change 1995 - *Social and Economic Dimensions of Climate Change*, Contributions of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) - Eds. J.P. Bruce, H. Lee and E. Haites, Cambridge University Press - 1996.

Principal Lead Author, *Chapter 10 - Integrated Assessment of Climate Change: An Overview and Comparison of Approaches and Results*, Climate Change 1995 - Social and Economic Dimensions of Climate Change, Contributions of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) - Eds. J.P. Bruce, H. Lee and E. Haites, Cambridge University Press - 1996.

Lead Author, *Renewable Energy on the World Market: A Policy Study*, International Energy Agency (IEA), Prepared by Advanced International Studies Unit, Battelle, Pacific Northwest National Laboratories, Washington DC, 1996.

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PUBLICATIONS

BOOKS: (Author/ Co-author of)

Power Sector Future: Reforms, Technologies and Environment, Allied Publishers, New Delhi, 2000 (Forthcoming)

Greenhouse Gases Inventories for India: Status and Concerns, Allied Publishers, New Delhi, 2000 (Forthcoming)

Climate Change Mitigation: Shaping the Indian Strategy, Allied Publishers, New Delhi, 2000 (Forthcoming)

India's Energy: Essays on Sustainable Development, Manohar Publishers, New Delhi, 2000

Energy and Environment Strategies for a Sustainable Future: Analysis with the Indian MARKAL Model, Allied Publishers, New Delhi, 1997

Energy Strategies and Greenhouse Gas Mitigation: Models and Policy Analysis for India, Allied Publishers, New Delhi, 1997

Strategic Management of Energy Conservation in Industries, Oxford & IBH Publishers, Delhi, 1992

Decentralized Energy Planning: Methodology and Case Studies, Oxford & IBH Publishers, Delhi, 1991

Energy Demand for Agriculture in India - In the Year 2000, Oxford & IBH Publishers, New Delhi, 1991

Regional Energy Demand Model and Analysis, Oxford & IBH Publishers, New Delhi, 1991

PAPERS IN JOURNALS, PROCEEDINGS, BOOKS etc.

Shukla PR and Rana A (2000), Energy Economy Model Applications for India: Long-term GHG Trends and Mitigation Costs, in *Climate Change Economics and Policy: Indian Perspectives, Toman M. ed.*, Published by Resources For the Future, Washington DC.

Shukla PR, Garg A and Ghosh D (2000), Energy sector policies and Mitigation of GHG Emissions from India, in *Climate Change Economics and Policy: Indian Perspectives, Toman M. ed.*, Published by Resources For the Future, Washington DC.

Garg A, Shukla PR, Bhattacharya S and Dadhwal VK (2000), Sub-region (District) and Sector Level SO_2 and NO_X Emissions for India: Assessment of Inventories and Mitigation Flexibility *Atmospheric Environment*, Accepted for Publication.

Garg A, Shukla PR, Bhattacharya S and Dadhwal VK (2000), Sub-region (District) and Sector Level Greenhouse Gas Emissions for India: Assessment of Inventories and Mitigation Flexibility, *Atmospheric Environment*, Accepted for Publication.

Ramana PV, Sinha C and Shukla PR (2000), Penetration of Renewable Energy Technologies and Climate Change Policies in India, *International Journal of Global Energy Issues, Forthcoming.*

Jung T.Y, La Rovere E. L, Gaj H, Shukla P.R. and Zhou D (2000), Structural Changes in Developing Countries and Their Implications to Energy-related CO_2 Emissions, *Journal of Technology Forecasting and Social Change*, Forthcoming.

Shukla PR and Pandey R (2000), *Energy and Emissions Projections for Indian Industries using AIM\ENDUSE Model*, in Energy and Emissions Studies using AIM Model - Eds. T. Morita, Y. Matsuoka and M. Kainuma, Springer-Verlag Publications, Forthcoming.

Shukla PR (1999), Justice, Equity and Efficiency in Climate Change: A Developing Country Perspective, in *Fair Weather?: Equity Concerns in Climate Change - Ference Toth (Ed)*, Earthscan Publications, London.

Shukla PR (1999), Implications of Proposed Emissions Protocols and Stabilization Trajectories for Developing (Non-Annex I) Countries, in *International Environmental Agreements on Climate Change: Carlo Carrier ed.*, Kluwer Academic Publishers, Dordrecht.

Pangotra P and Shukla P.R (1999), Dyestuff Industry in Gujarat: A Case of Environmental Impasse, *Published in the Proceedings of Workshop on Industry and Environment – Eds. P. Pangotra et.al,* Indian Institute of Management, Ahmedabad, February 5-6.

Kanudia A and Shukla PR (1998), Modelling of Uncertainties and Price Elastic Demands in Energy-environment Planning for India, *OMEGA, International Journal of Management Science,* Vol. 26 (3)

Ghosh D, Majumdar S and Shukla PR (1998), Demand-Side Management at Ahmedabad Electricity Company, in Proceedings of Tenth National Power System Conference (NPSC'98), Vadodara, India, October 14-16.

Majumdar S and Shukla PR (1998), Trading Opportunities through Unit Commitment in a Deficit System, in Proceedings of Tenth National Power System Conference (NPSC'98), Vadodara, India, October 14-16.

Shukla P.R. (1998), Implications of Global and Local Environment Policies on Biomass Energy Demand: A Long-term Analysis for India, *Proceedings of Expert Workshop on Biomass Energy: Data, Analysis and Trends*, International Energy Agency (IEA) Paris, March 23-24.

Saha J and Shukla P.R (1998), *Country Study: The Indian Primary Textile Industry*, in Technology, Practices and Competitiveness: A Study of the Canadian, Chinese and Indian Primary Textile Industry, ed. P. Chandra, Himalaya Publishing House, Mumbai.

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Chandra P, Ming WX, Saha J. and Shukla PR. (1998), *Manufacturing Management in the Primary Textile Industry: Some Assessments from a Plant Level Study in Canada, China and India*, in Technology, Practices and Competitiveness: A Study of the Canadian, Chinese and Indian Primary Textile Industry, ed. P. Chandra, Himalaya Publishing House, Mumbai.

Ghosh D, Majumdar S and Shukla PR (1998), Demand-Side Management at Ahmedabad Electricity Company, *Energy Management*, April-June 1998.

Majumdar S and Shukla PR (1997). Electric Load Forecasting Using Artificial Neural Networks and Deficit Management, *Energy Sources*, Vol. 19, No. 8.

Shukla PR (1997), Biomass Energy in India: Transition from Traditional to Modern, *The Social Engineer*, Vol. 6, No. 2

Shukla PR (1997), Energy for Sustainable Development: A Social Engineering Perspective, *The Social Engineer*, Vol. 6, No. 2.

Ramana PV, Shukla PR and Hommes EW (1997), Rural Electrification in India: Role of Renewables, *The Social Engineer*, Vol. 6, No. 2.

Shukla PR (1997), Implications of Uncertainties on Energy Investments and Emissions: Analysis for India, Proceedings of the 4th Workshop of IEA-ETSAP on Advanced Local Energy Planning, Rome, Italy, October 30 to November 6, 1997.

Fisher-Vanden K, Shukla PR, Edmonds JA, Kim SH and Pitcher HM (1997), Carbon Taxes and India, *Energy Economics*, Vol. 19, pgs. 289-325.

Shukla PR (1997), *Biomass Energy Future for India*, Proceedings of International Workshop on Science and Technology for a Modern Biomass Civilization, Rio de Janeiro, Brazil, Sept. 8-9.

Morita T, Shukla PR and Camarone OK (1997), Epistemological Gaps Between Integrated Assessment and Developing Countries, *in Climate Change and Integrated Assessment Models (IAMs) - Bridging* the Gaps: *Proceedings of the IPCC Asia-Pacific Workshop on Integrated Assessment Models*, Tokyo, March 10-12.

Shukla PR (1997), Socio-Economic Dynamics of Developing Countries: Some Ignored Dimensions in Integrated Assessment, , *in Climate Change and Integrated Assessment Models (IAMs) - Bridging* the Gaps: *Proceedings of the IPCC Asia-Pacific Workshop on Integrated Assessment Models*, Tokyo, March 10-12.

Shukla PR (1997), Biomass Energy in India: Policies and Prospects, Proceedings of Workshop on *Biomass Energy: Key Issues and Priority Needs*, International Energy Agency (IEA), Paris, February 3-5.

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Majumdar S and Shukla PR (1996), *Electric Load Forecasting and Deficit Management: An Algorithmic Approach*, in Proceedings of Ninth National Power System Conference (NPSC'96), Kanpur, India, December 19-21.

Shukla PR (1996), *When and Where Aspects of Climate Change Mitigation Actions: A Developing Country Perspective*, Proceedings of IPCC Symposium on "Integrated Assessment Process", Toulouse, France, October 24-26.

Shukla PR (1996), Wood Energy and Global Climate Change, *Wood Energy News*, Vol. 11, No. 3, FAO/RWEDP, Bangkok, September.

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Shukla PR (1994), Traditional Sector Dynamics and Energy and Environment Policies in Developing Countries: A Perspective, in *Towards Sustainable Development*, Eds. Skutch M, Opdam JHM and Nordholt GS, University of Twente, Netherlands.

Chandra P. and Shukla PR (1994), Economic Reforms Need Firm Level Response, *The Economic Times*, March 31.

Chandra P and Shukla PR (1994), Manufacturing Excellence and Global Competitiveness: Challenges and Opportunities for the Indian Industries, *Economic and Political Weekly*, Vol. XXIX, No 9.

Modak S and Shukla PR (1994), Energy Sector: The Green Angle, *The Economic Times*, January 3.

Shah J, Shukla PR and Tripathy A (1993), Application of Mathematical Programming for Optimal Allocation of Coal to Steel Plants, in *Operational Research in Indian Steel Industries*, Ed. Shah J and Tripathy A, Wiley Eastern.

Kalro AH, Raghuram G, Shukla PR and Tripathy A (1993), Dispatch Planning of Finished Steel Products at a Steel Plant, in *Operational Research in Indian Steel Industries*, Ed. Shah J and Tripathy A, Wiley Eastern.

Shukla PR (1992), Energy-Environment Models: A Retrospective and Perspective, Invited paper for *OR in India: A Retrospective*, Ed. Raghuram G, Wiley Eastern.

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Shukla PR (1992), Institutional Framework for Energy Efficiency in India, in *Energy Transition in Developing Countries*, October.

Shukla PR and Pangotra P (1992), Consumer Boom: Will Fragile infrastructure Spell Its Doom?, *The Independent*, September 21.

Shukla PR and Modak S (1992), Rural Energy Planning Needs Reorientation, *The Independent*, September 12.

Pangotra P and Shukla PR (1992), A Tale of Decaying Cities, *The Independent*, August 1.

Shukla PR and Modak S (1992), Strategic Management of Energy Conservation: A Case Study of Ashok Organic Industries Ltd., *Energy Management*, July-September.

Modak S and Shukla PR (1992), Energy Conservation: The Non-Issue of Efficiency, *The Economic Times*, June 13.

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भारतीय प्रबंध संस्थान वस्त्रापुर, अहमदाबाद 380 015
INDIAN INSTITUTE OF MANAGEMENT Vastrapur, Ahmedabad 380 015

P.R. Shukla, Ph.D. (Stanford)
Professor

July 26, 2000

Mr. Michael Gallia
Chief of Party (GEP-OCS)
The Louis Berger Group Inc.
C-4/7, Building Development Area
New Delhi 110 016
Fax: 011 651-8897

Dear Mr. Gallia:

Subject: GEP-OCS Project - CLIN 04; Institutions to Co-host the Forum on Climate Change research

This has reference to the dialogue we had with you on the above subject. We are glad to confirm in principle our acceptance to host a forum for research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing technical papers would be mutually agreed subsequently.

Thanking you.

Yours faithfully,

P.R. Shukla

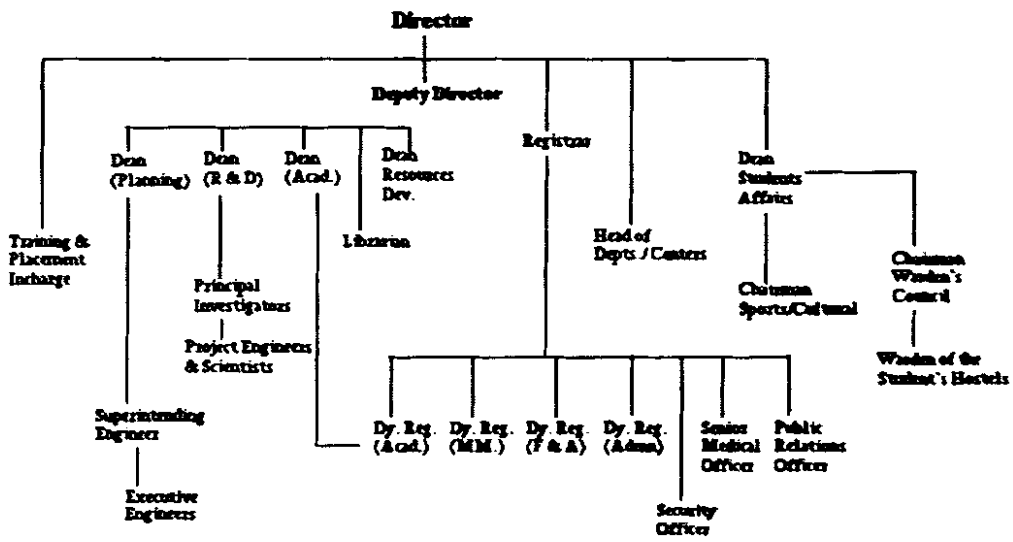
Phone 91-79-6327241 (7 lines) 6326327 (7 lines) • Fax 91-79-6306896 • Telex 121-6257 IIMA IN • Website http://www.iimahd.ernet.in

INDIAN INSTITUTE OF TECHNOLOGY (IIT)
Bombay

The Institute

IIT Bombay, one of the six Indian Institutes of Technology, set up by an Act of Parliament, was established in 1958, at Powai, a northern suburb of Mumbai. Today the Institute is recognized as one of the centers of academic excellence in the country. Over the years, there has been dynamic progress at IIT Bombay in all academic and research activities, and a parallel improvement in facilities and infrastructure, to keep it on par with the best institutions in the world. Figure 1 describes the organizational structure of the Institute.

Figure 1: Organizational Structure of IIT-Bombay

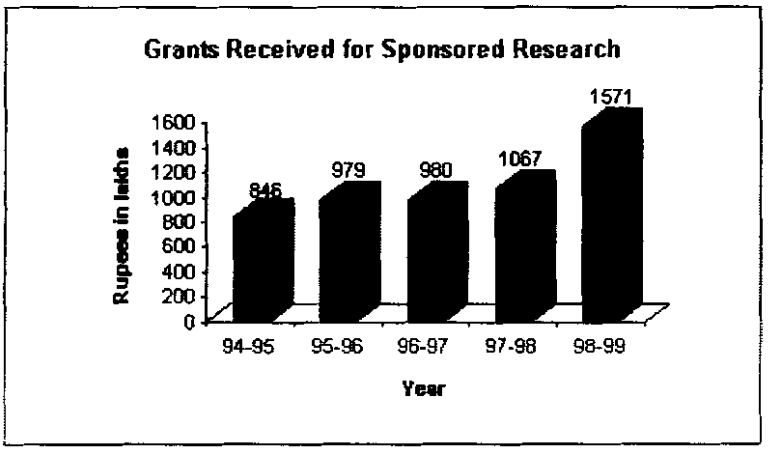


Research infrastructure – experience and facilities

IIT Bombay has placed considerable emphasis on Research and Developmental work as key component of its activities in pursuit of excellence. The institute plays a very significant role in diverse facets of R&D - in keeping with the rapidly expanding frontiers of knowledge, national needs & global developments. Research activities at IIT-Bombay range from sponsored research, to consultancy, technology development and technology transfer.

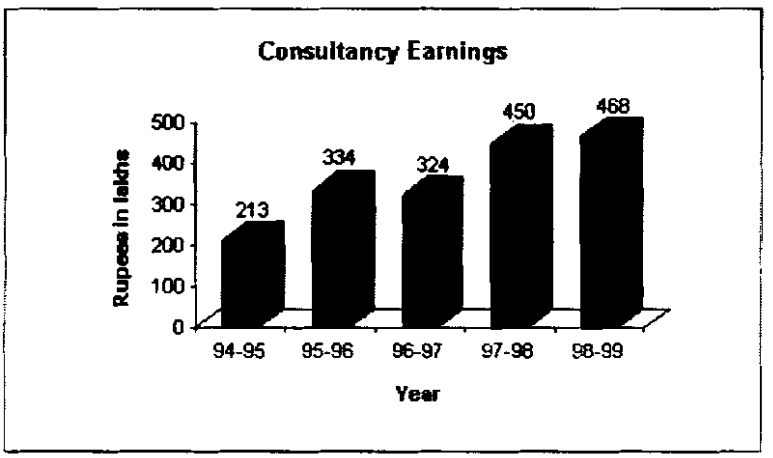
Sponsored Research and Development Projects

These are R&D projects funded by scientific/user agencies or industries with emphasis on developing a better understanding of a problem. These are usually of 2-5 years duration with substantial funding and generally lead to development of new knowledge and insight and result in publications.



Contract Research / Consultancy Projects

These are generally of shorter duration varying from a few weeks to 1 or 2 years with very clear cut deliverables and are aimed at solving specific problems of interest to user agencies / industries. Faculty or scientists may also be retained by industry in an advisory capacity. To a very limited extent testing work is also carried out for Government agencies or where it is of specialized nature.



Technology Development Mission Projects

This is a special category of sponsored projects which was initiated about 4 years ago. These are funded to the extent of 75-80% by The Government of India, the balance

funding coming from one or more industry partners. These projects have the clearly defined aim of developing a product/process/software or other technology which can be transferred to the industry partners on completion of the projects. The first set of TDM projects has been just completed successfully and the next set of TDM projects is under initiation.

Sponsorship of Student Projects

Another important mode of interaction between IIT Bombay and industry and other user agencies, is through sponsorship of projects of M.Tech. and Ph.D. students. While the students benefit from the experience of working on live projects of interest to industry, the industry benefits from the involvement of bright young minds in solving challenging and relevant problems. In recent times such sponsorships have been rapidly increasing.

Externally Funded Research Centres/Laboratories/Facilities

Recently there has been a trend of user agencies/industries establishing research centres / laboratories or highly specialized research facilities at IIT Bombay to take advantage of the involvement of faculty and students of the institute in undertaking high level research at international level. Examples are Centre for Aerospace Systems Design Engineering, Centre for Formal Design & Verification of Software, Structural Integrity Testing & Assessment Centre, Tata Infotech Laboratory, Intel laboratories etc.

Technology Transfers

The R&D work of faculty / scientists and students of the Institute have resulted in the development of a number of new technologies. This has resulted in a number of patents being filed and processes/products/designs/software developed being transferred to industry and other user agencies.

Facilities

IIT-Bombay has a range of facilities useful for research in the climate change area. These include laboratories as well as computing infrastructure.

Research in the area of climate change, greenhouse gases and energy systems

A number of faculty members from across different departments and units in the Institute work in areas related to climate change and energy systems. The primary departments involved are:

- School of Management
- Energy Systems Engineering
- Center for Environmental Science and Engineering (CESE)

Key personnel

Anand Patwardhan, School of Management
(CV attached)

Chandra Venkatraman, CESE
Research interests: Particulate matter and health; Regional atmosphere and climate; Urban aerosol chemistry, fate and source apportionment; Low-temperature biomass combustion

Sponsored projects:

National Science Foundation, USA, through the INDOEX-USA grant	Aerosols and Climate: PM-2.5 and chemical constituents from combustion of biomass fuels in the Indian subcontinent (Collaborator: Prof. G.R. Cass, Georgia Institute of Technology, USA)	Rs. 5.3 Lakh	2000-2003
Centre for Indoor Air Research, USA	Emission Factors of Respirable Aerosols and PAHs from Biofuel Burning Stoves	Rs. 48 Lakh ($130,400)	1997-2000
Department of Science and Technology, Government of India	Development of a standard method for measurement of polycyclic aromatic hydrocarbons (PAH) in emissions from biofuel stoves	Rs. 2.98 Lakh	1997-1999

R S Patil, CESE
Research interests: Modeling urban and regional scale air pollution in India

Rangan Banerjee, Energy systems engineering
Research interests: Energy Auditing and Management, Modelling of Energy Systems, Energy Planning and Policy

Anuradha Ganesh, Energy systems engineering
Research interests: Biomass Utilisation for Energy and Chemicals, Waste to Energy Technologies

Research topics

IIT-Bombay would be in a position to assume a lead role, individually, or in collaboration with another institution, in two of the research areas under CLIN 4:

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1. Analysis of vulnerability of India to global climate change and impacts on economic development
2. Assessment of potential carbon-neutral or low-carbon power sector growth in India. The research would include a combination of technology and policy studies.

प्रबंधन विद्यालय
भारतीय प्रौद्योगिकी संस्थान मुंबई
पवई, मुंबई-400 076, भारत

School of Management
Indian Institute of Technology Bombay
Powai, Mumbai-400 076, India

Direct : (+91-22) 576 7761
EPABX : (+91-22) 576 2545, Extn. : 7761
Fax : (+91-22) 578 3480

IIT Bombay

July 26, 2000

To:

Mr. Michael Gaffen
Chief of Party (GEP-CCS project)
The Louis Berger Group Inc.
C-6/7, Safdarjung Development Area
New Delhi – 110 016

Fax: 011 – 651 8807

Dear Sir:

Subject: GEP-CCS Project – CLIN 04; Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above subject. We are glad to confirm our in principle acceptance to host a forum for research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing technical papers would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

Thanking you,

Yours faithfully,

Prof. Anand Patwardhan

INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH (IGIDR)

Indira Gandhi Institute of Development & Research (IGIDR), an advanced research institute in Mumbai, was established by Reserve Bank of India in the year 1987. The institute is engaged in the study of national and global issues relating to economic development to promote and conduct research, to teach and train and to promote national and international collaboration.

The Institute frequently hosts national and international conferences.

The Institute is a deemed university and conducts M. Phil/ Ph. D. programs in development policy. It is designed to create professionals who are capable of conducting policy analysis, relating to national and global development issues, in a quantitative and inter-disciplinary manner. The Institute has at present some 37 faculty members and 50 M. Phil/ Ph. D. students.

The institute is located on a 14 acre site on a hill side 20 minutes drive from Mumbai's national and international airports.

The primary objectives of the institute are:

- To promote and conduct research on development form a broad inter-disciplinary perspective.
- To serve as a center for promoting cooperative endeavor and interaction between research scholars and institutions in India and abroad.
- To undertake any other project or activity which may be usefully carried out by the institute for the furtherance of development and social welfare.
- To carry out training for advanced degrees viz. Masters and Doctorate award.

ORGANIZATIONAL STRUCTURE

The institute's day-to-day activities are managed by the Director under the overall guidance of the Board of Management.

The present composition of Board of Management is as follows:

S.No.	Name	Designation
1	Dr. Bimal Jalan Governer Reserve Bank of India, Mumbai	Chairman
2	Dr. Kirit S. Parikh Director IGIDR, Mumbai	Member
3	Dr. Suhas Sukhatme Director Indian Institute of Technology, Mumbai	Member
4	Dr. Mrinal Datta Chaudhuri Delhi School of Economics, New Delhi	Member
5	Prof. Amaresh Bagchi National Institute of Public Finance and Policy, New Delhi	Member
6	Dr. Raghbendra Jha Professor IGIDR, Mumbai	Member
7	Dr. K. V. Ramaswamy Assistant Professor IGIDR, Mumbai	Member
8	Dr. Y. V. Reddy Dy. Governer Reserve Bank of India, Mumbai	Member
9	Dr. I. G. Patel Former Governer Reserve Bank of India, Vadodara	Member
10	Dr. L. K. Deshpande Economic Consultant, Mumbai	Member
11	Mr. T. V. Subramaniam Registrar IGIDR, Mumbai	Secretary

The core staff is involved in teaching and completing research projects. The other staff also gets involved from time to time according to their interests in the research projects given by external agencies. The list of faculty members and project staff involved, is as given below:

Core Staff:

Parikh Kirit S.	**Founder Director**
Member	Advisory Committee on Global Environmental Issues
Lead author	IPCC II & III Assessment Reports
Parikh Jyoti K.	**Senior Professor**
Member	Scientific and Technical Advisory Panel for UNEP for GEF
Member	AIJ Committee of Ministry of Environment and Forests, Govt. of India, New Delhi
Convening lead author	IPCC II Assessment Report
Reviewing Editor	IPCC III Assessment Report
Painuly J.P.	**Associate Professor**
Member, Currently at UNEP RISO, Denmark	STAP roster
Reddy B. Sudhakara	Associate Professor
Sharma V. K.	Associate Professor
Ramanathan R.	Associate Professor

Other Contributing Staff:

Panda Manoj	Associate Professor
Babu P. G.	Assistant Professor

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EXPERIENCE (GENERAL)

Current research activities cover the following areas:

a) Macroeconomic, trade, monetary and fiscal policies.

b) Poverty, employment and redistribution.

c) Energy systems.

d) Technology assessment.

e) Environment and sustainable development.

f) Agricultural and rural development.

g) Comparative studies.

h) Industrial structure, conduct and performance.

The following are the broad areas of research at IGIDR.

- Economic Reforms and Macroeconomic Policies
- Public Economics
- International Trade and Exchange Rates
- Industrial Organization, Industrial Economics
- Game Theory
- Financial Sector, Banking
- Agricultural Economics, Food Policy
- Poverty, Safety Nets, PDS, Rural Development
- Labor Economics
- Economic History
- Energy and Infrastructure
- Environmental Studies, Climate Change Issues

The institute has conducted research studies for the economic advisory council to the Prime Minister, Planning Commission, Department of Energy, Ministry of Environment and Forests, UNCED, UNPD, UNCTAD, ESCAP, The Asian Development Bank and The World Bank.

IGIDR at a Glance as of 1998-99

Established in	1987
Affiliated with Mumbai University	1990
Granted Deemed University status by the Govt. of India	1995
Faculty staff strength	37
Current number of students including part-time	58
No. of research publications (1986 to March 1999)	30
Books	350
Reprints (journals and chapter in books)	161
Discussion papers	39
Project reports	47

The following is a list of selected projects executed at IGIDR. These projects have been sponsored by various national and international agencies such as UNDP, UNEP, World Bank, CIDA and so on. The areas covered by these projects include, among others, energy, environment, trade, finance, agriculture, food security and industry studies.

1. Environmentally Sound Energy Development Strategies (Phase - I) for India
2. Environmentally Sound Energy Development Strategies (Phase - II) for India
3. Structural Transformation Process Towards Sustainable Development
4. Demand Side Management in the Electricity Sector
5. A Natural Resource Accounting Framework for NTGCF: A Tool for Sustainable Development
6. Economic Instrument for Climate Change
7. Waste Paper Trade and Recycling: A Case Study of India
8. Environmental and Natural Resource Accounting for India
9. IPCC WG-III SAR Decision Making Framework
10. Models for Sustainable Development
11. Trade and Environment Linkage: A Case Study of India
12. Metropolitan Environment Improvement Program
13. Contingent Valuation of Borivili National Park
14. Financial Sector Reforms in India
15. Policies for Industrial Competitiveness: What India Can Learn from the East Asian Countries
16. The Process of Financial Liberalization in Developing Countries
17. Opportunities and Challenges in Indian Tobacco
18. Food Security and Public Distribution System
19. Training Program under Institutional Development Component of the World Bank Projects
20. Development of Climate Change Impact Model for India

FACILITIES AVAILABLE

Library and Information Services

The library has over 40,000 printed documents and it subscribes to over 470 national and international journals. It has established contacts with over 100 national and international organizations for exchange of the Institute's publications and inter-library loan arrangement. Library homepage provides links to various websites, which are of importance to economists. All bibliographic details of books, journals and CD-ROM databases are accessible through the campus-wide Ethernet network.

Computing Facilities

The IGIDR computing infrastructure consists of the hardware infrastructure (including the various operating systems), the software and various databases. In addition, there is a help desk facility and ongoing maintenance and support activity.

Databases and Books

IGIDR maintains several databases that contain national and international economic data. Some of the bigger databases are Prowess and India Trades (produced by CMIE), Advanced Stock Analysis (ASA), Capitaline OLE from Capital Markets, STARS (world Bank), International Financial Statistics, Economic Literature (Econlit), Social Science Citation Index (SCSI), FAO Statistics, World Energy database, and INTELEC.

The Computer Centre also conducts various training and orientation seminars/ lectures on several computer-relatyed topics and software packages including E-mail, Win95, CIMM, Capatiline Ole, Internet technologies, and Netscape, to enhance and upgrade the computer skills of the user community of IGIDR.

Amenities

The campus includes office buildings for research and administrative staff, seminar rooms of different sizes, a 500-seat auditorium, library, computer center and a cafeteria. Housing for the staff is provided on the campus. A guest house/ hostel building provides furnished rooms for students and visiting scholars.

KEY PERSONNEL

Faculty and the areas of interest:

Faculty	Areas of Interest
Parikh Kirit S., Director	Development policy, policies and planning models, technology policy, environmental policy and agricultural policy.
Parikh Jyoti K., Senior Professor	Energy systems, energy modeling, science and technology, power systems policy and modeling, climate change, sustainable development, environmental econoixa.
Dev Mehendra, Professor	Agricultural economics, farm and non-farm employment, safety nets for the poor.
Jha Raghbendra, Professor	Macroeconomics, public economics, applied econometrics, economics of development
Jha Shikha, Professor	Public economics, agricultural economics and development economics.
Sen Anindya, Professor	Theory of the firm, industrial organization, regulation, law and economics
Suryanarayana M.H., Professor	Consumer demand analysis and development economics.

RESEARCH WORK IN CLIMATE CHANGE

Indira Gandhi Institute of Development Research (IGIDR) is a core institute with specific responsibility for a subcommittee on environmental research economics where priority areas for research support in environmental economics are identified and such research projects are funded.

In addition to climate change studies, IGIDR is also involved in wide ranging activities that include research, teaching and training, surveys, consensus building efforts and so on, by analyzing policies and discussing it with various stakeholders.

IGIDR's research activities include:

- Faculty involvement in committees and panels.
- Project studies.
- Ph. D. theses.
- Conference participation.
- Research publications and popular articles.

The studies and activities aim to answer questions like:

- What are the issues in global environmental negotiations and how can they be co-operatively addressed?
- What are India's likely emission scenarios under various policies?
- Which sectors will be affected and which sectors can take up mitigating role?

In relation to these issues the following analysis, in three major areas, is conducted.

- **Analysis of North-South issues:** consumption patterns, IPCC response strategies, GEF-incremental costs and paradigm of partnership, Joint implementation, Analysis of economic instruments to reduce GHG emissions.
- **Top down modeling or national issues for India:** climate change and India's energy policy options: carbon flows in the Indian economy, energy

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forecasting with macro-economic modeling for investments and imports, consumption patterns in India by rural and urban income groups and associated carbon emissions, trade and environment.

- **Bottom up modeling or sectoral issues for India:** Carbon dioxide emissions by power systems in India, demand side management and auxiliary and transmission losses, Carbon dioxide emissions in building construction through common practices as well as low cost constructions, transport sector, solid waste management and carbon sequestration are some of the ongoing themes.

All these areas together cover emission scenarios, mitigation measures, analysis of economic instruments and impact analysis, altogether providing in-depth studied for *integrated analysis*. The research agenda of the Institute is guided by policy concerns, by individual faculty members' research interests and by projects from national and international sponsors. The output of such research is disseminated as IGIDR publications in the form of discussion papers, project reports, books, monographs and reprints of journal articles.

Issues in Climate Change

Negotiations prior to Earth Summit regarding greenhouse gas (GHG) reduction and follow-up activities throw up a number of issues, which require considerable analytical skills and studies. COP-3, the Third Conference of the Parties to the FCCC (Framework Convention on Climate Change), was held in Kyoto in December 1997. Although much was expected of the conference, developing countries like India have not been able to arrive at a consensus regarding emission abatement responsibilities.

IGIDR studies show that multi-disciplinary research pertaining to energy and environmental problems, that addresses policy issues, is very much needed in the present context in India. It is hoped that these studies will vastly aid the Indian energy and environmental sectors in their strategic planning and policy formulation. The studies aim at answering questions like: what are the driving forces behind global environmental problems such as climate change? What should be our negotiating position in international fora?

IGIDR has interacted at various fora and with various organizations such as United Nations Conference on Environment and Development (UNCED), Ministry of Environment and Forests, United Nations Development Programme (UNDP), Intergovernmental Panel on Climate Change (IPCC), Global Environment Facility (GEF), and Intergovernmental Negotiations Committee (INC). In addition, IGIDR Interacts with academics and policy makers through research papers, popular articles, editorials and media events.

INTERNATIONAL SUPPORT

With the understanding obtained from research, IGIDR has actively participated in national and international policy dialogues. Thus IGIDR has interacted at various for a and with various organizations listed below:

Title of the Project	Funding Agency
Sustainable Development:	
Consumption Pattern by Income Groups and Environment Implications for India	United National Development Programme (UNDP), New York
Consumption Patterns: Driving forces of Environmental Stress	United Nations Conference on Environment and Development (UNCED), Geneva
Structural Transformation Process Towards Sustainable Development	Swiss Development Corporation
Models of Sustainable Development	ESCAP, Bangkok
Sustainable Development, Global Commons and India's Policy Options	Rockefeller Foundation
Climate Change:	
IPCC WG-III SAR Decision Making Framework	Intergovernmental Panel on Climate Change (IPCC), Second Assessment
Thematic Issues for Climate Change for Global Environment Facility (GEF)	IVM, Amsterdam
Limiting Carbon Dioxide Emissions Through Economic Instruments: Application to India and Canada	Canadian International Development Agency, Ottawa, Canada
Development of Climate Change Impact Model for India	NIES, Japan
Environmentally Sound Energy Development Strategies (Phase –II) for India	UNEP, RISO, Denmark
Environmentally Sound Energy Development Strategies (Phase –I) for India	UNEP, RISO, Denmark
GHG mitigation from transport sector	AIT/ SIDA, Bangkok

.ndira Gandhi Institute of Development Research

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DR. KIRIT S. PARIKH
Director

July 25, 2000

The Louis Berger Group Inc.
C-6/7, Safdarjung Development Area
New Delhi 110 016

Dear Sirs:

Subject: GEP-CCS Project - CLIN 04; Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above subject. We are glad to confirm in principle our acceptance to host a forum for research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing technical papers would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

With regards,

Yours faithfully,

Kirit Parikh

Annual Report
1998-99

Indira Gandhi Institute of Development Research
(A Deemed University)

An Advanced Research Institute
Established by
Reserve Bank of India

BEST AVAILABLE COPY

Annual Report
1998-99

Indira Gandhi Institute of Development Research
(A Deemed University)

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Information provided to the Louis Berger Group Inc.

by the National Institute of Advanced Studies

to be established as a Forum Institution

ABOUT THE INSTITUTE

The National Institute of Advanced Studies (NIAS) was conceived and established by the vision and initiative of the late Mr. J. R. D. Tata. He sought to create an institution which would conduct advanced research in multidisciplinary areas, and also serve as a forum that would bring together administrators and managers from industry and government, leaders in public affairs, eminent individuals in different walks of life, and the academic community in the natural and social sciences.

The objective of the Institute has been to nurture a broad base of scholars, managers and leaders who may contribute effectively to tackling the complex problems facing contemporary India with intelligence, sensitivity, confidence and dedication.

The philosophy underlying NIAS is given shape by its research teams, which are drawn from a variety of disciplines in the natural and social sciences. The Institute is unique in its integrated approach to the study of intersections between science and technology, social issues and leadership.

NIAS is a (private) society registered on 20 June 1988 under the Karnataka Societies Registration Regulation Act. It is located on the campus of the Indian Institute of Science, Bangalore and was established in 1988 with Dr. Raja Ramanna as Director until his retirement in July 1997. Professor Roddam Narasimha is the current Director. The Institute is an autonomous organization governed by a Council of Management.

ORGANIZATIONAL STRUCTURE

The National Institute of Advanced Studies is an autonomous organization with three authorities for the overall administration of the Institute. These are the Council of Management, the Academic Council and the Holding Trustees.

The Council of Management:

The Council has full powers and authority on overall management according to the Rules and Regulations of the Institute. The first Chairman of the Council was the late Shri J. R. D. Tata. The present composition is as follows:

Dr. J. J. Bhabha (Chairman)
Vice-Chairman and Managing Trustee,
Sir Dorabji Tata Trust
Mumbai

Dr. Raja Ramanna (Vice-Chairman)
Senior Homi Bhabha Fellow
National Institute of Advanced Studies
Bangalore

Mr. Ratan N Tata
Chairman, Sir Dorabji Tata Trust
Mumbai

Prof. Roddam Narasimha
Director
National Institute of Advanced Studies
Bangalore

Prof.V. S. Ramamurthy
Secretary, Department of Science and Technology
Government of India
New Delhi

Mr. Subhash Chandra Kuntia
Secretary, Finance
Government of Karnataka
Bangalore

Prof. C. N. R. Rao
President, Jawaharlal Nehru Centre for Advanced Scientific Research,
Bangalore

Mr. **R M Lala**
Director, Sir Dorabji Tata Trust
Mumbai

Mr. Arvind Varma
Secretary, Ministry of Personnel, Public Grievances & Pensions,
Government of India
New Delhi

Smt. Vatsala Watsa
Principal Secretary,
Education Department,
Government of Karnataka
Bangalore

Prof. G. Mehta
Director
Indian Institute of Science
Bangalore

Mr. Xerxes Desai
Vice-Chairman & Managing Director
Titan Industries Ltd.
Bangalore

Maj. Gen. M K Paul VSM[Retd] (Secretary)
Controller
National Institute of Advanced Studies
Bangalore

The Academic Council:

The Academic Council oversees the academic programmes of the Institute and advises the Council on academic matters. The present composition of the council is as follows:

1. **Prof. R. Narasimha**, Director, NIAS, - Chairman
2. **Prof. O. Siddiqi**, TIFR, NCBS
3. **Dr D.M. Nanjundappa**, Bangalore
4. **Prof. N. Balakrishnan**, Chairman, SERC, IISc
5. **Mr. T. R. Satish Chandran**, Bangalore
6. **Prof A. Madhavan**, Mysore
7. **Prof B. V. Sreekantan**, NIAS
8. **Prof. S. Rajagopal**, NIAS

9. **Prof. Dilip Ahuja**, NIAS
10. **Maj. Gen. M.K. Paul (Retd)** - Secretary

The Holding Trustees

The Holding Trustees include the Chairman of the Council of the Institute, a nominee of the Government of Karnataka, nominees of the Sir Dorbaji Tata Trust, Mumbai, the Director of the Institute and the Director of the Indian Institute of Science. The Trustees review periodically the overall functioning of the Institute.

GENERAL EXPERIENCE

Research Programmes:

The multidisciplinary research at the interface between natural sciences and technology on the one hand, and social science and humanities on the other, is being carried out in seven core units.

1. Environmental Studies
2. Epigraphy
3. Gender Studies
4. International and Strategic Studies
5. Philosphy of Science
6. Sociology and Social Anthropology
7. Science and Technology Policy Studies

Please see the attached Institute brochure for a brief description of the research programmes.

Courses:

The Institute also conducts several residential courses for senior executives of government and industry, university and college teachers, Indian Foreign Service probationers, the Indian Administrative Service and the Indian Space Research Organization. Although focused on specific themes, these courses are distinguished by their interdisciplinary character and are taught by Institute Faculty and by reputed Guest Lecturers from across the country.

Conferences and Seminars:

NIAS has an active programme of public lectures, conferences, seminars and workshops organized independently or jointly with other organizations. A wide spectrum of events is held ranging from major international meetings to informal discussion groups. NIAS has

emerged as a key public policy forum in India contributing to informed national debate, and providing advice on critical national issues.

Associates' Programmes:

NIAS maintains a strong outreach with its Associates' Programmes. NIAS **Associates** include distinguished persons from widely different backgrounds in the industry, government, media, the arts, and academia. Associates join the faculty at a monthly meeting, which always includes a lecture or some other important event. The Associates constitute a strong base of ongoing outside support and interaction.

Visiting Scholars:

NIAS has openings for a limited number of visiting professors who interact with the permanent faculty in planning and executing new or ongoing research programmes. There is also a programme to encourage researchers, from both India and abroad to come and work as visiting fellows/associates on specific research projects within the framework of the programmes of the Institute. Visitors generally have to secure support for their projects, but have a chance to work closely with the permanent faculty.

Doctoral Programme:

In collaboration with the Manipal Academy of Higher Education, Manipal, NIAS runs a programme that awards doctoral degrees to students interested in pursuing independent research towards a doctoral degree in the areas of specialization at NIAS.

FACILITIES

NIAS is situated on 5 acres of land within the campus of the Indian Institute of Science. The main building of NIAS has a strikingly distinctive architecture, pleasant with elegant lines, a bright-red tile facade and an arched corridor running the full length of the building. The building has spacious and cheerfully furnished rooms.

J. R. D. Tata Auditorium

The architecture of the auditorium blends harmoniously with the main building. It has a capacity of 350, but with its excellent acoustics, flexible seating arrangement, and long foyer, it is a distinguished venue as much for an international symposium as for a round table discussion, a performing arts event or an exhibition of paintings and sculptures.

Lecture Hall

The main building of NIAS has a lecture hall with a seating capacity of 100.

Accommodation for Participants:

The Institute has 30 fully equipped residential rooms along with a dining hall and lounge, capable of accommodating 60 people at a time.

Library

The library emphasizes acquisitions in support of the Institute's research units. It has a small but carefully selected collection of current literature on sociology, psychology, history, philosophy and reviews in modern science. The present collection includes over 3500 books and 40 journal subscriptions. In addition the library has audio recordings of all lectures given at the Institute.

RESEARCH WORK DONE

In areas pertinent to climate change, greenhouse gases, global warming and energy efficiency, research is being carried out in three different units of the Institute. These are the Environmental Studies, International and Strategic Studies and the Science and Technology Policy Studies Units.

Environmental Studies Unit

The Unit is involved in pursuing various issues related to ecology and environment, particularly in agriculture, and has recently carried out studies of the ecological crisis in Bidar district of Karnataka, and the restoration of Bangalore lakes. Ongoing Projects include Bioremediation of soils and effluents contaminated with pesticides and the Creation of a database on use and misuse of pesticides in India

International and Strategic Studies Unit

Major research activities include a study of global perspectives on cooperation in technology transfer; a comprehensive analysis of the technical and political aspects of selected treaties and agreements; a study on gender and security; and issues related to energy security. The Unit has arranged rewarding dialogues on security issues with the Committee on International Security and Arms Control of the U. S. National Academy of Sciences. One of the ongoing Projects deals with the Assessment of Electric Power Technologies. This is an Indo-US collaboration, funded in part by Carnegie Mellon University. The aim is to assess and recommend different technology options for India.

Science and Technology Policy Studies Unit

This new unit, created in January 2000, will initially focus on policies for the promotion of renewable energy, sustainable transport and the reform of the electricity sector. It will also study technology transfer and policy instruments for responding to global climate change and possible trade-offs with other policies undertaken to address more local concerns. The Unit is conducting a study of subsidies for renewable energy.

INTERNATIONAL SUPPORT

The following table shows the grants received from International organizations for the conduct of various research programmes at the Institute.

Sponsoring Organization	Amounts in Rupees (Lakhs)
Ford Foundation	82.65
Rockefeller Foundation	69.92
Boston University	16.21
Carnegie-Mellon University	10.30
Wenner Gren Foundation	06.34
Spencer Foundation	14.92
Total International Support	**200.34**

KEY PERSONNEL AND THEIR CVs

The following is a list of the core group of Professors from NIAS and Indian Institute of Science who will be involved with the project.

1. Professor Dilip Ahuja, Principal Investigator, CV is attached.
2. Professor S. Rajagopal, NIAS
3. Professor Arcot Ramachandran, NIAS
4. Professor D. P. Sen Gupta, NIAS
5. Professor H. S. Mukunda, IISc.

Brief CVs of other NIAS Professors, who will be involved in the project, are given in the attached brochure. We will draw upon, as required, other Professors at I.I.T Madras, and the Indian Institute of Management, and the Central Power Research Institute, both at Bangalore.

METHODOLOGY ADOPTED FOR CONDUCTING RESEARCH

Starting with a survey of the work already done in the country by, *inter alia*, the Planning Commission, the Ministry of Non-conventional Energy Sources and the Tata Energy Research Institute, the core group will assess the existing energy policies in the country and develop an "implementable" energy policy for India. The group will examine a mix of options that promote efficient generation, transmission and use of energy, use of decentralized energy options including renewable energy sources and sources that are either carbon-neutral or carbon sequestering. The focus will be on those technologies where India has a natural advantage (e.g., solar, biomass) and those that are unlikely to be developed elsewhere (e.g., biogas, and efficient biomass stoves). Policies for increased R & D in the country will also be assessed and recommendations made where increased government support and public-private partnerships are needed. International and

multilateral sources of support for the implementation of the suggested policies will be identified.

Naturally expertise in all relevant areas to energy technologies and policy making does not exist in NIAS or in I. I. Sc. We will collaborate with other institutions in Bangalore such as I.I.M and C.P.R.I. and to neighboring I.I.T. in Chennai. As the list of NIAS publications below indicates we already have good working relationships with these institutions.

PROPOSED RESEARCH TOPIC ON WHICH THE INSTITUTION WOULD TAKE A LEAD ROLE

Assessment of potential carbon neutral power sector growth for India through a combined strategy including the development of carbon sinks, renewable energy and highly efficient fossil fuel conversion technologies.

CONFIRMATION LETTER

Attached.

RECENT PRINTED PUBLICATIONS / BROCHURE

The following documents are attached.

1. National Institute of Advanced Studies, Bangalore, India information brochure.
2. H. S. Mukunda: "A Biomass Option for Enhancing Energy Security", NIAS Report R5 - 99, Bangalore, 1999.
3. Kolar, Ajit Kumar and V. M. K. Sastri: "Advanced Coal Technologies for Power Generation in India", NIAS Report R8 - 99, Bangalore, 1999.
4. D. P. Sengupta: "Distribution of Electric Power", NIAS Report R9 - 99, Bangalore, 1999.
5. S. Parameswaran: "Status of Electric Power Transmission in India and Possible Technological Developments", NIAS Report R1 - 2000, Bangalore, 2000.
6. J.-J. Saloman: "Recent Trends in Science & Technology Policy, NIAS Lecture L1 - 2000, Bangalore, 2000.

TATA ENERGY RESEARCH INSTITUTE (TERI)

1. About the Institute

TERI is an autonomous, non-profit research institute established in 1974. It is deeply committed to every aspect of sustainable development, and conducts scientific and policy research in diverse fields such as energy, environment, biotechnology, and forestry. Project activities in TERI focus on formulating local- and national-level strategies to suggesting global solutions for critical energy- and environment-related issues. These range from providing environment-friendly solutions to rural energy problems to tackling global climate change issues across many continents; from combating urban transport and air pollution problems to enhancing forest conservation efforts among local communities. The emphasis is always on finding an innovative approach to make the world a better place to live in.

TERI analyses policies relating to energy, environment and the sustainability of natural resources, and addresses issues such as the links between energy and environment, the mitigation of adverse impacts on the environment, and the economic and social implications of global environmental concerns. Its research activities are based on the firm belief that efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development towards the goal of sustainability.

With a staff strength of around 500, drawn from multidisciplinary and highly specialized fields, and offices and regional centres equipped with state-of-the-art facilities, TERI celebrated its silver jubilee in 1999/2000. As the Institute has grown in size and reach, so have its activities grown and diversified. TERI is now the largest developing country institution working to move human society towards a sustainable future.

2. Organization Structure

TERI's head office is in New Delhi, in addition to which it has three regional centers in India at Bangalore, Goa and Guwahati. On the international front, TERI has an affiliate institute in Washington DC, USA – TERI-NA (Tata Energy and Resources Institute-North America); and office in London, UK, called TERI-Europe; and overseas representation in Germany, Russia, and Japan.

It has five main divisions:

- Policy Analysis
- Regulatory Studies and Governance
- Energy-Environment Technology
- Bioresources and Biotechnology
- Information Technology and Services

3. Experience (general)

TERI's activities can be broadly classified into the five major areas of Policy Analysis, Energy Technology, Renewable Resources Management, Biotechnology and Information Services. TERI staff are drawn from backgrounds as diverse as energy economics, biotechnology, chemical engineering, and econometrics, and conduct a wide-range of cutting-edge research activities.

Some of the specific issues which the Policy Analysis Division addresses include analysis of the current state and policies relating to energy, environment and the sustainability of natural resources, the links between energy and environment and the mitigation of adverse impacts on the environment, the economic and social issues pertaining to global environmental concerns especially climate change issues, and research in the power, hydrocarbon and coal sectors.

TERI has a dedicated centre for research on climate change issues, called **Centre for Global Environment Research (CGER)**, which was set up in 1989. Its mission is to undertake research and outline effective policy initiatives that integrate developing country concerns in the search for effective and equitable solutions to global environmental challenges. CGER participates actively in various debates and discussion forums around the world. It not only tracks and analyses issues emerging from the climate change negotiations, but also plays a proactive role by raising key concerns and providing balanced, meaningful solutions. In addition to providing professional and analytical support to the Ministry of Environment and Forests, Government of India in preparing the Indian negotiating position, it currently provides technical support to the Governments of Bhutan, Lao PDR and DPR Korea in the preparation of their national communications. CGER members also contribute to the Intergovernmental Panel on Climate Change (IPCC) process by providing inputs to the IPCC Special Reports on Sinks, Technology Transfer, and Working Groups II and III of the Third Assessment Report.

The **Resource and Development Economics** centre studies policies and strategies for the sustainable, equitable and efficient use of natural resources. This is done through the application of integrated environmental, social and economic analysis, and through the design of appropriate and effective policy instruments and strategies. Research is focussed in the areas of environmental accounting, green budgeting, modeling, economic and financial analyses, and the analyses of governance and institutional issues. Other activities include state-of-the-environment reporting and capacity building, environmental impact assessments, and demography-environment interactions.

The **Centre for Environmental Studies** conducts applied action and policy research to address environmental problems. Projects undertaken examine the environmental impacts associated with the various stages of the fuel life cycle, analysis of the impacts of air, water and land pollution, stress on biomass resources, and related socio-economic issues.

The **Biodiversity group** is actively involved in studying the impact of natural and anthropogenic activities on natural ecosystems and biodiversity, and addresses scientific and policy related issues in the sustainable utilization and conservation of biodiversity. The **Forestry group** is involved in R&D activities related to the technical and socio-economic aspects of forestry. Its activities include information dissemination, community organization, capacity building. Forestry-related issues pursued include global warming, carbon dioxide emissions abatement, environmental education and mining area reclamation.

The **Urban and Transport Systems** area undertakes environment-friendly, energy-efficient policies and targeting urban and transport areas. It establishes effective partnerships with relevant stakeholders and major support agencies to provide training, capacity building, information and best practices. The area identifies, analyses and offers solutions for context-specific critical issues in urban and transport sustainability. Major research areas include, transport and traffic, application of GIS in planning and capacity building of municipal bodies and local agencies.

The **Modeling and Economic Analysis** area undertakes integrated analysis of policies and crucial issues relating to energy-economy–environment interface in pursuit of sustainable economic development. This is done mainly through use of quantitative modelling of linkages amongst sectors, statistical analysis of energy, environment and related data and use of Geographic Information System (GIS).

Renewable Energy Technology Applications Area seeks solutions to the immense problems that arise consequent to the rapid depletion of natural resource and the serious environmental hazards that result from their use. The basic thrust is to seek solutions to the energy-related issues that are sustainable and environmentally benign. Since its inception, it has been carrying out applied research with the aim of providing clean and cost-effective solutions to energy needs of diverse user-groups, encompassing industrial and commercial sectors on one hand and rural sector on the other. Its basic strength lies in its competence of tackling challenging problems and its flexibility borne out of variety of skills and experience. RETA offers a range of services in the following fields, such as, Solar Thermal Energy, Solar Photovoltaics Energy, Building Energy & Efficiency, Wind Energy, and Renewables based Hybrid Power Systems.

4. Facilities available

TERI has equipment and personnel trained in the use of Geographic Information System (GIS) and remote sensing techniques. GIS is being used at TERI for the analysis of variables with spatial and/or temporal dimension, and remote sensing data is used for the mapping of natural resources, assessment of resource degradation, and infrastructure development. A statistical analysis wing and state-of-the-art information technology systems provide energy-environment related data to energy planners, managers, and researchers both within and outside the Institute.

TERI's specialized Library and Documentation & Information Center also provide research support to energy-environment scientists and institutions worldwide. The TERI library has over 15000 books, reports, and conference proceedings in the fields of energy, environment, plant biotechnology, forestry and natural resources. It has around 600 current journal titles and over 8000 back volumes, and a large collection of literature such as government documents, reprints, press clippings, and annual reports. Apart from conventional services, TERI offers modern facilities like a CD-ROM collection of bibliographic and statistical resources and Internet connection for accessing worldwide scientific information and databases. Electronic information is gathered form online and offline sources and is organised to build the electronic virtual library collection. The Library and Information Centre in TERI acts as an Environmental Information System (ENVIS) Centre- one among 24 such centres sponsored by the Ministry of Environment and Forests, Government of India.

The Publications Unit in TERI functions both as a service unit and as a publisher. Publishing professionals at TERI include writers, editors, and computer professionals trained in the latest desktop publishing and graphic designing software, working with high-end computers, scanners and printers.

5. Research Work Done

Details of selected research projects undertaken by TERI are provided below.

A. CLIMATE CHANGE IMPACTS

Impact Assessment Study of Climate Change
This study funded by the Ford Foundation had three components, which were (1) an assessment of the impact of climate change on forestry and sea level rise in India, (2) five publications for non-specialist readers, and (3) a directory on global warming. For the forestry sector, a case study was conducted to examine the impacts of climate change on forests based on climatic scenarios generated for the region. The project also assessed the vulnerability of parts of the Indian coast to a one-metre sea level rise, and estimated the worth of economic activities carried out in these regions which would be affected in the event of such a rise in sea level. The component related to the development of a comprehensive global warming directory for India with information on sources and sinks, impacts and responses.

Greenhouse Effect and Its Impact on the SAARC Region
The study comprised the following: (1) analysis of sources and impacts of greenhouse gases, (2) legal framework for environmental protection and measures for enforcing its provisions, (3) strategies for reducing emissions, (4) monitoring requirements, and (5) organisations active in the SAARC (South Asian Association for Regional Co-operation) countries, namely Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka.

India Country Study on Global Environmental Issues

This country study sponsored by the Asian Development Bank, addresses the issues of
- socioeconomic impact assessment
- policy options to cope with climate change
- the national response strategy
- regional strategy recommendations

The Ministry of Environment and Forests, Government of India, which had coordinated this study, constituted an Expert Group for the same. TERI's scope of work included reporting on GHG inventories and a sectoral analysis of mitigation options in India.

B. GREENHOUSE GAS INVENTORY AND ABATEMENT

Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS): India component
This was a 12-country project funded by United Nations Development Programme (UNDP)/ Global Environment Facility (GEF) and executed by the Asian Development Bank (ADB). The objective of the ALGAS project was to strengthen the national capacity to:
- develop necessary and reliable information on greenhouse gas sources and sinks
- assess, analyse and verify the information and report the results to the Secretariat of the Framework Convention on Climate Change (FCCC)

- identify, formulate and evaluate viable GHG abatement strategies and Cost of Emission Reduction Initiatives (CERI) curves
- assist in securing the resources to implement the most cost-effective, i.e. least-cost, greenhouse gas abatement options

For India, TERI was responsible for examining the greenhouse gas abatement strategy, estimating the cost of abatement, developing the cost of emission reduction curves, identifying viable abatement options for implementation, and securing finances for identified projects.

Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS): Democratic People's Republic Of Korea Component

The objectives of the ALGAS Project for the Democratic People's Republic of Korea (DPRK) is identical to that described above. UN-Economic and Social Commission for Asia and the Pacific (UN-ESCAP) and UNDP commissioned TERI to assist the Government of DPRK in implementing the ALGAS project. Through this project TERI provides technical assistance and training to the government of DPRK to develop their inventory of GHG sources and sinks, to identify, formulate and evaluate viable abatement strategies, and to secure financial and other support to implement the most cost-effective abatement options.

Selected Options for Stabilizing Greenhouse Gas Emissions for Sustainable Development

This UNDP project aims to assist the Government of India in identifying and assessing specific investment projects and related institutional and policy options for stabilizing GHG emissions, and to strengthen institutional and technical capabilities in line with its developmental objectives. The main areas of focus in this project are power, coal, forestry, and renewables.

Greenhouse Gas Mitigation Study for Southern India and Implementation Project for Bangalore City

The major objectives of the project were (1) preparation of GHG emissions inventory and identify possible GHG mitigation options for Southern India (2) implementation/demonstration of projects for GHG mitigation for city of Bangalore which would also have local environmental benefits, particularly in the areas of transport and solid waste management.

Non-Energy Use Carbon Dioxide Emissions Project (NEUCO2)

So far most attention has been paid to carbon dioxide emissions from the combustion of fossil fuels. But a significant fraction of fossil fuels is used for non-energy applications, i.e. the consumption of fossil feedstocks for the manufacture of synthetic materials and chemical products. This project was undertaken with the following objectives:

- To establish an international network on non-energy use and material efficiency experts including seven EU members, United States, India and Russia
- To link up with the activities of international organisations, especially IPCC and ETC/AE (Corinair)
- To improve the methodology for estimations of carbon dioxide emissions from non-energy use.

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UNEP Greenhouse Gas Abatement Costing Study
This project supported by UNEP-Riso, aims at clarifying the economic issues involved in assessing the costs of limiting greenhouse gas emissions and proposing approaches to carry out comparable costing studies. Phase I of the project comprised a broad review of the subject and a methodological discussion. Phase II aimed at developing and testing a to methodological approach arrive at a least-cost strategy to limit carbon dioxide emissions in India.

Use of Economic Instruments in Carbon Dioxide Mitigation
Funded by UNEP (United Nations Environment Programme), the purpose of the project was to provide a developing country perspective to the range of policy options available for CO2 mitigation. The project examined economic instruments such as energy, emission, and carbon taxes (global and national) and tradable permits and evaluated the application potential based on results from macroeconomic modelling efforts. It also reviewed the current international initiatives (particularly in the European Community, strategy of the United States and Japan) and has summarised the developing country concerns on the issue. The study is to be published as a monograph of the Trade and Environment Series of UNEP.

C. CAPACITY BUILDING

Bhutan Greenhouse Gas Project

TERI was awarded the Institutional contract under the UNDP/GEF Bhutan Greenhouse Gas Project to provide technical training and to be ultimately responsible for ensuring the technical quality of all project outputs. A standard UNDP/GEF enabling activity project, the activities of this project are expected to lead to the national communication of the Royal Government of Bhutan to the Climate Change Secretariat. This communication is expected to contain an inventory of greenhouse gases following the Intergovernmental Panel on Climate Change (IPCC) methodology and an assessment of the vulnerability of Bhutan to climate change. Other components include examination of adaptation measures and possible costs of adaptation, and analysis of mitigation options along with their costs.

Lao PDR GHG Inventory Project

TERI was awarded the institutional contract under the UNDP/GEF Lao PDR greenhouse gas project to provide technical training and to be ultimately responsible for ensuring the technical quality of all project outputs. A standard UNDP/GEF enabling activity project, the activities of this project are expected to lead to the national communication of the government of Lao PDR to the climate change secretariat. TERI is providing technical support in the preparation of the communication and the focus is on an inventory of GHGs following the IPCC methodology, an assessment of the mitigation options and costs relevant in the context of Laos.

Enabling Activity for the Preparation of National Communications for DPR Korea

TERI was awarded the institutional contract to provide technical training and to be ultimately responsible for ensuring the technical quality of all project outputs. TERI is providing technical support in the preparation of the communication and the focus is expected to be on impact assessment and adaptation to climate change. In addition, this would capitalise on the work undertaken for the ALGAS-DPR Korea Project in the preparation of the national communications.

Global Trends and Statistics

The objective of this UNFCCC Secretariat funded project was to prepare a paper on global trends and statistics related to activity data, emissions factors and emission estimates. In addition, an assessment of the policies and measures that are being adopted in developing countries, which lead to greenhouse gas abatement.

Technical Support to Ministry of Environment and Forests, Government of India
The Centre provided professional and analytical support to the Ministry of Environment and Forests, Government of India for a period of three years leading up to the Framework Convention on Climate Change. The purpose of the technical support was to provide Indian negotiators at the Intergovernmental Negotiating Committee (INC) with analytical support to interpret the implications of different proposals. Support was also provided to the Indian negotiators to prepare country positions and statements. Activities to brief the Indian negotiators included a series of briefing workshops before the different sessions of the INC. Subsequently, TERI participates in the Working Group on Climate Change which requires the preparation of research papers on key issues at forthcoming negotiations.

D. ENVIRONMENTAL POLICY INSTRUMENTS

Green Budget
The Green Budget project aims at integrating fiscal policy and sustainable development by exploring how budgetary policy, as it affects energy issues in particular, can be changed so as to support energy efficiency, reduce the detrimental impact of energy use on local environmental problems, and reduce green house gas emissions. The project seeks to assess the socio-economic and environmental impacts of budgetary initiatives in various sectors of the economy- industry, energy, agriculture, forestry and bio diversity, residential and transport-in order to suggest viable "green budget" solutions for some of the impending environmental problems in the country.

DISHA (Directions, Innovations, and Strategies for Harnessing Action)
This study developed district-level scenarios for India for the years 2019 and 2047. It projected the state of India's environment and natural resources over the next 50 years. The study also identified key issues, hot spots and drivers, and suggested solutions through

- alternative technologies

- greater involvement of corporate sector
- improved governance
- economic instruments and policy.

E. OUTREACH

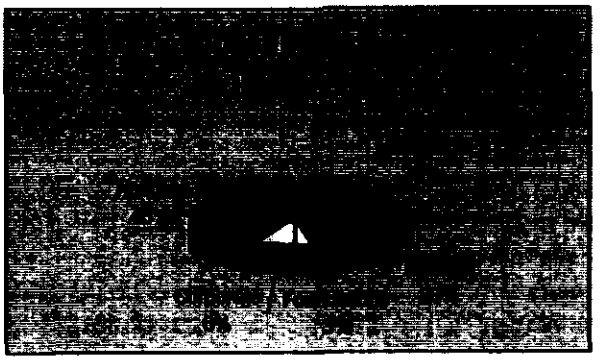
The Climate Change in Asia website hosted by TERI provides information on greenhouse gas inventory, mitigation, impacts of climate change, project initiatives and contact points for different Asian countries. This project is funded by the United States Department of Energy, and is currently being updated and extended.

In addition, CGER hosts the Secretariat of the Asian Energy Institute, a network of energy institutes from around the world, which aims to analyze the implications of global energy developments and facilitate the sharing and dissemination of knowledge. CGER also publishes a biannual abstracting journal titled Global Environment Review.

6. International Support

TERI receives project funding from

- Multilateral organizations (European Commission, Asian Development Bank, World Bank, United Nations organizations)
- Bilateral aid agencies (Swiss Agency for Development and Cooperation, Canadian International Development Agency, Swiss International Development Agency, Department for International Development)
- Foundations (Ford Foundation, MacArthur Foundation)
- Corporate organizations, both Indian and international
- National sources



7. Review Mechanism

To peer review the project output and ensure a level of quality and standard, both internal and external review mechanisms will be incorporated into the project implementation.

Review Experts

(i) TERI in-house experts (Senior Fellow)
(ii) National panel of experts working in relevant field within India
(iii) International expertise of US Partner Institute

Review Process

(i) The TERI in-house expert review committee will be involved in vetting and providing inputs at each stage of the project from conceptualization to the delivery of final outputs.
(ii) The Panel of National Experts will review project design and project outputs. The review process will involve presentations to the experts and review of project reports.
(iii) The output of each task will be reviewed (after the in-house review) by both national experts and international experts though the US partner institute before report finalization.
(iv) Workshops will be organised to get feedback on the project outputs from people working in research organisations, government, academia, and others.

Project Implementation Review

(i) A steering committee of TERI, Indian Partner Institutes and representatives from the Louis Berger Group will be constituted to review the implementation.
(ii) TERI and all Indian Partner Institutes to Steering Committee will submit quarterly reports.
(iii) The steering committee will meet every six months to review the progress of the project.

8. Proposed Research Topic

8A *"Analysis of vulnerability of India to global climate change and its impacts on the planned economic development"*

Project Team

Dr Sujata Gupta, Dean, Policy Analysis Division
Dr Ligia Noronha, Fellow, and Area Convener, Western Regional Centre, TERI
Dr Malathi Lakshmikumaran, Fellow, Bioresources and Biotechnology Division
Dr T P Singh, Senior Fellow, and Area Convener, Biodiversity and Forestry Group
Dr Sudhir Sharma, Area Convenor, Center for Global Environment Research
Ms Ulka Kelkar, Research Associate, Center for Global Environment Research

Research Methodology

The methodology for the proposed research would follow an iterative and interactive approach involving the following steps:

Step 1: Literature Survey
The first step would be to conduct a rigorous survey of existing impact assessment methods and models. In order to benefit from expert knowledge both within India and in partner institutes in the US, a workshop would be held to discuss the types of models used in climate change vulnerability and impacts assessments. Appropriate methods or models would be selected, which could be modified, if needed, to suit Indian conditions and match the availability of data and other resources.

Step 2: Data Collection
The data needs of the selected models would be examined and the information required during the course of the assessment would be collected. An important component would be data collection to compile GIS maps.

Step 2: Scenario Development
This phase would begin with a workshop to discuss scenario development and prepare detailed work plans for impact assessment. Baselines that describe current climatic and socioeconomic conditions would be developed. Climate change scenarios would be identified and scenarios of future environmental and socioeconomic conditions would be constructed.

Step 3: Vulnerability and Impact Assessment
The impacts of climate change on key sectors such as agriculture, forestry, and coastal zones would be computed, and their socioeconomic implications would be assessed. This could be done first under the assumption of a limited range of autonomous adjustments, and subsequently by introducing different forms of adaptation into the analysis. The results obtained from the modelling exercise would be combined with expert judgement.

The results of the study will be presented in the form of a paper that highlights the implications of climate change in view of national food security, sustainable resource use, and poverty alleviation.

8B *"Review and Assessment of the development and deployment of various policy instruments and impact on carbon emissions growth rate"*

Project Team

Dr Leena Srivastava, Dean, Regulatory Studies and Governance
Dr Sujata Gupta, Dean, Policy Analysis Division
Dr Sudhir Sharma, Area Convenor, Center for Global Environment Research
Mr Pradeep Kumar , Fellow, Renewable Energy Technology
Ms Meeta Mehra, Area Convenor, Resource and Development Economics
Mr P V Shreedharan. Senior Consultant, Center for Environment Studies

Research Methodology

The following steps will be followed in assessing development and deployment of various policy instruments.

(i) Review of environmental concerns associated with development in India and present modalities of addressing these. Existing literature will be reviewed, both governmental policy and programme documents as well as independent research, to develop an understanding on this issue.

(ii) Review of international literature on various policy instruments used worldwide to address the environmental concerns. This review will also cover the growing literature on policy instruments to address GHG emissions.

(iii) Identify a list of policy instruments with relevance to addressing local environmental issues.

(iv) Develop methodology to assess the environmental, economic and GHG impact of identified policy instruments.

(v) Analyse design and implementation issues associated with identified policy instruments. The analysis will be used to tailor the instruments to minimise the adverse economic effects and also address the ground work need to implement the instruments.

Name Sujata Gupta
Telephone (91-11) 4622246 Extension 2308
E-mail sujatag@teri.res.in

SUMMARY BACKGROUND

I am with the Tata Energy Research Institute (TERI), New Delhi since 1986. My areas of research interest are:

- Economic, energy and environmental modelling, planning and management
- Global environmental issues

The focus of my work has been developing countries. In my doctoral thesis I developed a macroeconometric model for India, integrating micro and macro analysis, to estimate the cost of carbon abatement.

EDUCATION

1991-1995	London Business School University of London Ph.D. (Environmental Economics) *Carbon dioxide abatement costs in an empirical model of the Indian economy - an integration of micro and macro approaches* (thesis title)
1984-1986	University of Delhi MA (Business Economics)
1981-1984	Lady Shri Ram College, University of Delhi BA. (Honours) Economics

PROFESSIONAL EXPERIENCE

Work Profile

My projects relate to global environmental policy, planning as well as financial and economic analysis of energy and technological options. Besides research, we interact extensively with national policy makers, clients, stakeholders and the international research community.

As Dean of the Policy Analysis Division at TERI, my responsibilities include management as well as identification and implementation of the division's research agenda.

I am the Co-ordinating Lead Author for the chapter on *Energy, Industry and Settlements* in Working Group II (Impacts, Adaptation and Vulnerability) of the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC).

1996 to date	Fellow, Tata Energy Research Institute. Dean, Policy Analysis Division (April 1999 to date) Area Convenor, Resource and Development Economics (1998 to March 1999) Area Convenor, Modeling and Policy Analysis (1996 and 1997)
1992-1993	Research Consultant (part-time) at the International Institute for Applied System Analysis (IIASA), Laxenburg, Austria.
1986-1991	Research Associate at the Tata Energy Research Institute Area Convenor for the Centre for Information and Research on Global Warming at the Tata Energy Research Institute 1990-1991.

Some projects worked on include

Clean Development Mechanism

Research report for the Asian Development Bank on the economic implications of the key elements of proposals for institutional design of the Kyoto Protocol Mechanisms.

Asia Least-cost Greenhouse Gas Abatement Strategy (ALGAS)

The Asian Development Bank and UNDP have sponsored this project for 12 Asian countries. My responsibilities were to estimate and evaluate least-cost technological options using the MARKAL model and to develop bankable projects for greenhouse gas abatement for India.

Measuring Monitoring and Managing Sustainability: the Coastal Dimension (ongoing)

This is a collaborative and interdisciplinary research project to design a system to measure, monitor and manage coastal area development with a view to promote sustained economic development. It will be based on investigations on how societal driving forces - demographic, commercial and market, cultural and technological - interact with the natural systems to result in impacts on coastal resources of India. The Project is supported by the European Union.

Structural Transformation

The project had three components: a/ to estimate the energy demand path for India in the long-run incorporating the processes of structural transformation; b/ to estimate the potential for improving the efficiency of pumpsets used for irrigation; and c/ to determine the socio-economic impact of low-cost technological options for irrigation and the factors which prevent technology diffusion. The project was sponsored by the Swiss Development Co-operation.

Development of the MARKAL model for India

The MARket Allocation (MARKAL) is a dynamic, optimization bottom-up model to estimate the least-cost energy supply and utilization options. The model includes detailed representation of energy supply technologies as well demand-side energy end-uses and technologies.

Assessing Economic Impacts of Annex-I Commitments

This project assesses the economic impact of commitments to reduce emissions of greenhouse gases by Annex-I countries on developing countries.

Natural gas master-plan for India

This project assesses the potential demand for natural gas in India and examines the supply side alternatives as well as the environmental considerations. Involved financial and economic analysis of fuel options in the power sector (funded by the Asian Development Bank).

Long-term projections for energy use in Gujarat

Energy demand for the state of Gujarat was projected for electricity, coal, oil and gas till the year 2025.

Technical support to the Ministry of Environment and Forests on the elements of the Kyoto Protocol

Inputs were provided to the Government of India on various aspects of the Protocol to be signed at Kyoto. This included the issue of differentiation of commitments, coverage

of greenhouse gases, basis, targets and timing of commitments, transfer of technology and resources, evaluation of financial mechanisms and issues related to monitoring and compliance.

Natural Gas Markets in Eastern India

This project involved the estimation of markets for piped natural gas in seven states of India. Power is the anchor load for a gas pipeline. I worked on estimating gas demand for the power sector and evaluating alternative routes for the pipeline within the country.

Directions Innovations and Strategies for Harnessing Action (DISHA) 2047

Modelling energy and other resources demand and supply by agro-ecological zones to determine the stressed areas. Suggest policies to reverse trends determined under the baseline scenario.

Other projects

- Development of the MARKAL model for India
- Forecasting demand of oil products for India (state-wise)
- Economic pricing of fuels
- Economic valuation of the impact of sea level rise
- Valuation of LNG
- At IIASA, development of carbon dioxide mitigation technologies data bank (CO2DB) for India.
- At IIASA, compilation and assessment of base year data and developing future energy scenarios for South Asia for the World Energy Council sponsored project.
- Development of a Quantitative Model for Systems Evaluation of Energy Related Technologies (TEESE) and their environmental impacts. This entailed estimating energy related NO_X, SO_X and CO_2 emissions and a cost-benefit analysis was done for key management options.
- Evaluation and categorization of potential natural gas utilization options.
- Development of an integrated energy plan for the state of Gujarat.
- Industrial process models for selected industries (cement).
- Development of a rural energy model (REM).
- Long-term energy scenarios for India using the STAIR model developed by the Lawrence Berkeley Laboratories.
- Collaborative study on strategies to limit CO_2 emissions in Asia and Brazil (submitted to the UNCED).

OTHER INFORMATION

Intergovernmental Panel on Climate Change (IPCC) Working Group II: Impacts, Adaptation, and Vulnerability - Co-ordinating Lead Author for the Chapter on Energy, Industry and Human Settlements for the Third Assessment Report.

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Professional affiliations	Publications Editor, Environment and Development Economics (published by the Cambridge University Press).
	Editor, Global Environment Review (published by the Tata Energy Research Institute)
Awards	Ministry of Human Resource Development, Government of India National Scholarship (1991-1995)
	Ph.D. Programme Financial Award, London Business School (1993-94, 1994-95)
	Research Grant from the UK Economic and Social Research Council (No 1320 25 3010) 1992 - 1994 (London Business School)
Teaching experience	
1992-93	Teaching Assistant (Principles of Economics)
1993-94	King's College, University of London
1991-1995	Tutor (Statistics, Macroeconomics)
	MBA Pre-Programme Course, Sloan Programme, Masters in Finance London Business School, University of London
Computer skills	Excel, Linear Programming Software, REG-X, Dataview, Microsoft Word, Lotus 123 and Word Perfect.

PUBLICATIONS

Sujata Gupta and Preety Bhandari "An Effective Allocation Criterion for CO_2 Emissions" To be published in *Energy Policy*.

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Ulka Kelkar
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July 24, 2000

The Louis Berger Group Inc.
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New Delhi – 110 016

Dear Sir,

GEP-CCS Project: CLIN 04 – Institutions to Co-host the Forum on Climate Change research

This is with reference to the dialogue we had with you on the above. We are glad to confirm our in principle acceptance to host a forum for the research on climate change and its impact on economic development in India. The topic(s) of the research could be agreed upon based on our expertise and in consultation with other partners who may extend their support for the related activities on this issue.

The modalities and other terms and conditions for conducting research and publishing paper would be mutually agreed subsequently. If necessary, a MOU in this regard could be signed on the terms and conditions agreed upon by both the parties.

Thanking you,

Yours sincerely,

Ulka Kelkar

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CLIMATE CHANGE

Post-Kyoto Perspectives from the South

Summary

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Climate Change

Post-Kyoto Perspectives from the South

Prepared by

TERI

Supported by the

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Climate Change

Post-Kyoto Perspectives from the South

Summary

38'

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AGBM	Ad hoc Group on the Berlin Mandate
AIJ	Activities Implemented Jointly
AOSIS	Alliance of Small Island States
CDM	Clean Development Mechanism
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
COP	Conference Of the Parties
ET	Emissions Trading
EU	European Union
FCCC	Framework Convention on Climate Change
GCM	General Circulation Model
GEF	Global Environment Facility
GHG	Greenhouse Gas
GNP	Gross National Product
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
N_2O	Nitrous Oxide
O_3	Ozone
ODA	Official Development Assistance
PFC	Perfluorocarbon
R&D	Research and development
SAR	Second Assessment Report
SF_6	Sulphur hexafluoride
UNCED	United Nations Conference on Environment and Development
WRI	World Resources Institute

Climate Change
Post-Kyoto Perspectives from the South

Introduction

The spectre of climate change haunts governments of most nations, albeit for different reasons. Economies, where the energy industry plays a dominant role, are walking the tightrope between the energy lobby and international forces. Developing countries are grappling simultaneously with their more urgent developmental needs and pressures from powerful nations to make commitments to reduce their use of fossil energy and greenhouse gas (GHG) emissions. Small island states as well as other nations more vulnerable to climatic changes and their impacts (for example, a rise in sea level) are drawing the world's attention to a doomsday scenario if the problem of climate change goes unchallenged by the global community.

Action to combat the threat of climate change is being stalled by a North–South divide. Neither the North nor the South is a homogenous collection, but the groupings are sufficiently powerful to retard any significant action. Developed countries are of the view that unilateral steps taken by them will not be adequate in dealing with climate change as, in future, developing countries will be the main contributors to global GHG emissions. The contention of the South is that emissions are not the cause for the enhanced greenhouse effect, rather it is the increased concentration levels of these gases, and the North's contribution to these concentrations is very high and will continue to be significant for many decades in future. Also, the developing countries with their low levels of income

and high incidence of poverty are not in a position to divert resources to invest in issues related to the distant future. According to the South, the onus lies with the North to take immediate steps to address the problem as their contribution to the problem is, and will be, substantially higher.

The Third Session of the Conference of the Parties (COP-3) in Kyoto injected some expectations of breaking this North–South deadlock. This document presents a summary of a more detailed publication that assesses post-Kyoto developments from the perspective of the developing countries. It targets a range of readers by providing a basic explanation of the science of the problem, the physical and economic impacts, the political history of the negotiations on the issue, and the turning point at Kyoto. The second part of the document examines issues arising from the Kyoto Protocol which are of direct concern to the South [for example, the Clean Development Mechanism (CDM)]. As these issues are far from being resolved and involve both the North and the South, the document is of value to readers actively involved and interested in climate change negotiations.

The science of climate change

The atmosphere functions like a 'greenhouse' and insulates the earth from extremes of temperature. Incoming solar radiation can pass through the atmosphere, whereas terrestrial radiation emitted by the warm surface of the earth is partially absorbed by a number of trace gases in the cooler atmosphere above. These trace gases are called greenhouse gases. The main natural GHGs are water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and ozone (O_3) in the troposphere and stratosphere. In the absence of these GHGs, the

mean temperature of the earth's surface would have been about 33 °C lower than what it is today. Thus, these gases are essential for maintaining habitable temperatures on earth.

Human activities are increasing the concentration of naturally existing GHGs, and adding new gases like chlorofluorocarbons (CFCs). Figure 1 illustrates the historical evidence for increasing concentration levels of CO_2. Increasing anthropogenic GHG emissions and resultant higher concentration levels are capable of raising the global temperature, which would have further indirect impacts such as changes in precipitation quantity and pattern, changes in

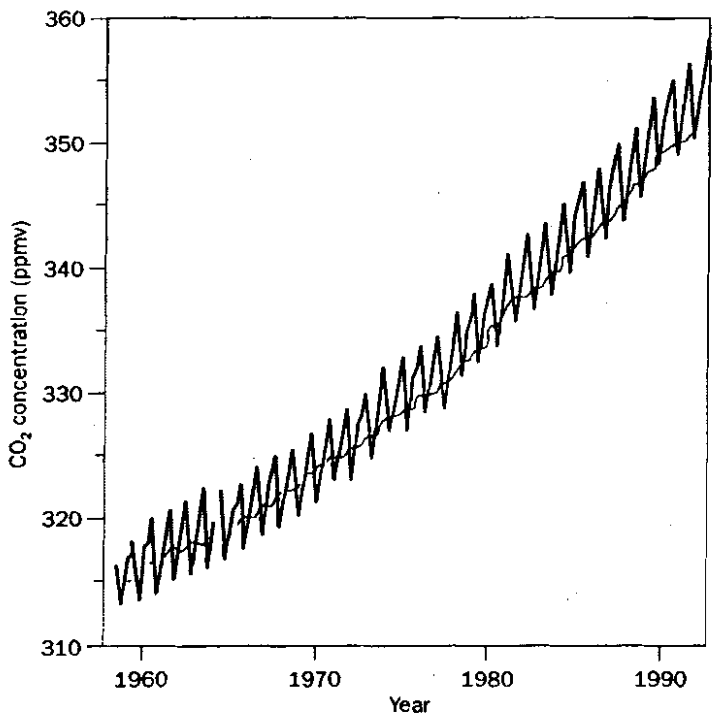

Figure 1 Carbon dioxide concentration since 1959 as observed at Mauna Loa
Source. Houghton (1994)

vegetation cover and soil moisture, increased intensity of tropical storms as well as rise in sea level due to thermal expansion of water and melting of polar ice sheets. These indirect impacts and their regional distribution are important from the economic and social point of view.

Each GHG has a different warming potential, which depends on its ability to trap outgoing radiation and its residence time in the atmosphere. Global warming potential (GWP) for different gases have been estimated using CO_2 as an index. Future concentrations of all anthropogenic GHGs are often presented and aggregated in terms of CO_2 levels. CO_2 is the least potent GHG. However, with large emission levels, it is the largest contributor to greenhouse effect.

An enhanced greenhouse effect will increase the global temperature and disrupt other climatic factors. To assess the likely impacts of climate change, global climate models have been developed. Climate models are mathematical formulations of the major components of the climate system based on physical laws, and are referred to as General Circulation Models (GCM), or more complex versions as Ocean-coupled GCMs. However, considerable uncertainty is attached to the description of many processes and predictions of climate change. Consequently, the uncertainty range of the model outputs is rather high. Uncertainties in climate predictions arise from imperfect knowledge about:

- the future anthropogenic emission rates for various GHGs,
- how these emissions will change the atmospheric concentrations of GHGs, and

- the response of different components of the climate system to these changed concentrations.

It can be summarized that:

- the emissions resulting from human activities are substantially increasing the atmospheric concentrations of GHGs; and
- evidence from modelling studies indicates that by AD 2100, the global mean surface temperature would be in the range of 1 °C to 3.5 °C with the best estimate at 2 °C [IPCC 1996a].

The predicted increase in temperature due to higher concentrations of GHGs, and the likely rise in sea level are shown in Figures 2 and 3[1], respectively.

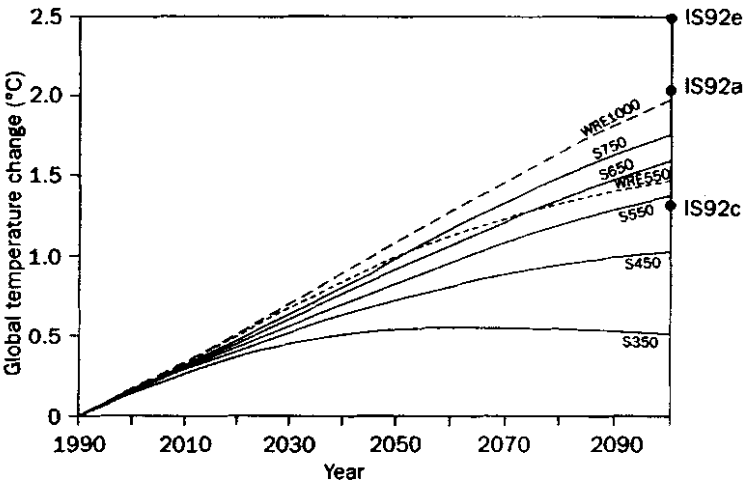

Figure 2 Projected global mean temperature change relative to 1990 levels for various GHG stabilization scenarios
Source. IPCC (1997a)

[1] In figures 2 and 3, 'S' and 'WRE' represent two different pathways for GHG concentration stabilization; '550', '750', etc. represent the stabilization target; IS92a, c, and e represent the Intergovernmental Panel on Climate Change (IPCC) emission scenarios.

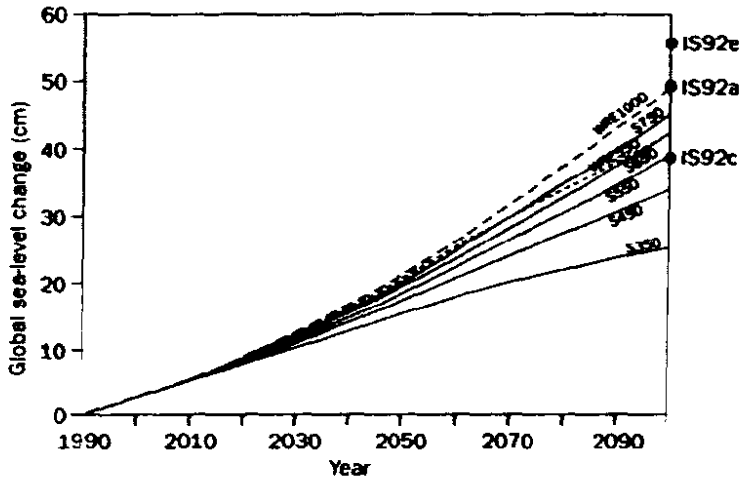

Figure 3 Projected global sea level change relative to 1990 levels for various GHG stabilization scenarios
Source. IPCC (1997a)

The economics

Abatement of GHGs, particularly CO_2, implies curtailment of energy consumption. Energy is a vital factor of production, and its replacement and/or reduction will entail a shift away from current production methods. If current systems employ efficient production techniques, a change in factor proportions will increase the cost of production, and have a negative impact on the national income.

Economic models have been developed to determine optimal policy for GHG abatement. Given the range of uncertainties and unknown factors, most models carry out only a partial cost-benefit analysis limited to abatement of CO_2 in the energy sector. Some economic studies consider other GHGs by converting them to their CO_2 equivalent GWP. Recently, a few integrated impact assessment models were developed. These combine the economic, climate, and impact models to assess both the costs

and the benefits of policies to abate or adapt to climate change. These models are highly aggregated, and designed to investigate the effectiveness of policy actions under large ranges of uncertainty.

Economic costs of abatement strategies can often be overstated if the efficiency gains resulting from these strategies are not considered. Estimates of energy demand, CO_2 emissions, and the cost of CO_2 abatement vary in different studies. Important determinants explaining these differences are assumptions made with respect to:

- the rate and pattern of economic growth;
- energy prices in the base year and their projections;
- energy availability and the rate of autonomous energy-efficiency improvements;
- substitution possibilities between energy sources, technologies, and production methods;
- impact of price signals on technological innovation; and
- the inclusion of economic instruments such as carbon taxes.

Figure 4 shows the dispersion of costs and level of abatement among various models.

Recently, the World Resources Institute (WRI) examined 162 different simulations using 16 widely-used economic models. They found that just eight basic assumptions accounted for more than 80% of the differences in the models' predictions. As a result of this heavy reliance on the set assumptions, the authors in the report unambiguously say that:

People need not accept all the best case or all the worst-case assumptions. It is more reasonable to predict that with

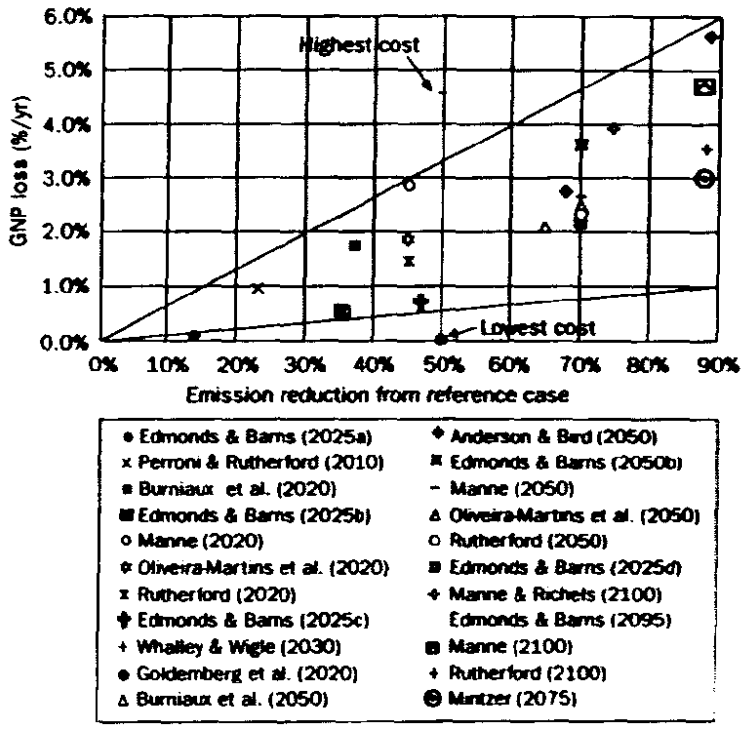

Figure 4 Range of cost estimates for mitigation
Source. IPCC (1997b)

sensible public policies and international cooperation, carbon dioxide emissions can be reduced with minimal impacts on the economy [Repetto R and Austin D 1997].

There are policies which improve or at least do not reduce national income while, at the same time, lead to complementary reductions in GHG emissions. These 'no-regret' option policies are justified because of their non-climatic advantages that complement gains from reduced GHG emissions.

The summary for policy-makers of the Second Assessment Report (SAR) indicates that the potential risk of damage from climate change is enough to *justify action beyond* such 'no regrets'

measures owing to 'the risk of aggregate net damage from climate change, consideration of risk aversion, and application of the precautionary principle' [IPCC 1996b].

Impacts and vulnerabilities

Estimating the potential impacts associated with climate change is a daunting task. The extent of uncertainty is vast. Though there is a fairly broad consensus among climatologists about the expected changes in the global mean temperature, the confidence level is lower while predicting regional and seasonal variations, and also the changes in the variables dependent on temperature, such as precipitation, evaporation, storm frequency, sea level, etc. Even if the degree of change in climate variables is known exactly, the effect it would have on human health, ecosystems, and agricultural yields is far from being clearly understood.

Overall, it appears that more severe impacts can be expected in Asia and Africa as compared to higher latitude countries. Based on various results, IPCC (1996c) has reported the following aggregate impacts in terms of a loss in gross national product (GNP) for a scenario with doubling of CO_2 concentrations ($2 \times CO_2$ scenario).

Global	1.5% to 2.0% of world GNP
Developed country	1.0% to 1.5% of national GNP
Developing country	2.0% to 9.0% of national GNP

It may be noted that the impact estimates are largely based on extrapolation of estimates done for the developed countries. The range of impacts on the developing countries is substantially large compared with that on the developed countries due to wide disparity in climatic and socio-economic conditions that prevail amongst the developing countries.

The developing countries depend on natural resources to a large extent, which increases their vulnerability. The IPCC has reported a vulnerability index based on export dependence, insularity and remoteness, and proneness to natural disasters for the developed and the developing countries. The index for developed, developing, small island developing, and all countries is 0.208, 0.417, 0.590, and 0.376, respectively.[2]

There are a number of drawbacks associated with this index. Firstly, exports alone cannot provide an indication of vulnerability as many countries do not export their primary sector outputs, and to that extent, an indicator like net-exports would be more appropriate. As for insularity and remoteness, it may be noted that in this age of information, it is not lack of information that prevents one country from helping another in the event of a disaster, but the willingness to help. Also, one need not expect climate change related impacts to be occurring suddenly. Finally, proneness to natural disasters is important, but equally important is preparedness of each country to face climate change induced impacts. A more integrated index considering a number of other relevant parameters should be used for identifying the relative vulnerability of various countries.

It could be misleading to draw conclusions on climate change impacts on developing countries based on the studies carried out in developed countries. This could be due to many differences that exist among different parts of the world in terms of prevailing climatic conditions, crops grown, agricultural practices, and the adaptive capacity of different countries to the changes in climate. Dinar et al. (1998) highlight the difference between

[2] Note that high vulnerability is indicated by values closer to 1.

impacts on the US and the Indian agriculture under a similar climate change scenario. The impacts associated with a 2 °C temperature rise could range from +1% to –12% of farm level net-revenue for the US and India, with the US at the lower-end of the range, and India at the upper-end. This difference could be explained to some extent by the initial temperature conditions of the two countries. The average temperature in the US is about 12 °C, while that in India is about 23 °C. For a quadratic temperature response function of crop growth, it is likely that the US is near optimum and India is more climate sensitive because it is warmer to start with.

The emission reduction targets agreed at Kyoto were governed more by the cost of mitigation, which are to be borne by the developed countries, than by the cost of impacts. An integrated analysis requires the inclusion of costs of impacts, which as mentioned above are likely to be more adverse on the developing countries, along with the costs of mitigation. This would make the process of international cooperation more achievable with constructive participation of both the developed and the developing countries.

The political history

The Stockholm Conference on Human Environment in 1972 was the first global recognition that the environment was endangered, and that a collective effort was required from both the government and the industry. Developed countries realized that their development path had been completely oblivious to the impact on the environment, and a spate of rules and regulations were instituted to correct the situation.

In 1987, the Brundtland Commission report highlighted that if the use of natural resources continued in a flagrant manner, pollution and

waste unabated, and the plight of the poor ignored; it would lead to a noticeable decline in the quality of life.

In 1989, the IPCC was established to assess the technical issues that were being raised. The first report of IPCC in 1990 reported a broad scientific consensus on the proposition that the possibility of global warming had to be taken seriously.

In early 1991, negotiations began on a world treaty known as the Framework Convention on Climate Change (FCCC). Doubts were raised over scientific uncertainties and economic costs on the one hand, and suspicion over derailing economic development in the developing countries, on the other. The FCCC was signed at the United Nations Conference on Environment and Development (UNCED) (the Earth Summit), held in Rio, in 1992.

The road from Rio

The major milestones that led up to Kyoto were: the submission of the SAR of the IPCC in late 1995, which confirmed that human activity was responsible for warming of the climate; and the declaration at COP-1 known as the Berlin Mandate which called for strengthening the FCCC.

The Berlin Mandate called for strengthening of commitments, and for setting up quantified emissions limitation and reduction objectives within specified time frames. Further, an ad hoc group of Parties [Ad hoc Group on the Berlin Mandate (AGBM)] was established to initiate the process. It was also categorically stated that there would be no new commitments for Parties not included in Annex I (*viz.* developing countries). A pilot phase for Activities Implemented Jointly (AIJ) on a completely voluntary basis among the Parties was launched. There were no commensurate credits accruing to a Party participating in the AIJ

programme. It was stipulated that the financing of AIJ should be additional to the financial obligations of the Parties as specified in the Convention as also to the Official Development Assistance (ODA) flows.

At COP-2, the Ministerial Declaration (Geneva Declaration) endorsed the findings of SAR, and called for 'legally binding' objectives and 'significant' reductions in emissions. The declaration also called for accelerated negotiations on a legally binding protocol to be adopted by COP-3.

The road to Kyoto

Throughout the long series of negotiations, beginning with the drafting of the FCCC, the US and the European Union (EU) have had significant differences in their approaches.

By 1996, however it was clear that in AD 2000, neither the EU nor the US would reach emission levels below 1990 levels. The EU, however, was taking a progressive stand suggesting 10% to 15% reduction by 2005 and 2010, which was finally echoed in their proposal. While the US had agreed to binding limits, they were not suggesting any quantitative target or time period. This was primarily due to the political clout of the energy industry in the country.

In addition to the US–EU dimension, the differences between the North and the South were highlighted. While at Rio, the North had promised new and additional resources for the South, very little was forthcoming. Added to this was the demand by oil exporting nations to be compensated for any attempt to drive down energy consumption, and consequently their income. The Alliance Of Small Island States (AOSIS) was seriously contemplating a scenario where continued sea-level rise would submerge them. To exacerbate this, the US Senate unanimously passed a resolution barring

US signature on any treaty at Kyoto (COP-3) which would limit emissions in the developed world, and not commit the rest of the world. The call at Kyoto turned out to be 'meaningful participation' by the developing countries, which almost scuttled the negotiation process at Kyoto.

In the above context, the culmination of negotiations into a draft Protocol on Climate Change at Kyoto was a major milestone in international efforts to avert the threat of climate change. The main features of the Kyoto Protocol are listed in the box below.

- Include the six major GHGs - CO_2, CH_4, N_2O, hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6).
- Annex I Parties would reduce their overall emissions to 5.2% below 1990 levels by the first commitment period (2008-12) with differentiated targets for various parties, e.g., 8% for EU, 7% for USA, and 6% for Japan.
- Annex I Parties can use net changes in GHG emissions resulting from human-induced land use change and forestry activities, limited to afforestation, reforestation, and deforestation since 1990, to meet their commitments.
- Introduction of flexibility mechanisms - Joint Implementation (JI), CDM, and Emissions Trading (ET).
- Annex I Parties that have agreed to jointly fulfil their commitments are allowed to do so by setting out their respective emission levels in agreement (the bubble concept).
- Annex I Parties can carry forward unused allowances from one commitment period to another.

Issues and concerns

The issues and provisions that are of utmost importance for the developing countries are listed below.

The developed countries' call for voluntary commitments or 'meaningful participation' by the developing countries.

- Emissions entitlements or rights.
- The flexibility mechanisms, in particular the CDM, and their implications.
- The financing options made available to the developing countries for climate change related activities.
- The development and transfer of efficient and 'climate-friendly' technologies.
- Measures for adapting to the adverse impacts of climate change.
- Non-compliance with the abatement targets and other commitments.

These issues have been discussed further in the following sections. It should be pointed out here, that the issue of voluntary commitments by the developing countries and the flexibility instruments (in particular, the CDM) have received enormous attention at the negotiations and policy forums. The others, which are equally important from the point of view of meeting the objectives of the Convention, have in effect been sidelined in the process.

Voluntary commitments by the developing countries

At Kyoto, a few developed countries, particularly the US, brought up the issue of voluntary commitments by the developing countries. It is the contention of the developing countries that if voluntary commitments are part of any agreement at all, they no longer remain 'voluntary'. Also, a reference must be made to the Berlin Mandate where it was clearly specified that the non-Annex I countries would not be required to make any commitments to mitigate GHG emissions, either voluntary or involuntary.

In this context, it should also be emphasized that several developing countries, even without having any commitments, are doing a substantial amount in

terms of adopting a less-carbon intensive development path – for instance, promoting greater use of renewable energy resources and adopting energy-efficient methods. Many of these actions include experimenting with environment-friendly technologies that have not yet attained commercial maturity in any market.

Despite this, some developed countries are justifying their inaction due to lack of 'meaningful participation' by the developing countries. Thus, it is important for the developing countries to document and highlight actions that are resulting in global environmental benefits. The non-Annex I countries, particularly those that are sizable in terms of population and economic activity must undertake a programme of research and analysis to provide evidence of actions taken which ultimately result in lower emissions per unit of activity.

Entitlements issue

While the current need for negotiations on some short-term issues has to be given priority, it is also important to put forward the importance of few long-term principles that define actions in future. Developed countries have to understand and accept the need for the world to move towards what has been put forward as a 'convergence corridor'. The convergence corridor does not equate all countries of the world reaching the same level of per capita emissions over a period of time, but actually separates these, and allows them to lie somewhere within a band. The acceptance of a convergence corridor in future is also important for Annex I countries in sensitizing their own people to the moral, ethical, scientific, and social imperatives for changing economic structures and activities to attain a place along the convergence corridor. It is thus

important that additional commitments from the second budget period be based on the concept of convergence corridor, and further on the issue of entitlements.

Flexibility instruments, in particular the CDM

Cooperative mechanisms have been introduced in the Kyoto Protocol to provide flexibility to the Annex I Parties in meeting their commitments. As mentioned earlier, these are JI[3], CDM, and ET. While the first two are project-based mechanisms, ET is based on GHG emissions inventory at the national level. These mechanisms have not been effectively defined or elaborated in the Protocol, and, it is thus, important to analyse these individually, and in relation to each other. As per the current understanding, the most significant one from the perspective of the developing countries is the CDM. This is because, it may be the only mechanism that could involve participation of the developing countries.

The issues related to the mechanisms that are of major relevance are listed below.

- *Caps or utilization limit.* It is important to agree on a cap or a limit to which the cooperative mechanisms can be used by the Annex I Parties to meet their abatement commitments. This would ensure that: the credits or emission permits procured in these cases are supplementary to domestic actions; and the developed countries are undertaking climate change related measures within their boundaries and not just buying off emission rights from elsewhere.

[3] The term Joint Implementation has not been explicitly used in the text of the Protocol.

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Along with this collective cap, individual limits should also be set for each of the flexibility instruments. A cap on CDM would ensure that the onus of mitigating GHG emissions does not get shifted to the developing countries, while those on JI and ET would restrict abatement by recourse to exchanging the 'hot air'.[4]

- *Starting dates.* The Kyoto Protocol does not clearly state as to when JI and ET would begin. It is implicit though, that they would commence from the year 2008 – the onset of the first commitment period. CDM, on the other hand, is expected to commence from the year 2000 as banking of the certified emission credits for utilization in the first commitment period is allowed.

  Keeping in mind the equity considerations, and providing a level playing field for the two mechanisms, it may be recommended that JI and CDM start at least at the same time (provided individual caps have been levied on each mechanism). This would also encourage the participants of one mechanism to learn and draw lessons from the experiences of the other. In any case, some interim guidelines would have to be developed between COP-4 and COP-5, which could be followed in the initial phase of the CDM, and finalized at the COP/Meeting of the Parties to the Protocol at its first session.

- *Financial additionality.* It is important to include the financial additionality clause as a criterion to ensure that the funds being made available, are over and above those that would be available in the business-as-usual scenario. In particular, the

[4] Emission targets in excess of expected emissions by economies in transition in the first commitment period.

public funds [as mentioned in Article 14(b) in the Protocol] for project development, financial management, and risk management should not be derived from ODA funds.

- *Players and markets.* From the current understanding of the Kyoto Protocol, it appears that ET would take place only between Annex I Parties, while JI and CDM would take place between Parties as well as their legal entities. However, ambiguity exists regarding the market characteristics in which the credits or the emissions rights would be transacted. These would have to be clearly specified in order to correctly predict the impact of these mechanisms on the Protocol, and in meeting its objectives.
- *Baselines.* As CDM and JI are project-based activities with private participation, it is essential to establish clear guidelines for baselines. ET on the other hand, is an inventory-based mechanism, and thus, calls for a national baseline.

There are a number of other questions related to the working and design of cooperative mechanisms that need to be addressed in order to develop them as equitable and practicable means which could assist in meeting the objectives of the Protocol. Some of these include issues related to monitoring, reporting and verification of reductions of GHGs, nature of credits, bankability procedures, certification processes, and the role and nature of administrative machinery. The guidelines for these have to be set ensuring transparency, credibility, and equity.

Financing needs for addressing climate change

The financing needs of the developing country Parties arise from the need to submit their National

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Communications for meeting the incremental costs of voluntary projects, as well as for combating the adverse impacts of climate change, and any adaptive measures that such Parties may need to undertake. In line with these requirements, the financial commitments outlined by the Convention and the Protocol arise from the recognition that the problem of climate change was caused primarily by the developed countries.

While most Annex I Parties have reported on ODA transfers, contributions to Global Environment Facility (GEF), and activities implemented through bilateral and multilateral channels in their national communications; it has not been possible to quantify aid flows supportive of the Convention at an aggregate level due to a varying degree of reporting[5]. Thus, the financial contributions of reporting Parties cannot necessarily be termed as new and additional financial resources.

It is also difficult to measure the sufficiency of funds made available to the developing countries for climate change. Some significant trends, however, can be seen for various options. The ODA funds to the developing countries, for instance, are declining in general, and it is unlikely that, in future, significant additional ODA finances would be made available. Within this also, the proportion directly targeted at projects and programmes emphasizing on environment has been limited. The decline in ODA is often contested by the fact that there has been a substantial increase in the transfer of private capital flows to the developing countries. However, most of these funds are driven by commercial considerations, under which environmentally-sound

[5] Second compilation and synthesis of First National Communications from Annex I Parties (FCCC/CP/1996/12/ Add.1. 27 June 1996).

technologies can only be transferred depending on the capacity of the countries to attract capital and not always to the country which requires them most.

The GEF has funded a number of activities in the area of climate change, but here too, if the contributions to this fund are analysed, they cannot be categorically stated as additional. The pace of disbursement of GEF funds has not been satisfactory. Moreover, for the next phase of GEF, there has been hardly any increase in the core funding, implying the need to enhance co-financing further. And, lastly, in the AIJ Pilot Phase little progress has been seen till now, and hardly any activities exist in the major GHG emitting countries. In this light, the following recommendations are provided.

- It should be effectively ensured that the funding made available for climate change related activities, in particular by the GEF, are outside the ODA funds.
- Multilateral and bilateral programmes designed specifically for climate change should be encouraged.
- The national communications of the Annex I Parties should report on the financial support extended to the developing countries, as well as the opportunities and national programmes existing for financing climate change activities.
- Along with mitigation activities, financing adaptation measures in the developing countries need to be emphasized.
- Major GHG emitting countries and the most vulnerable countries should be targets for the majority of financial transfers for mitigation measures and adaptation projects, respectively, in order to derive a sizable impact in terms of addressing the climate change problem.

Technology transfer and development

The issue of technology transfer and development is one of the most important issues included in the FCCC and the Kyoto Protocol. However, not much has been achieved in terms of identification of actions required and actual implementation. Innovative programmes to facilitate effective technology transfer and development can be devised in the following manner.

- Adapting technologies that exist in the Annex I countries for use in developing countries, could be financed by bilateral and multilateral organizations in the developed countries.
- Joint projects for the development of technologies that involve organizations in both the developed and the developing world and provide mutual benefits, should be undertaken.
- To ensure a quick start to R&D activities, the Annex I countries should take greater interest and provide support for them.
- South–South transfer of technology (from a scientifically and technologically more advanced developing country to another developing country) should be facilitated by multilateral or even Annex I Parties funding.
- Programmes for capacity building should be country specific.

Adaptation measures

There has been little development in the negotiations on climate change related impacts and the issue of adaptation. In this regard, there is a need for greater R&D, and evolution of institutional and organizational strengths that would make such activities effective.

The Kyoto Protocol addresses the need for funding for adaptation measures. This issue is also

brought up in Article 12, where it is stated that a share of proceeds from the certified project activities (under CDM) would be used to assist the developing country Parties that are particularly vulnerable to adverse affects of climate change to meet the costs of adaptation.

It is recommended that an Adaptation Fund be set up upfront in the Protocol, which should be separate from the CDM. This fund should constitute:

- periodic contributions from the developed country Parties;
- contributions from each activity undertaken within all the cooperative mechanisms. These contributions should not be confined to only activities under CDM (as this implies a 'tax' on CDM projects)[6]; and
- penalties collected from Parties failing to meet their commitments.

Non-compliance

Another issue of importance in analysing the implications of the Protocol is the setting up of a non-compliance mechanism. This mechanism is significant from the following two angles.

- Annex I Parties could default on their emissions obligations.
- Carbon credits promised under the cooperative mechanisms are not generated or ratified/ certified on time (leading to the Parties defaulting on their reduction commitments).

[6] If the Annex I Parties are making use of the flexibility options to meet their commitments, it is a benefit for them for which they should be ready to pay some price. In fact, there should be a provision in place to ensure that the burden of these costs is not shifted on to the host Parties, as is likely if only CDM contributes to the fund.

A well-defined non-compliance mechanism is essential for it would present a system of redressal, generate confidence in the cooperative mechanisms, and prevent unhealthy speculation and undercutting for projects and available finances. It could be in the form of imposing either monetary penalties (which are set higher than the value of emissions rights or credits in the markets for the flexibility mechanisms) or more stringent emissions reduction targets in the immediate next budget period. The penalties could contribute to the adaptation fund that has been discussed in the above section.

At Buenos Aires

At the outset, it must be mentioned that the Kyoto Protocol is overall a major step forward. If one looks at the history of complex international agreements, it would be seen that several years often elapse before any agreement is reached on necessary action. In the case of Kyoto Protocol, progress has been relatively fast. This, of course is a reflection of the gravity with which the world community, with some unfortunate and significant exceptions, views the whole problem of climate change.

Negotiations now must focus on ensuring that the planet is not subjected to unmitigated emissions of GHGs in future as well as protecting the interests of the most vulnerable, the poorest countries of the world. Current concentrations and emission patterns have already brought about some change in climate, the evidence of which is now being manifested by extreme events that have taken place recently.

The developing countries have to take a more proactive role and a far more purposeful stand on the negotiations at Buenos Aires. The position of EU

ABOUT TERI

TERI is an autonomous, not-for-profit, research institute established in 1974. In the initial period, the Institute concentrated on documentation and information dissemination activities. Towards the end of 1982, research activities were initiated in the field of energy, and expanded soon to cover the environment, biotechnology, forestry, and the whole range of sustainable development issues. Over 300 professionals, drawn from a wide range of disciplines, work at TERI's headquarters in New Delhi as well as at its regional centres and field sites in India and overseas.

BELIEFS

TERI's beliefs are centred on the merits of human civilization moving away from the use of fossil fuels on account of their finite availability and the harmful environmental effects of the entire fossil energy cycle. In general, the Institute is committed to (i) reducing all forms of waste, (ii) promoting efficient use of raw materials and depletable resources, (iii) protecting the environment, and (iv) conserving natural resources. More specifically, its activities are geared to promoting large-scale use of renewable forms of energy, protecting the earth's ozone layer, mitigating the threat of climate change, and reversing the loss of forest cover and biodiversity, all of which transcend national boundaries and require solutions through global cooperation. TERI also takes a comprehensive view of development, wherein efficient use of natural resources and protection of the environment are seen as essential prerequisites for economic welfare.

MISSION

To develop and promote technologies, policies, and institutions for efficient and sustainable use of natural resources, which encompasses:

- the promotion of integrated energy policies that are environmentally benign, economically sound, and socially equitable;
- the promotion of technological solutions to meet the challenge of energy through conservation, innovation, and management;
- the promotion of efficient management of natural resources, particularly forest wealth, to ensure adequate supplies of energy to rural areas;
- harnessing modern biological techniques to enhance yields, protect and conserve biodiversity, and control environmental pollution; and
- the dissemination of information to researchers, policy-makers, administrators, and technocrats.

VISION

Individuals, enterprises, institutions, and government can each contribute in their own way to making the world a better place to live in. TERI has been fortunate in obtaining the encouragement and financial and professional support from many of them, both national and international, in undertaking research projects in furtherance of its beliefs. It is TERI's vision that many more will come forward to discuss, debate, and decide on some of the complex issues of our times with the support of accurate and up-to-date information, analyses, and successfully demonstrated options that TERI offers.

Today, the Institute is poised for the twenty-first century, driven by a global vision and outreach, a dynamic and flexible organization with a philosophy that emphasizes and assigns primacy to enterprise in government, industry, and individual actions.

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is moderately more sympathetic to the specific problems of the developing countries and is aware of the need for the Annex I countries to take actions primarily within their own territories if the problem of climate change is to be effectively solved. The developing countries would be well served by initiating a serious dialogue with the EU to ensure that their development is not constrained on account of a deliberate attempt by some parties to ignore the differentiated responsibilities for the problem of climate change that the world is facing.

It is absolutely essential that the non-Annex I countries forward specific proposals and plans that would help operationalize the Kyoto Protocol. Some possible proposals are listed here.

- The developing countries should put forward concrete plans and proposals by which issues related to monitoring, measuring, certification, and general procedures are addressed clearly.
- It is essential for the developing countries to propose linkages among the three major flexible mechanisms, since these are viewed as part of a single approach.
- Developing countries should specify the limits in terms of percentages or other aspects that should place a cap on the extent to which the flexible mechanisms can be used by the Annex I countries, providing the reasons and a rationale for such proposals.
- Given the complexities of the negotiations involved in operationalizing the CDM, it would be particularly useful for the developing countries to suggest how the CDM could take off early and get a quick start at least on a tentative or preliminary basis. Developing countries should provide substance to the largely undefined and vague principles, and directions

to effectively implement CDM. Such actions would demonstrate that the developing countries are meeting their responsibilities towards the implementation of the Kyoto Protocol. The initiative for putting forward a positive proposal on the flexible mechanisms, and the CDM in particular, should be taken up by countries like India and China.

- All flexible mechanisms should contribute to the adaptation fund. Given the complexity of ensuring a system that applies to all the flexible mechanisms for funding such projects, it may be best if the adaptation fund is separated from the operation of the CDM, and a specific and clearly demarcated flow of resources is earmarked for adaptation projects.
- Developing countries must put forward the importance of some long-term principles that define actions in future. Developed countries have to understand and accept the need for the whole world to move towards a 'convergence corridor' where the per capita emissions lie within a range. Once long-term principles are accepted and generally believed, short-term steps and actions would become somewhat easier for all governments of the world. It must be recognized that governments alone cannot solve the problem. A major and almost radical change in the perception of human society on the way human activities are pursued both in the developed and in the developing world, is required.
- There is need for governments, bilateral and multilateral organizations to step up research fundings on climate change related impacts.
- The transfer of technology was an important element included in the UN FCCC, but so far,

the results achieved have been most unsatisfactory both in terms of actions taken and in the identification of actions that need to be taken. Hence, in Buenos Aires, it would be vitally important for G77 and China to put forward a clear programme of action which focuses on building capacity in the developing countries, whereby the assessment of technologies, their adaptation and dissemination can take place far more effectively. Innovative programmes for financing these can be devised.

The issue of voluntary commitments by the developing countries should be put to rest at Buenos Aires on the following grounds. The Berlin Mandate clearly specifies that the non-Annex I countries would not be required to take any action to mitigate GHG emissions, voluntary or involuntary. In addition, without any commitments, several developing countries are adopting policies and measures that promote renewable energy technologies and efficient utilization of energy. Developing countries need to demonstrate that these actions, being taken for local and national benefits, ultimately lower emissions per unit of activity. Developing countries must provide a firm commitment to continuing on such a path.

Buenos Aires should be a step forward as was Kyoto. Deferment of action based on the demand for 'meaningful participation' by the developing nations should be transformed to 'meaningful cooperation' to protect the world from irreversible damaging phenomena.

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Climate of Concern

bridging the divide

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A dynamic and flexible organization with a global vision and a local focus, TERI was established in 1974. While in the initial period the focus was mainly on documentation and information dissemination activities, research activities in the fields of energy, environment, and sustainable development were initiated towards the end of 1982. The genesis of these activities lay in TERI's firm belief that efficient utilization of energy, sustainable use of natural resources, large-scale adoption of renewable energy technologies, and reduction of all forms of waste would move the process of development towards the goal of sustainability.

A unique developing-country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. It is with this purpose that TERI has established regional centres in Bangalore, Goa, and Guwahati, and a presence in Germany, Moscow, and Japan. It has also set up an affiliate institute in Washington, DC, USA – TERI–NA (Tata Energy and Resources Institute, North America).

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Today, TERI is poised for the 21st century, driven by a philosophy that emphasizes and assigns primacy to enterprise in government, industry, and individual actions.

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Introduction

The UNFCCC (United Nations Framework Convention on Climate Change) drawn up in Rio in 1992 firmly placed the climate change problem on the global agenda. The widespread endorsement of the Convention signified the recognition of both the problem as well as the need to find a solution both by the developed and the developing countries.

Intense political negotiations leading up to the Third Session of the COP (Conference of Parties) in Kyoto culminated in the adoption of a protocol at Kyoto in 1997. However, developments thus far do indicate that the world is still divided – the political from the scientific and the industrialized from the developing.

- The First Assessment Report of the IPCC (Intergovernmental Panel on Climate Change) concluded that the GHGs (greenhouse gases) – CO_2 (carbon dioxide), NO_2 (nitrous oxide), and CFCs (chlorofluorocarbons) – would require immediate reductions in emissions from human activities of over 60% to stabilize their concentrations at today's levels. The 'Toronto target' called for a 20% reduction in GHG emissions. However, the agreement in the Protocol is for a 5.2% emissions reduction below that of 1990 levels between 2008 and 2012. Are we then serious about the problem?
- In the negotiations leading up to Kyoto, nations have clearly safeguarded their interests with apparently scant regard to meeting the ultimate objective of the Convention. For example, economies in transition have gained a higher degree of flexibility in meeting their commitments coupled with the potential of resultant economic gains, while the non-Annex 1 countries thwarted all efforts to undertake commitments. Again, the Annex 1 countries committed to quantified emissions reductions with flexibility options. Are these commitments adequate?

There also remain several uncertainties and unresolved issues that could derail the process. Not only is there a need to review the provisions in the Kyoto Protocol, but also to develop a framework for operationalizing it. Additionally, there is a need to identify drivers that can maintain and build on the momentum that was achieved at Kyoto, ratification of the Protocol notwithstanding.

It is in this context that TERI undertook an exercise – based on a survey of the literature, personal interviews, and questionnaire responses – to synthesize the views of a broad spectrum of experts on their perceptions of the strengths and limitations of the Kyoto Protocol and the required steps forward.

The aim of this publication is essentially to present how thinking has evolved since Kyoto on the implementation of the UNFCCC and the Kyoto Protocol. Have views changed and, if so, in what direction? What are the concerns which still persist? And, what are the ways in which these can be addressed?

From Rio to Kyoto

In 1988, there was a dramatic shift brought about by an unusually hot and dry summer in the US. At a Senate hearing, it was reported that the unusually high temperatures of 1980s were not a natural variation; in fact they were being caused by the accumulation of GHGs in the atmosphere. Also, in 1987, the successful negotiation of the Montreal Protocol to protect the ozone layer had set a precedent for international action on an environmental threat, beyond the confines of national governments. In 1989, the IPCC was established to assess the technical issues that were being raised. The first report of the IPCC in 1990 reported a broad scientific consensus on the proposition that the possibility of global warming had to be taken seriously.

Guiding principles provided by the Convention

- 'Common but differentiated responsibilities'
- Recognizing that 'the share of the global emissions originating in the DCs will grow to meet their social and development needs'
- 'The extent to which the DC Parties will effectively implement their commitments ... will depend on the effective implementation by developed country Parties of their commitments ... related to financial resources and transfer of technology ...'
- Developed countries and East European economies aim to return 'individually or jointly to their 1990 (emission) levels' by the year 2000.

Source UNFCCC Secretariat (1999)

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In early 1991, negotiations began on a world treaty known as the UNFCCC. Despite doubts raised over scientific uncertainties and economic costs on the one hand, and suspicion over derailing economic development in the DCs (developing countries) on the other, the FCCC was signed at Rio, which committed the signatories to make an effort to curtail their emissions and no more.

It was soon realized that a non-binding agreement such as the UNFCCC would not accomplish much in protecting the climate and hence the scientific and the political process continued. At COP-1 in 1995, the Berlin Mandate called for the pursuance of an attempt over the next two years to set specific and binding targets and timetables for developed countries. In fact COP-1 ended with a declaration known as the Berlin Mandate which called for strengthening the FCCC. This engendered a new round of negotiations to prepare a stronger treaty by COP-3 at Kyoto. At COP-2, the Second Assessment Report, which confirmed that human activity was responsible for warming of the climate, was endorsed.

Throughout the long series of negotiations, beginning with the drafting of the FCCC, the US and the EU (European Union) have had significant differences in their approaches. While the US firmly opposed any firm emission limitation targets, the Europeans managed to introduce text in the Convention acknowledging the desirability of reductions and a voluntary goal of cutting back emissions to 1990 levels by 2000. And, although a change in vanguard in the US Administration in 1992 raised hopes of a more environmentally sympathetic stand and a Climate Change Action Plan was unveiled in 1993, these efforts turned out to be inadequate. In 1996, the US agreed to the legally binding commitments on the condition that it would do so if other countries also undertook the same, which was a significant departure from the original stand.

However, by 1996 it was clear that in 2000 neither the EU nor the US would reach emission levels below 1990 levels. The exceptions were Russia, Germany, and Britain, who would be able to achieve these due to events and imperatives other than environmental ones. The EU, however, was taking a progressive stand with some countries suggesting 10%–15% reduction by 2005 and 2010, which was finally echoed in

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their proposal. While the US had agreed to binding limits they were not suggesting any quantitative target or time periods. This was primarily due to the political clout of the energy industry in the country.

The US criticized the EU proposal, which allowed for differentiation of targets for countries in the EU, while opposing differentiation outside EU. Also, critics pointed out that the EU had said little about policies that would help them achieve the targets they had proposed. In addition to the US–EU dimension, the differences between the North and South were highlighted. While at Rio the North had promised new and additional resources for the South, very little was forthcoming. Added to this was the demand for compensation by oil-exporting nations for any attempt to drive down energy consumption, and consequently the income. The Alliance of Small Island States was seriously contemplating a scenario where continued sea-level rise would submerge them. To exacerbate this, the US Senate unanimously passed a resolution barring US signature on any treaty at Kyoto (COP-3) which would limit emissions in the developed world and not commit the rest of the world. The call at Kyoto turned out to be 'meaningful participation' by DCs, which almost scuttled the negotiation process at Kyoto.

In the above context, the culmination of two years of negotiations into a draft Protocol on Climate Change at Kyoto was a major milestone in international efforts to avert the threat of climate change.

The Protocol, however, has its strengths and limitations as shown in Figure 1. Also, there are certain issues that have not been adequately addressed in the Protocol. And, there are doubts on the ratification of the Protocol by the US. Only if it is ratified with US participation, would it be an achievement. It is likely that the Protocol may be renegotiated, which will lead to a resurgence of arguments on the level of commitments of Annex 1 Parties, as also a need for meaningful participation by the DCs. Despite the aforementioned problems that need to be addressed in the short term, it is time that a vision for the long term is agreed upon to effectively combat climate change. This vision must necessarily embrace notions of equity, efficiency, sustainable development, and technological transitions. Also, this vision will need to be effected on certain mutually agreed principles for convergence, based on any of the following: per capita

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emission levels, per capita income, GHG intensity, or a combination of the above.

Figure 1 indicates the structure of this publication, while highlighting the issues that have been addressed herein.

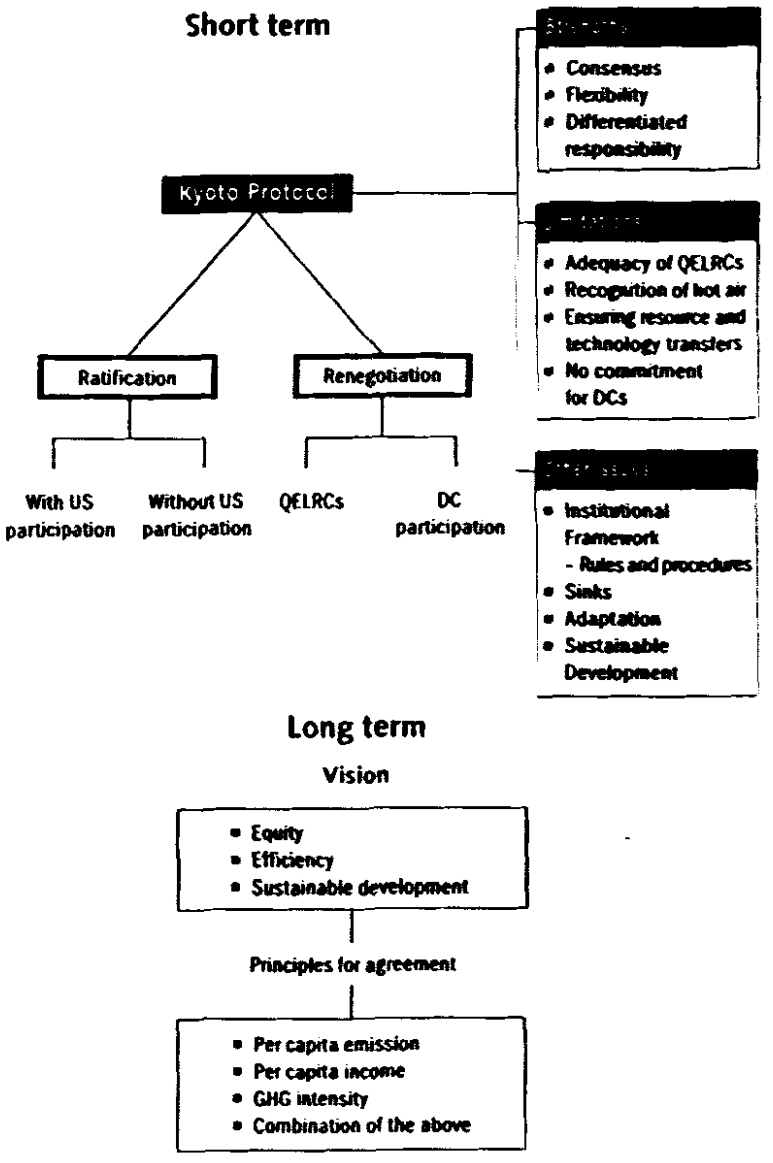

Figure 1 Climate of concern

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Kyoto Protocol: relevance in the short term

The Kyoto Protocol can be perceived as a major milestone in the climate change negotiations. In light of the long-term objective spelled out in the UNFCCC, the Kyoto Protocol at best ushers in short-term initiatives. As such, it is only a step in the right direction, bringing forth a semblance of a consensus on different views of the world that existed prior to COP-3, to address the threats posed by global climate change. It also gives a strong indication that the global community is serious about the issue of climate change.

On the other hand, it is the contention of some that an international treaty is only symbolic and provides legitimacy. However, it is not effective instrumentally in reducing GHGs or for policy-making. The global civil society, industry, and the scientific community need to get involved to make this an effective process.

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However, it needs to be recognized that the short-term initiatives outlined in the Kyoto Protocol will eventually need to be synchronized with the longer-term requirements. 'Implementing Kyoto without reference to the long-term goal is like inviting the Treasury to mint money while ignoring inflation' (CCI 1998).

Commitments

The adequacy of commitments made under the Kyoto Protocol, in the form of the quantified emissions limitations and reductions, has been the subject of intense debate ever since the drawing up of the Protocol. 'Among the first conclusions that springs to mind is that the five per cent

'Among the first conclusions that springs to mind is that the five per cent emissions reductions for Annex 1 countries during the first commitment period 2008-12 is a long way from the required reductions indicated by the IPCC' (Lunde 1998).

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emissions reductions for Annex 1 countries during the first commitment period 2008–12 is a long way from the required reductions indicated by the IPCC' (Lunde 1998). Wigley (1998) calculated the 'saved' warming under the Kyoto Protocol agreements and concluded that the earth's temperature in 2050 will be a mere 0.07 °C lower as a result.

Almost two years after the Kyoto Protocol, some experts still feel that an agreement on the QELRCs (quantified emissions limitations and reduction commitments) is a significant achievement politically, although inadequate in a quantitative sense. These can be regarded as a first step in a 100-year time horizon. The timing and duration of the first commitment period is somewhat irrelevant in this context, in that the real scale of reductions required may not be achieved during this period.

A majority of respondents have, however, expressed the view that the QELRCs have put the process in a strait jacket. The political (not technical or economic) compulsions have rendered this as the most contentious issue that may jeopardize not only ratification of the Protocol but also decelerate any effective efforts to reduce emissions. To further this argument, some answers polled emphasize that a more appropriate approach would have been to agree to efforts whose effects would constrain the growth of emissions, and more importantly stimulate technological innovations, diffusion, and transfer that will be critically important for changing the long-term trend of emissions.

A DC view, which needs to be seen in light of the US insistence on 'meaningful participation' by this group, is that the Annex 1 countries have earned a reprieve at Kyoto and have also given due consideration to the demands for special consideration by certain members of their group. However, the same courtesy is not being extended to the non-Annex 1 countries that have been asking for the consideration of emissions rights on an equitable basis that would facilitate their more active participation in resolving the climate change problem.

Flexibility

The flexibility mechanisms in the Protocol, namely, ET (emissions trading), JI (joint implementation), and the CDM (clean development mechanism), are perceived as a strength

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of the Protocol, by a majority of the respondents, although the implicit recognition of 'hot air'[1] is seen as a definite limitation. In the words of Mr Lunde, the Norwegian 'government regards the flexibility mechanisms as key elements and prerequisites for the agreements reached on targets and timetables. ...We need to design these mechanisms to be as reliable, workable, credible, and effective as possible' (Lunde 1998).

Several critical issues would need to be addressed in order to operationalize the flexibility mechanisms. Apart from these, cautionary statements and observations on the flexible mechanisms issued by many experts soon after COP-3 deserve attention.

- The CDM alone cannot accomplish the steep worldwide cuts necessary for avoiding dangerous climate disruption (Seth 1998)
- The concept of emissions trading was undermined by the unnecessarily generous emission allowances provided to Russia and Ukraine in the Protocol. Their emission levels at the time of drawing up the Protocol was already 30% below their 1990 levels. Grubb, Vrolijk, and Brack (1999) point out that the cutback implied for the US from their 1995 levels almost exactly equals the increase allowed to Russia, and the increase allowed to Ukraine is greater than the cutback required in the EU or Japan individually.
- The Protocol does not recognize the fact that the mechanisms are inter-related and is visualizing the creation of artificial markets (Grubb, Vrolijk, and Brack 1999).
- Abuse of the unique market-based flexibility mechanisms in the Kyoto Protocol could lead to corruption and the collapse of global efforts to contain climate change. The policies that may be the most efficient in implementing the reductions in the Protocol's single budget period may not be the best to solve the longer-term problem of climate change (CCI 1998).

[1] Hot air refers to the excessive assignment of emissions quota or assigned amounts that are likely to be far greater than baseline emissions. For example, even though emissions in the central and eastern Europe and the Commonwealth of Independent States countries have declined by 31% in the period 1990–96, the assigned amounts for these countries is much higher.

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The recent responses reveal that there are reservations on flexibility in undertaking commitments that give recognition to differences in natural resource endowments, climate, etc. These do not pertain to granting flexibility per se, but to difficulties in developing technical/mathematical formulations to account for it. It was felt that natural resource endowments matter when countries decide on how to meet QELRCs and not at the time of setting them. On the other hand, some respondents have clearly differentiated between emissions in production and those in domestic consumption, arguing that the latter is no criterion for differentiating commitments.

Flexibility over time and space is seen as a positive factor. The cost-effectiveness, both spatial (where you undertake emissions reductions) and inter-temporal (budgets and banking of credits), rendered by the flexible mechanisms seems to be crucial to the Protocol. A regime has to be designed such that transaction costs are not higher than the efficiency gains and at the same time ensures financial and environmental additionality.

Any delay in action is not justified in light of the magnitude and rate of climate change and also due to the uncertainty in economic consequences. Further, beyond the Kyoto Protocol, targets and stabilization would be required, quantification of which may be premature at the moment due to inadequate information. But the absence of perfect knowledge does not justify the luxury of doing nothing till we learn more.

Sinks

There is divided opinion among the experts polled on the merit in including carbon sequestration projects to meet commitments.

Article 12 of the Protocol, relating to the CDM does not mention carbon sequestration sinks or 'emissions avoided' projects, and indicates that it authorizes only 'certified emissions reductions'. Article 6 outlining JI, however, does contain an explicit mention to include such projects.

Ambassador Estrada-Oyuela (1998) states that different wordings in the two articles clearly mean that carbon sequestration projects are excluded from Article 12. Further, he argues that a project on forest management to reduce

emissions (as in the absence of proper management, there would have been deforestation and hence carbon emissions) does not qualify for CERs (certified emissions reductions), the reason being that in such projects it is difficult to specify the baseline. Estrada-Oyuela (1998) goes on to further say that it is the normal responsibility of governments to protect their own natural resources. Few will argue in favour of making large-scale deforestation a baseline scenario. Recent trends in reforestation and in plantation agriculture make a deforestation baseline difficult to defend. This has clear implications that projects with 'emissions avoided' are not CDM projects.

Those in favour of excluding sinks put forth the arguments that sink projects (e.g., afforestation) are not a transfer of technology and further limit development by locking host countries in long-term commitments on patterns of land-use. Another concern associated with sink projects is related to their permanency. Carbon savings in forestry projects will also divert attention from energy sector projects which save fossil-fuel-based carbon.

Those strongly in support of sequestration projects in the CDM point towards their strong potential to stop loss of biodiversity, protect critical watersheds, and accelerate reforestation of degraded forests. It needs to be borne in mind that managing the world's forest to mitigate climate change is not a realistic and ecologically healthy ambition (Mattoon 1998).

It can also be argued that at the current level of data availability and the monitoring and verification system, it is difficult to correctly estimate carbon sequestered. Including sinks may give rise to large amounts of carbon savings but one with a high degree of uncertainty.

Given the uncertainties and ambiguities, the outstanding issues need to be resolved in a way to minimize potential loopholes. No decisions on sinks should be taken until the IPCC Special Report is complete and its contents assessed fully (Hare 1998).

Supplementarity

The views on flexibility and supplementarity vary considerably. While some argue that domestic action in Annex 1 countries is absolutely essential and recourse to the flexibility mechanisms should be limited, a diametrically opposite view

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is that there should be no caps on using the flexibility options. The latter view suggests that the concept of supplementarity should be dropped altogether. This could lead to an unacceptable dependence on external measures. It is anticipated that the high transaction costs accompanying ET, JI, and the CDM will spur domestic action in Annex 1 countries.

At the same time, there are certain civic responsibilities (e.g., military service), which everyone should undertake regardless of their income and wealth. It may be more efficient to allow some countries to trade their way out of reducing emissions by buying emissions reductions in some other country. But, reduction in emissions at home should be regarded as a civic duty.

'Future climate change negotiations should consider limiting the flexibility mechanisms as these could undermine incentives to develop new processes, technologies and habits that are crucial for tackling climate change in the long term' (Grubb, Vrolijk, and Brack 1999). There is merit in both the arguments. It seems that flexibility is a good provision in the Protocol. However, it is flawed in that it may lead to complete inaction in Annex 1 countries. Figure 2 illustrates the rationale for supplementarity.

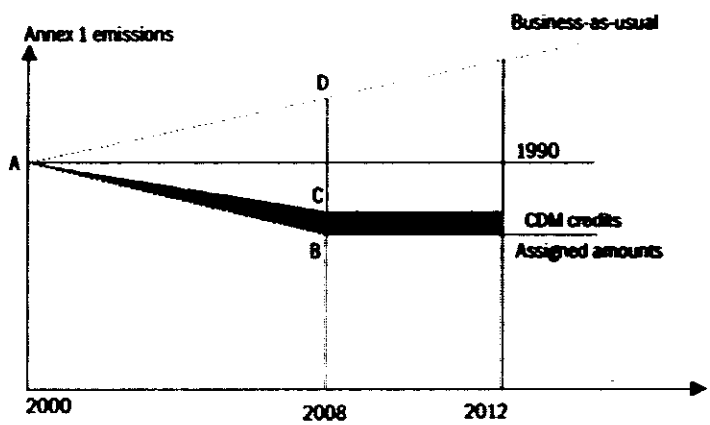

Figure 2 Rationale for supplementarity

In the absence of any commitments, the emissions would have proceeded along the BAU (business-as-usual) line.

However, with assigned amounts under the Kyoto Protocol, emissions allowed between 2008 and 2012 are constrained. In order to achieve the assigned amounts, the emissions path would be AB. If flexible mechanisms are allowed, this implies an increase in allowable emissions and the emissions path would be AC. Emissions depicted by the area ABC represents the flexibility/scope for domestic inaction in the Annex 1 country prior to the first commitment period. An extreme case would be when the Annex 1 country follows the BAU path and avoids domestic control to the extent of ABD and brings about no change in emissions patterns. Therefore, a balance is required between the flexibility argument and the requirement of supplementarity.

It seems that a large part of the concern regarding the flexibility mechanisms and the issue of supplementarity arises due to the existence of what is now popularly known as 'hot air'. 'Even if the DCs do not come up with conditions that effectively "cripple" the instrument, it can be expected that the EU will want to limit the contribution of the trade in "hot air" (Berk 1998).' A serious reservation on hot air is that it may encourage a 'do nothing' scenario and imply rewarding polluters and punishing sustainability. At the same time, hot air is the price we may have to pay to get the Protocol ratified.

Ratification

In fact, the issue of hot air notwithstanding, the respondents by and large had mixed reactions on the ratification of the Protocol. There are fears that flaws in the Protocol may undermine the future path of the Protocol and that a decision by the US not to ratify may jeopardize the entire process. The more optimistic feel that with a possible change of vanguard in the US Senate, there will be a better probability of ratification. Further, they deny the claim that the Protocol will be a non-starter without the US on board. It is expected that even without Congressional ratification, some forward-looking members of the private and public sectors in the US will participate in this global agenda.

There is definitely a view that ratification by the US may be forthcoming, but would be probably delayed and that this should not stymie efforts in other countries to meet their targets. Although 'a long delay by the US would cause other

countries to pause in their own ratification process, which in turn would foster a "wait-and-see" attitude by industry and discourage the investment needed for a technology revolution' (Benedick 1998).

However, it needs to be recognized that even if the Protocol were to come into force without US ratification, the agreement could not be sustained without effective US participation achieved sometime in the years 2000–2004. (Grubb, Vrolijk, and Brack 1999).

However, the need to ratify the Kyoto Protocol, with all its flaws, is underscored by the feeling among some DCs that a renegotiation of the Protocol would in effect amount to a complete undermining of the FCCC. This fear arises out of the anticipation that a renegotiation would inevitably place the issue of 'meaningful participation' (read targets or commitments) by key DCs on the centre stage without the Annex 1 countries having undertaken any significant measures since 1992 to date. This would be a major deterrent to any further negotiations and would tantamount to the death of the FCCC.

It is perceived that the unequivocal stance of the DCs on commitments has weakened the Protocol and left it '... open to right-wing attacks'. In hindsight, the stance could have been that 'we have started but our path is slower'. Also, some indication on the broad time-frame within which the DCs could take commitments may have helped. The way forward that is being suggested by the various responses is to be open to the CDM and actively seek such cooperation, and, at the same time, begin a review of domestic GHG policy incentives through the implementation of win-win measures such as energy sector reforms. Some convincing action or commitment by non-Annex 1 countries is needed as a start.

Developmental aspects

There is no denying the fact that the DCs necessarily have to grow to meet the growing needs and aspirations of their populations. Any international treaty cannot obviate this fact. In this context, the Kyoto Protocol has somewhat underplayed the development aspect. Further, adaptation to climate change, which is likely to have a greater impact in vulnerable DCs, has not been accorded significant priority. Although, there is a provision in Article 12 for an Adaptation

Fund, the fact that it will result from proceeds of CDM projects, and not through any other mechanism may render CDM to be a relatively more expensive option, thereby foreclosing any chances of the DCs undertaking meaningful measures to combat climate change.

As mentioned earlier, resource and technology transfers should have been clearly mandated for in the Protocol to ensure that the DCs break the vicious circle of poverty and pollution.

Long-term perspective

The ultimate objective of the UNFCCC is the stabilization of GHG concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. This objective can be addressed only partially and marginally in the short term. This is not to undermine the importance of the short term, but is a recognition that measures in the short term are steps towards the longer-term objective.

However, there is growing opinion that it is fair that the DCs have no commitments for the first commitment period, but thereafter non-Annex 1 countries cannot be treated as a homogeneous mass, and some select countries will necessarily have to undertake some form of commitment. The question that looms large is not whether but when the DCs should have commitments, keeping in view and distinguishing between stages of development.

> The question that looms large is not whether but when developing countries should have commitments, keeping in view and distinguishing between stages of development.

The burden-sharing could be akin to the current mechanism for sharing of the budget of the United Nations. If GHG limitation is considered a public good, then the reluctance of non-Annex 1 countries to do anything is akin to the free-rider problem. In principle, some participation is called for. However, one cannot ignore that meaningful participation by Annex 1 countries is as important.

The DCs could agree to a target, and not a cap, in the second or third commitment period provided Annex 1 countries have met their commitment in their previous commitment period. This would be a fair way to proceed, similar to

that of the Montreal Protocol. This, accompanied by educational and publicity efforts, would take away the initiative from industrial groups opposed to action to combat climate change. Targets could be linked to growth and declining emissions per unit of GDP (gross domestic product), and need not be rigorously defined at this point in time. However, they need to be linked to Annex 1 commitments and performance.

Under these circumstances, there is a need to find ways and means to ensure that governments continue to confront the risks of global climate change, and discussions need to be looking ahead for ways to keep governments engaged. Views expressed on the necessity of initiating a debate on long-term principles ranged from being very important to the extent of providing a panacea to several issues being debated, to those that such a debate would distract resources and energies away from the more meaningful issues. The diversity in views expressed is also evident by what respondents felt were 'meaningful issues'. Some defined meaningful issues as 'a substantial, binding agreement', while others were of the opinion that setting emissions limits, at least in the near term was a fundamental error of the Kyoto Protocol. A set of views held is that in addressing longer-term principles, the 'short-term issues' like the question of DC participation could be addressed and this would help in moving the Kyoto Protocol forward.

It is essential that all the Kyoto mechanisms be fully constituted and ready to be implemented after COP-6. Otherwise, the time-frames in the Kyoto Protocol will quickly become unrealistic – targets will not be able to be reached in less than a decade. It was necessary to have long-term targets and for the scientist to develop scenarios for different levels of stabilization. The selection of the level of stabilization is a political process and will form the basis of long-term negotiations.

A rare and sole point of view expressed was that the total absolute emissions for a country should be the basis for deciding a longer-term agreement. Clearly, this respondent felt that population, the level of economic activity, and the composition of output, resource endowments, etc., were not important factors in the longer term. Could this be taken to imply that the US would have to undertake the largest reduction (both in percentage and absolute amounts) by virtue of being the single largest emitter?

Issues with respect to the long-term principles are discussed at two levels. First, is it meaningful to talk about a longer-term perspective? A view expressed was that there exists no perfect agreement for the long term. A process of adjustment is required; for example, the experience of the Montreal Protocol has been to negotiate every two years and implement. Second, what are the relevant criteria in addressing the longer term?

Another viewpoint expressed was that the concentration level of 450–550 PPM (parts per million) with commitments from all major countries (both developing and developed) was difficult to achieve with the technological options currently available. Further, if the DCs are allowed to catch up, then the target of 550 PPM or less would have to be given up. This viewpoint clearly indicates the helplessness of the developed world to show leadership and their hope that it would be possible to limit emissions in developing economies.

There were those who held the opinion that meeting commitments under the Kyoto Protocol was unlikely. They felt that the Kyoto Protocol was badly flawed and it would be useful to begin to think more rationally about the kind of emissions reductions agreement, which should be undertaken in the long term. Quite different views and perceptions drive different countries. It is very useful to continue the discussion, not so much with the short-run objective of another agreement, but with the objective of educating everyone about the science, the economics, and the politics of global warming.

The emphasis has to be on encouraging more countries to participate and reduce absolute emissions. It was felt that the long-term agreement or any agreement is not a technical issue and that a higher level of participation is called for. This can be achieved when the capacity for effective participation is enhanced, specifically for the DCs.

It is unlikely that, in a negotiating sense, principles for longer-term agreement will yield anything more specific than what we already have (i.e., common but differentiated responsibilities, avoid dangerous human interference, promote sustainable development, etc.). What is required is an intellectual debate on equity and the longer term. A long-term vision

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and not a long-term agreement is required. Negotiating a longer-term agreement would only distract people, absorb resources that are better employed elsewhere, and would almost certainly not yield a meaningful result.

However, a discussion beyond the Kyoto Protocol is essential, as it does not address the problem. But, future discussions need not adopt the Kyoto Protocol structure of emissions limits. They should move away from setting emission limits at least in the near term. It was a fundamental error in the Kyoto Protocol to have defined early emission targets. A more appropriate approach would have been to agree to efforts whose effects would constrain the growth of emissions, and, more importantly, stimulate technological innovations, diffusion, and transfer that will be critically important for changing the long-term trend of emissions. The precise level of emissions in a decade is unimportant and specifying the emissions target for particular years in this time-frame distracts attention from the important work that needs to be done. What we need to do is to lay the groundwork for changing the fundamental drivers of future emission trends. Measures that could help with this are programmes to stimulate R&D, pilot projects to demonstrate and transfer innovative technologies, removal of subsidies that are in conflict with GHG mitigation, carbon taxes, reorienting the objectives, and implementation of transportation and land-use planning and programmes directed at influencing the character of major new infrastructure investments, such as electricity generating plants.

If we are looking at confidence-building measures/framework, then a planning horizon of 2020–30 is more realistic. Prior to this, commitments for the first budget period would need to be achieved. The stone age did not end because there was a shortage of stone. Similarly, we would need to move towards a decarbonized civilization by 2050. For moving ahead in the long term, there is a need to work towards a decarbonized civilization backed by development process for the poor.

The level of emissions from fuel combustion across different countries shows considerable variation in terms of absolute amounts (Figure 3), per capita emissions (Figure 4), and GHGs emitted per unit of GDP (GHG intensity). The GHG

intensity has been projected in terms of both GDP at market exchange rates (Figure 5) and GDP valued at PPP (purchasing power parity) (Figure 6).

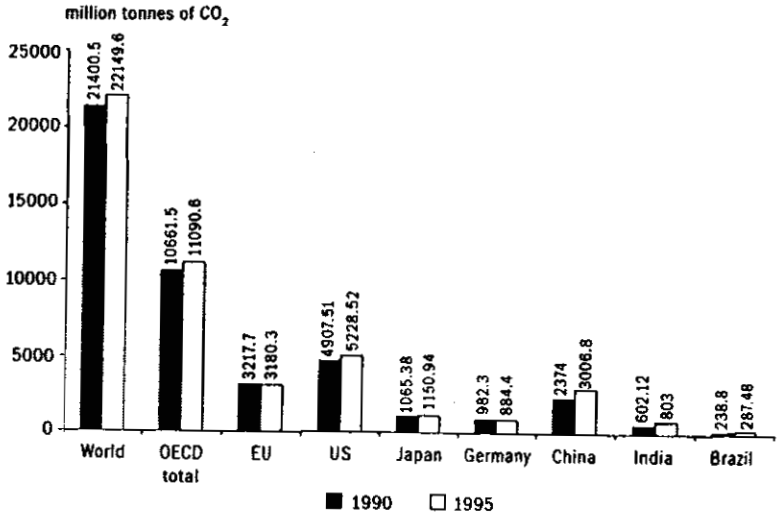

Figure 3 Total CO_2 emissions from fuel combustion
Source IEA (1998)

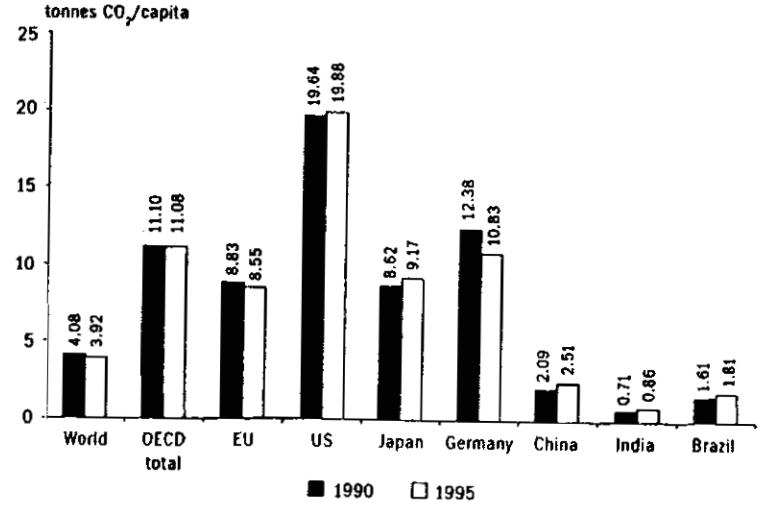

Figure 4 Per capita CO_2
Note CO_2 from fuel combustion
Source IEA (1998)

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It may be argued that the DCs like China and India are significant contributors of GHG emissions. However, on a per capita basis, their emissions levels are lower by a large margin. This clearly indicates low levels of energy combustion, making further reductions practically impossible.

It is evident that not only is the contribution of the OECD (Organization for Economic Cooperation and Development) countries large in absolute terms, but also in per capita terms.

On the other hand, the GHG intensity of large DCs is relatively high, leading to the argument that in the future emissions from this group of countries will grow significantly. However, estimates of GHG intensity in the context of PPP narrow the difference between the OECD and developing countries. Also, some large and highly CO_2-intensive DCs like China have shown significant improvements in reducing CO_2 intensity.

It is time that interpretations and arguments based on such numerics are jettisoned in favour of a global vision to address the climate change problem.

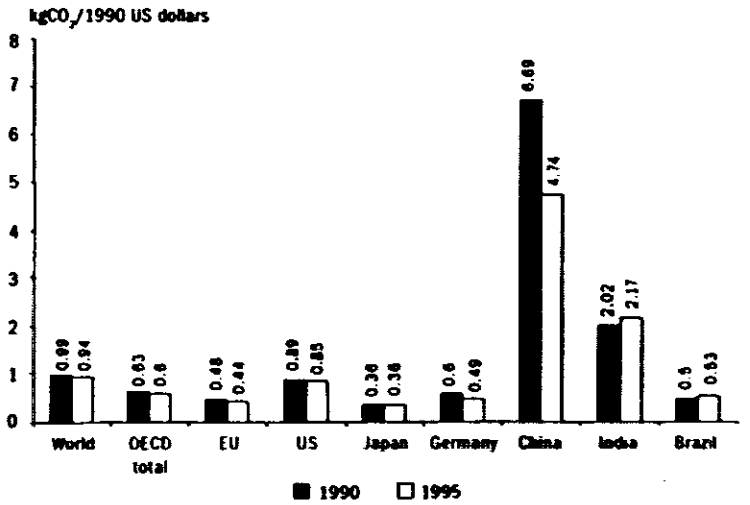

Figure 5 CO_2 intensity
Note CO_2 from fuel combustion
Source IEA (1998)

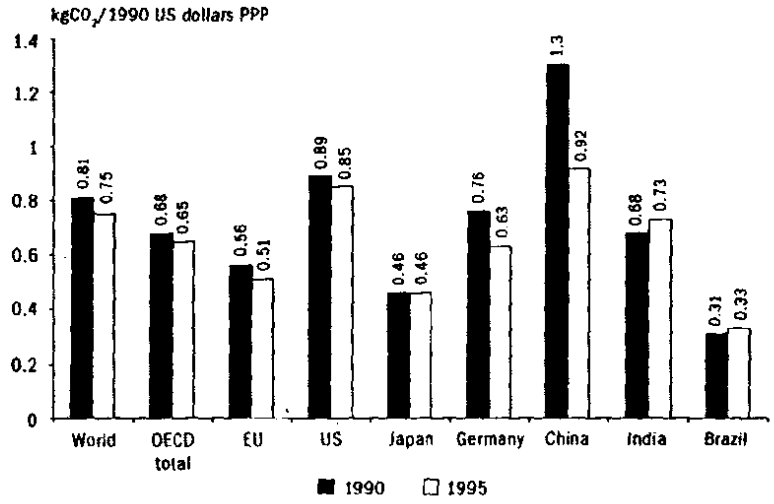

Figure 6 CO_2 intensity
Note CO_2 from fuel combustion
Source IEA (1998)

Several respondents to the survey felt that an equitable basis for a longer-term agreement was desirable. These could be defined as Parties taking on binding commitments when the per capita incomes reach the OECD average of 1990. Other criteria suggested for non-Annex 1 Parties to take on commitments were those when their per capita emissions reach the world average in 1990 or reach the OECD average in 1990. Some respondents from developed countries were of the opinion that though theoretically the long term has to be based on the principle of equity, in practice this would never be, and hence a more pragmatic approach was required. It was iterated that it is not good enough to have an equitable all-round disaster through no action.

The long-term agreement has to be structured in a way that it is to the benefit of the DCs that are, or would become, major sources of GHG emissions. Often this is discussed in terms of what is equitable or fair. But, ultimately, burden sharing will be decided on pragmatic grounds. The DCs cannot be compelled to take actions that are not clearly in their self-interest; they will choose courses that best support their many objectives, including very prominently economic

development. If we are serious about stabilizing concentrations of GHGs, this can be achieved only with substantial mitigation in the DCs, probably well in excess of what would be within their self-interests. So, for any strategy to be successful at stabilizing concentrations, it will be necessary to structure agreements such that the burden is shifted very much on to the developed countries. One framework that can readily be designed to achieve this result is a system of tradable emission rights. It can provide a framework in which GHG emissions are mitigated in industrialized and developing countries, with the costs of mitigation being borne largely by the wealthier countries while accommodating the development goals of poorer nations.

As seen in Figure 7, developed countries are farthest down the road of not sustainable production and combustion, and must redirect their economy most drastically toward a development path C. The DCs must now start redirecting their technologies and economies as well. There has to be a change in lifestyles; this is not easy. However, sacrifices have to be made; this requires a movement away from a target-based approach. In other words, without the shift in obligation, we need to focus mutually cooperative, action-oriented approach with less emphasis on legally binding targets.

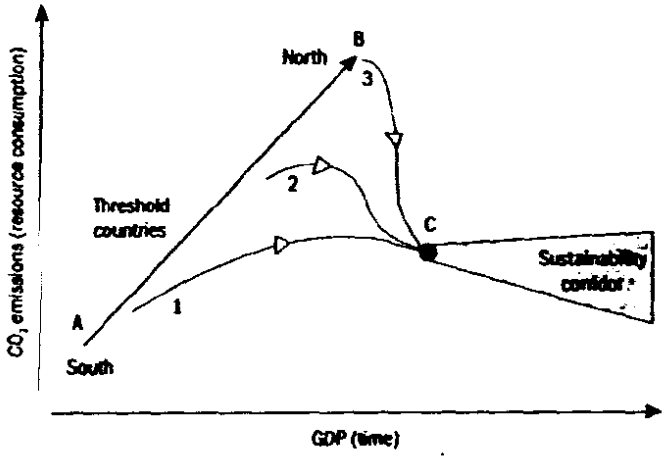

Figure 7 Sustainability corridor
Source INFRAS AG/TERI (1997)

The policy question that the IPCC is trying to provide answers to is the future level of stabilization. An agreement on the level of stabilization can be flexible; what is required is to initiate a dialogue on various alternatives to define equity. The basis for burden-sharing should be indicators that were considered when differentiation was discussed, for example, economic growth rate, as a surrogate for development.

Per capita emissions or per capita income levels are ideal but naive solutions and probably the most realistic option would be based on GHG intensity. The DCs can demonstrate participation by adopting 'leapfrogging' as a development strategy, i.e., adopt sustainable and better technologies early in the process of development.

Not everything hinges on negotiations and agreement. Social change comes about with changes in values and behaviour. Adoption of new technologies would contribute to addressing this problem. The Kyoto Protocol certainly sends out a message about the direction, namely to move away from fossil fuels, which would pave the way for global consensus. It is being recognized by all including multi-national corporations that it is important to adapt to survive. The value of the Kyoto Protocol is above and beyond what it says.

A consensual approach is the only way out. While political negotiations continue, efforts should be made to identify sectors, technologies, and constituencies that contribute towards meeting the objectives of the UNFCCC, independent of the political process. The focus could be on negotiating acceptable and desirable energy regimes rather than on contentious issues such as targets for emissions reduction. The critical goal is to transform the global economy from its current dependence on fossil fuels to sustainable energy forms such as renewable energy sources.

In doing this, the corporate sector's role is integral. Some leading business entities have responded quite positively to meet this challenge and perceive it as good business sense. This is typified by the actions being taken by the Shell Group of Companies, British Petroleum, and DuPont. Rather than being passive observers, these companies are proactive in finding avenues within their business operations to limit emissions.

- Shell International Renewables will be investing 500 million dollars in the next five years to build a commercial

business in this field. The focus of Shell Solar is on photovoltaics and biomass energy. Shell Forestry is concentrating on energy plantations that will provide feedstock for biomass energy, as also fix CO_2. The aim is to explore the possibility for large-scale power generation using wood gasification.

- British Petroleum is as innovative as the Shell Group of Companies in seeking solutions to the climate change issue. British Petroleum has committed to reduce its global GHG emissions by 10% below 1990 base levels by 2010. Further, it has installed an emissions trading system among 12 of its business units. These units represent 25% of British Petroleum's global emissions, and it is envisaged that by 2003, against a baseline of 1995, it can effect a 3% emissions reduction.
- DuPont has set the goal of deriving 25% of its revenue in 2010 from areas other than those requiring depletable raw materials. Also, it aims to source 10% of its energy needs in 2010 from renewable energy sources.

Eventually, the global civil society, industry, and the scientific community need to get involved in the process. A decentralized response, without being part of a coherent national or international agreement, could perhaps be more effective. An international treaty is only symbolic and provides legitimacy.

Conclusions

While the Kyoto Protocol is perceived as a major achievement by many of the respondents, there is a significant divergence of views on the provisions in the Kyoto Protocol – some strongly endorsed the flexible mechanisms, rejecting strict rules of supplementarity, others feel the contrary. There is almost a consensus that non-ratification by the US should not overwhelm the entire process. Also, it became apparent through the responses that although a longer-term agreement to limit GHG emissions is essential, it should not dominate the negotiation agenda to the extent that short-term goals are ignored.

An overwhelming need to take initiatives now and capitalize on agreements came through in this exercise. In sum, the above analysis leads us to the following conclusions.

- The Kyoto Protocol is, by and large, perceived as a major achievement.
- The reaction to QELRCs is mixed. But the QELRCs need to be viewed in the context of the non-existent compliance mechanism. This, in effect, translates the commitments into a target or a guidance path.
- The flexibility mechanisms are considered to be an important part of this international agreement. It does seem, however, that the issue of hot air is perceived to be against the spirit of the Convention, bringing about no real reductions in emissions. As such, one approach would be to explicitly exclude hot air from any measures used to fulfill commitments under the Protocol. What this would translate into essentially is that trading in emissions be restricted primarily to the CERs from the CDM and the *certified* ERUs (emissions reduction units) generated from the JI mechanism. The considerable potential that exists for cost-effective emissions reductions from countries such as Russia and Ukraine could then be exploited tangibly and with real and measurable reductions in GHG emissions. As a reciprocal measure, the demand in relation to the issue of supplementarity could be more accommodating.
- There is almost a consensus that non-ratification by the US should not overwhelm the entire process and result in a 'do nothing' scenario. It is important, for the spirit of the Framework Convention to survive, that the Kyoto Protocol is ratified with an obvious desire that the US would be in a position to stamp its endorsement of the same soon.
- Non-Annex 1 countries should be responsive to mechanisms such as the CDM, under the rules and guidelines developed, and this should suffice as 'meaningful participation' by them for the first commitment period. In addition to a proactive approach to the CDM, it is necessary for the DCs to highlight the actions/efforts that are being undertaken to reduce CO_2 emissions in the absence of any legally binding commitments. These efforts need to be recognized globally.
- The question with respect to the participation of the DCs is not 'whether' but rather 'when' they can take on legally binding targets. In other words, the DCs have initiated conducive policies and measures, but are at a stage where they can contribute in a limited way. The onus is on the

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Annex 1 countries to show leadership and demonstrate the way forward.

- There is a need for scientists to define different stabilization scenarios. These will determine the magnitude of collective action required. Theoretically, equity principles should prevail in determining burden-sharing. In practice, the agreement on any formulation for burden-sharing will evolve and be influenced by the ability to pay and the willingness to pay. It is hoped that ultimately moral pressures will prevail rather than political bargaining.
- Also, it became apparent through the responses that although a longer-term agreement to limit GHG emissions is essential, it should necessarily be the aggregate of a series of shorter-term measures that would need to be defined. There exist synergies between the short term and the longer term. The short-term policies have to be forward-looking to induce technological innovation and a change in lifestyles. This would require increasing the participation of countries, not only governments, but also the scientific and social community. This will bridge the many 'divides' – between the North and the South, science and politics, and between the present and future generations.
- There is a need to look for areas of agreement – and perhaps there is a greater probability of having identical views on the future global energy regime. Creating such a consensus builds confidence for concerted action – lifting attention beyond the limiting scope of Kyoto and frozen postures. Already Annex 1 corporates are focusing on the future, as exemplified by Shell's scenario of 50% renewables in 2050 and its commitment to spend 500 million dollars on renewables in the next five years. DuPont's commitment to source 10% of all its energy from renewables by 2010 is another example.
- There is a need to define business opportunities for the North arising out of such a future scenario and possible local benefits for the South – e.g., grid independent power and lower pollution at the local level. Perhaps, there is need for a 'partnership protocol' beyond Kyoto, on which discussions should start now for finalization by 2005 or so, to focus on actions to reach the above vision – moving away from burden-sharing to initiative-sharing.

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The mission of the Centre is to undertake research and outline policy initiatives that integrate developing country concerns in the search for effective and equitable solutions to global environmental challenges.

The Centre's activities focus on Asia, and specifically India. Capacity building in other developing countries, which assists them in fulfilling their commitments under the Climate Change Convention, is undertaken. The scope of activities range from preparing inventories of GHG (greenhouse gas) emissions, abatement strategies and policies, assessments of impacts, and climate change adaptation strategies and policies, to examining financing options and mechanisms for implementing GHG mitigation strategies and projects. The Centre actively tracks and analyses issues arising from the climate change negotiations. This involves interacting with negotiators from India and other developing countries. The Centre also provides inputs to the IPCC (Intergovernmental Panel on Climate Change) – contributing to the IPCC Special Reports on Sinks, Technology Transfer, and in the Working Groups II and III of the Third Assessment Report. The recently established TREAT (TERI Repository of Environmental Activities and Technologies) within the Centre would function not only as a mechanism for information dissemination and exchange, but also develop, in a proactive manner, a portfolio of potential abatement projects in India and provide technical assistance to implement such projects. Trade and environment is a complementing research area.

- *Lao People's Democratic Republic national CHG inventory project* [UNDP–GEF, New York, USA]
- *Enabling activity for the preparation of national communications for the Democratic People's Republic of Korea* [UNDP–GEF, New York, USA]
- *REAT* [Different sponsors for each programme]
- *North–South financial flows project* [World Resources Institute, Washington, DC, USA]
- *CDM/Activities Implemented Jointly (AIJ) project* [CIDA, Quebec, Canada; IISD, Winnipeg, Canada; Pembina Institute for Appropriate Development, Alberta, Canada]
- *International Energy Agency GHG R&D programme* [Federal Office for Foreign Economic Affairs, Government of Switzerland, Berne]
- *ALGAS-India (Asia Least-cost Greenhouse Gas Abatement Strategy)* [Asian Development Bank, Manila, The Philippines]
- *A survey of Indo-Japanese trade focusing on the environmental considerations in select industries* [NEDO, Tokyo, Japan]
- *Preparation for the Fourth and Fifth Sessions of the CoP to the UNFCCC* [Swiss Agency for Development and Cooperation, New Delhi, India]
- *Technology opportunities to reduce GHG emissions in key developing countries and emerging economies* [Lockheed Martin Energy Research Corporation, Oakridge, USA]

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KBA
FAX : 651 8807

FICCI

FEDERATION OF INDIAN CHAMBERS OF COMMERCE AND INDUSTRY

M. A. J. Jeyasselan
Secretary

August 1, 2000

The Louis Berger Group Inc.
C 6/7, Safdarjung Development Area
New Delhi 110 016

Dear Sir:

Subject: GEP-CCS Project – CLIN 04: Communications and Information Outreach Forum on Climate Change Research

This is with reference to the dialogue we had with you on the above subject. We would be glad to provide information support facilitation services to the forum institutions for the research on climate change and its impact on economic development in India under the above project.

Thanking you

Yours faithfully,

M. A. J. Jeyasselan

FEDERATION OF INDIAN CHAMBER OF COMMERCE & INDUSTRY (FICCI)

Federation of Indian Chambers of Commerce and Industry (FICCI), the leading apex chamber in India, has been playing a catalytic role in the economic development of the country since 1927. Backed by a nationwide network of regional, state and local chambers of commerce and industry, trade and industry associations, professional institutions, bi-national chambers of commerce, corporate bodies and private firms, FICCI represents directly and indirectly over 1,00,000 business units, small, medium and large employing over 10 million people.

FICCI has a strong international networking. It is the nodal agency in India for International Chamber of Commerce (ICC), Confederation of Asia-Pacific Chambers of Commerce (CACCI), SAARC Chamber of Commerce and Industry and is also the Secretariat for Indo-US Commercial Alliance, India-South Africa Commercial Alliance and India-Israel Business Alliance. FICCI is also coordinating the Indian Ocean Rim Business Center and the IORNET – an online information exchange service for the 14 member countries of IOR-ARC.

In the emerging global village, Joint Business Councils' (JBCs) agreements with 64 countries provide a forum for promoting trade, investment and technology flows between partner countries. JBCs are jointly sponsored by FICCI and ASSOCHAM from the Indian side and the leading Chamber of Commerce and Industry in the partner country.

FICCI has twenty-six Committees and expert desks to deal with various sectors of the economy supported by a Secretariat of 250 well-trained experts. Foreign Investment and Trade Promotion Office (FITPO) of FICCI is the gateway to foreign investors and provides much needed matchmaking services.

FICCI has formed a Quality Forum, which strives to enhance quality awareness among India's entrepreneurs. The Socio-Economic Development Foundation of FICCI works for the social sector development of the country through specific projects on health education and population modernization. FICCI has also set up specialized bodies to cater to sectoral interests including the All India Organization of Employees (AIOE), All India Shippers' Council (AISC) and Indian Council of Arbitration (ICA). The FICCI Ladies Organization (FLO) and Economic and Scientific Research Foundation (ESRF), Confederation of Indian Food Trade and Industry (CIFTI) and Food Research and Analysis Center (FRAC) add special value to FICCI's national and global initiatives.

CLIMATE CHANGE ACTIVITIES

Climate change transcends all borders. It is a global issue that concerns all. FICCI has established the Environmental Information Center (EIC) with a view to promoting and facilitating industry actions for environmental improvement, compiling and disseminating business relevant information on CC, energy efficiency, clean technologies and for providing technology intermediation services to the Indian industry. The Climate Change India website has been developed under USAID/India GEP project's Climate Change Outreach and Awareness Activity (CCOA) component by FICCI. The website aims at generating greater awareness about this vital issue and the initiatives being taken at both national and international levels to enable industries make decisions on mitigation efforts. The website provides information on topical Environmental issues related to global climate change, like the Clean Development Mechanism and the Kyoto Protocol, etc. and has a compendium of information on the Indian scenario.

The Global Climate Change section provides information on the science of climate change, global climate change treaties and conventions, and ODS regulations of countries. The Clean Development Mechanism section an overview on the CDM and research papers relating to the issue information on the greenhouse gas inventory in India, policies and programs, look up the Indian Scenario section. The site also provides a detailed guide on opportunities for Indian industries to reduce their greenhouse gas emissions and to develop projects towards mitigation. Details in this regard are available under the Project Guide section of the Handbook. The Funding Options section provides information on how to secure funding for various mitigation projects as well as the sources of funding.

The site also provides links to the sources of greenhouse gas mitigating technology providers through the Techno Sources section. The site helps keep the industry updated on major climate change events taking place worldwide in the Event Calendar section and provides a list of publications on climate change related issues in the Publications section.

The site is maintained and operated by the Business Information Services Network (BISNETWORLD) of FICCI.

Proposed role under the CLIN 04 of the Climate Change Supplement (CCS) component of GEP project

As a resource created under a previous project of the USID/India EIC FICCI is interested in extending services to the US and Indian institutions hosting forums. These services would mainly be of the nature of "Information Provider". The website could work as the information repository and could be used to solicit views from the research community at large. This could be achieved through various means like invited articles, discussion groups, opinion polls etc. EIC would be providing the information back up to all the forums and would enable dissemination of information on a regular basis. The final

research paper could then be made available on the site for reference purpose to the industry and Governments.

GLOBAL CLIMATE CHANGE

Human activity around the globe has reached a level where it is beginning to affect the earth's climate. Climate change is now becoming one of the major global environmental challenges, requiring new levels of international cooperation and portending potentially dramatic changes in many economic sectors. Even in fairly optimistic scenarios, carbon emissions from burning fossil fuels (in the form of CO2) are predicted to increase quite dramatically. They will probably double from a total of 6.5 Gigatons of carbon today to 13.8 Gigatons by 2050. Overall, about 80% of greenhouse gas (GHG) emissions from human activities are related to the production and use of energy and particularly the burning of fossil fuels. The bulk of the remaining 20% is associated with agriculture and changes in land use (such as deforestation).

The IPCC predicts that, unless policies to reduce GHG emissions are widely implemented, global average temperatures will rise a further 1–3.5 degrees Celsius by the year 2100, with sea levels rising too. That means the rate of warming over the next century could be greater than any that has occurred over the last 10,000 years, the period over which civilization developed. This warming would bring about adverse impacts on human health, ecosystems, agriculture, water resources, and human settlements, inter alia.

Moreover, the impacts of the warming are likely to lead to higher costs for developing countries than for industrialized countries (warming of 2–3 degrees by 2100 has been estimated to cost developing countries 5–9% of GDP), as well as major disasters for island states and low-lying countries such as Bangladesh. India is the sixth largest emitter of GHGs in the world. Its rate of growth of GHG emissions is more than double the world average – 4.6% growth annually versus 2% for the world average. Net emissions of CO2, the largest contributor to global warming, doubled in India between 1980 and 1990. Thus India will be an important player in meeting the climate change challenge in the coming years.

Nations around the world have been organizing a global response to the climate change challenge. In 1992, most nations signed the United Nations Framework Convention on Climate Change (UNFCCC). Subsequent meetings of the Conference of the Parties established the Kyoto Protocol where industrialized countries committed to reduce their GHG emissions to below 1990 levels. The Kyoto Protocol also established flexible mechanisms for countries to meet their GHG reduction commitments, including the Clean Development Mechanism, where companies in industrialized countries can invest in developing countries, such as India, to achieve carbon reduction objectives.

The potential benefits of participating in efforts to address climate change are available now and in the immediate future. India could take advantage of these efforts to address

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climate change and thereby increase foreign direct investment, technology transfer, and job creation while reducing environmental impacts.

This website is intended to be the definitive source of information on climate change issues in India. It contains up-to-date statistics and analysis on the policy, legal, financial, and development facets of the climate change debate. We hope that researchers, government, industry, academics, and civic society will be informed and provoked by its contents, and that it will enhance the caliber of the global debate on this pressing issue for the new millenium.

CLIMATE CHANGE - INDIA

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Objectives

- Promoting and facilitating industry actions for environmental improvement and management.
- Compiling and disseminating business relevant information on global climate change, energy efficiency, clean and climate friendly technologies and other topical environmental issues.
- Providing technology intermediation and business-to-business matchmaking services to the industry in support of its environment related initiatives.

EIC serves as

- A Clearinghouse for Environmental Technologies, Products & Services
- A Single Window for foreign companies to reach out to Indian companies
- A Database Provider for Environment Related Information
- An Intermediation Mechanism for specific queries
- An Outreach Cell for Indian companies to reach out to their potential clients as well as to achieve pollution reduction objectives

EIC Databases

Cleantechindia is your information source on

- Environmental Regulations in India: Information on all Indian environmental regulations, acts, notifications and minimal national standards, covering all central as well as state level regulations.
- Environmental News: The latest in Indian and global environmental news filed by EIC's special correspondents and also culled out from various sources.
- Guidelines & Manuals: Elaborate Guidelines and Manuals on environment impact assessment, environmental audit, consent management and others.
- Best Practice Guides: Best management practices applicable to different sectors.
- Checklists and Tech-tips: Take quick steps with the help of Pollution Prevention Tips, Waste Minimization tips and Checklists for different industries and sectors.
- Indian and International Success Stories: Case studies of companies and organisations who have implemented environmental management practices and have demonstrated environmental excellence.
- Technology Options: Get information on various environmental technologies pertaining to different media and applicable to different industries.
- Technology, Product, Service Sources: Listing of companies

EIC Services to Industry

- Business Promotion Packages – Dynamic and Interactive Homepages, Product & Technology Showcases, Advertisements
- Hosting Business Enquiries, Company Profiles & Technology Profiles
- Information Referral Library
- Organising One-on-one Business Matchmaking, Seminars, Conferences and Workshops
- Walk-in services at Delhi, Mumbai, Calcutta and Hyderabad
- Intermediation services for technology solutions
- Single window Information Service

Environmental Information Centre
Federation of Indian Chambers of Commerce & Industry (FICCI), New Delhi
Federation House, 1, Tansen Marg, New Delhi 110 001
Tel: 3325110, 3738760-70 (Extn. 354, 339)
Fax: 91-11-3721504, 3320714
Email: eic@ficci.com
Contact: **M A J Jeyaseelan,** Secretary (FICCI) & Executive Director (BISNETWORLD)
Rita Chaudhury, Manager

EIC Regional Centres...

EIC Eastern Regional Centre
Indian Chamber of Commerce (ICC), Calcutta
4, India Exchange Place, Calcutta-1
Tel.: 033-2202342, 2202344, 2203976,
Fax: 033-2204495
Email: icccal@giascl01.vsnl.net.in
EIC Western Regional Outreach Centre
United States Environmental Resource Center
Indo-American Chamber of Commerce
I-C, Vulcan Insurance Building, Veer Nariman Point, Churchgate, Mumbai 400 020
Tel: 91-22-2821413, 2821485, 2836340
Fax: 91-22-2046141
EIC Southern Regional Centre
Federation of Andhra Pradesh Chambers of Commerce & Industry (FAPCCI), Hyderabad
Federation House, # 11-6-841, Red Hills
P.B. No. 14, Hyderabad 500 004
Tel.: 040-3393428, 3393658
Fax: 040-3395083, Telefax: 040-3393712
Email: fapcci@hd1.vsnl.net.in

and organisations offering environmental technologies, products and services.

- Business Enquiries: Search for or register business enquiries on environmental technologies, equipment, instruments, products and services relating to joint ventures, marketing arrangements, export and import offers, technology tie-ups, etc.
- Global Climate Change: A whole range of information on global climate change issues covering climate change treaties and conventions, country reports, greenhouse gas inventory in India, ODS regulations and measures, and clean development mechanism issues.
- Contact Directories of Environmental Organisations worldwide: Get comprehensive mailing lists and merge lists of environmental companies, organisations and agencies arranged by country.
- Calendar of Environmental Events: Get list of upcoming environmental events in India and abroad, which includes seminars, workshops, conferences and training programmes.
- Publications Index: An index of environmental publications searchable through keywords.
- Global Web links: Links to other sources of environmental information across the globe, provided in clearly sorted topics and searchable with keywords from the EIC database.

India's first Portal Web site on Environment

www.cleantechindia.com is a highly interactive and content rich web site providing environmental information relevant for Indian Industry. It also offers dynamic features for environmental technology and service companies in India and abroad to register their product and services and keep them updated with the help of online forms.

Cleantechindia.com provides a large volume of textual information covering regulatory framework, technology options, best practices, check lists and environmental status reports.

It offers a large database of technologies, sources of technologies and consultancy services and environmental business directories. All in an easily searchable format using multiple parameters.

Other features in the website include discussion forums on different environmental subjects. There are a large number of hyper links to all the important web sites on the internet providing environmental information.

Cleantechindia is also accessible from other major web site services of FICCI such as www.ficci.com, www.bisnetworld.net, www.iornet.org, www.saarcnet.org which provide a variety of business information and business match making services.

Cleantech India

FICCI

Towards Green, Clean & Competitive Enterprises

www.cleantechindia.com

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www.bisnetworld.net

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- Explore business opportunities in the Indian Ocean Rim countries through the IORNET www.iornet.com
- Establish business links with African countries through Bisnet-Africa www.bisnetindia.com/africa

Unrivalled Business Utility Services

- Become a part of India's largest business directory on the Internet
- Showcase all your products and services with pictures and specifications
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- Make instant announcements and upload information from single or multiple locations
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- Avail of contextual hyper links to your home pages and product/service showcases
- Find business enquiries, tenders and trade fair information related to your business
- Get regularly updated country, state and industry profiles
- Use Bisnetindia's policy update database to regularly track changes in Govt. regulations
- Avail of special database services on environment, energy efficiency and agribusiness

Federation of Indian Chambers of Commerce and Industry

For Membership and other details contact:

BISNETINDIA, FICCI, Federation House, Tansen Marg, New Delhi - 100 001

Tel: 91-11-3721503 / 3738760 (Ext. 321) Fax: 91-11-3320714 / 3721504 E-Mail: bisnet@bisnetindia.com

ENVIRONMENTAL TECHNOLOGY NEWS

EATTLE PLEDGES ZERO REENHOUSE GAS MISSIONS

ATTLE, Washington, April 13, 2000 NS) - The City of Seattle plans to ibrace renewable energy and energy iciency to drop its emissions of eenhouse gases to zero. The City uncil has unanimously adopted a posal to meet Seattle□s future electricity eds with no net emissions that are ked with global warming and climate ange.

e goal will be met through reliance existing hydropower and velopment of new wind, geothermal, lar and landfill gas facilities, as well gy conservation measures. If any ssil fuels are required to meet ectricity demand, the City plans to fset the carbon emissions through her measures such as forest otection.

IK MOVES TO ELIMINATE OXIC PCBS

ONDON, England, April 13, 2000 (ENS) The United Kingdom announced new easures today to phase out and dispose f toxic polychlorinated biphenyls (PCBs). nvironment Minister, Michael Meacher id the regulations are intended to reduce nvironmental damage from the hemicals which can harm sea mammals cluding seals, otters, dolphins as well as olar bears.

h vironmental Protection Regulations 000 (Disposal of Polychlorinated iphenyls and other Dangerous ubstances) tabled in the House of Commons provide for the phasing out and destruction of identifiable PCBs and certain PCB substitutes, along with associated equipment.

The regulations deal with remaining PCBs found in electrical equipment such as transformers and capacitors.

The new regulations apply to England and Wales. Similar regulations are being introduced separately for Scotland and Northern Ireland.

DOE BUILDS WORLD'S FIRST HYBRID FUEL CELL TURBINE

PITTSBURGH, Pennsylvania, April 18, 2000 (ENS) - The world□s first hybrid fuel cell power plant has been built and is beginning a cross country trip to its test installation in Irvine, California. The new power plant, the first in the world to combine a state of the art fuel cell with a gas turbine, is one of the cleanest and most efficient ways to produce electricity. Its success could help usher in a new option for the world□s electric power industry - a source of power that would not require combustion. "America□s need for electricity is growing. This innovative hybrid fuel cell turbine will help meet that need by providing us with reliable electrical power-generation resources," said Energy Secretary, Bill Richardson. "This is a tremendous achievement that will promote cleaner and more efficient production of electricity."

The advanced technology relies on a solid oxide fuel cell which is an assembly of *ceramic tubes that each operates like a*

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Environmental Information Centre is a Joint Project of

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never run down as long as fuel - in this case, natural gas and air are provided. Siemens Westinghouse has completed a factory acceptance test of the power plant and will now transport it to the National Fuel Cell Research Center at the University of California-Irvine, where it will be operated by Southern California Edison for a year of testing in a commercial setting. When installed, the system is expected to generate electric power at 55 percent efficiency - meaning that 55 percent of the energy value of the natural gas fuel will be converted into electricity. A conventional coal plant, by contrast, converts only 35 percent of its fuel into electricity, while today□s natural gas turbines average just over 50 percent.

Powerful Pulsed Ultraviolet Light Headed for Municipal and Industrial Use

RESTON, Va., March 20-E-Wire-LightStream Technologies, Inc. announced engineering breakthroughs today that will accelerate the large-scale application of advanced chemical-free pulsed ultraviolet (UV) light, the long-anticipated treatment technology that could replace chlorine and its associated health risks in water disinfection by municipalities and industry. According to company officials the breakthroughs achieved in scale, performance and cost will result in the advanced disinfection technology becoming commercially available later this year.

Pulsed UV dramatically enhances the advantages of ultraviolet light for water disinfection by delivering the light in high-intensity pulses that can be repeated many times per second as water moves through a reaction chamber. These advances have been the focus of research and testing for several years by academia, governments and industry because these pulses deliver the disinfection effects of UV at intensities thousands of times stronger than conventional UV systems and without the risks associated with chemicals such as chlorine. Research has further documented that pulsed UV is effective in dealing not only with bacteria but also a wide range of pathogens in water such as Cryptosporidium which is of increasing concern to public health officials and against which chlorine has been found to be ineffective. The US Environmental Protection Agency and other world regulators have also begun restricting the use of chlorine due to the discovery of disinfection by- products that have been found to release carcinogenic volatile organic compounds.

Managing waste disposal, the economically intelligent way

As environmental drawbacks of wast disposal methods like land-filling and incineration become evident, the process of biomethanation of waste by anaerobic digestion offers several benefits - economic, environmental and social. End products are valuable biogas and good quality orgnic manure. Internationally, this technology has been recognised for its pollution abatement schemes of solid and liquid organic waste. TERI-INDIA has developed a high rate digester for fibrous and semi-solid municipal solid waste that promises to revolutionize the waste disposal industry. This TEAM (TERI Enhanced Acidification and Methanation) process is quick, economically vible, and apt for food and agro-based industries, including vegetable mandis.

Environmental Agenda for 21st Century

"The new environmental agenda of the 21st century should be one that drives continuous environmental improvement to accompany continuous economic and social gains. This new environmental management agenda must aim at continuous environmental improvement that respects the importance of social and economic health. It must drive continuous environmental improvement to accompany continuous economic and social gains.

This integrated approach must recognize that there are economic and social dimensions to almost every environmental issue, and that they are often interrelated or connected. Therefore, the focus of this functional integration must be to replace the traditional compartmentalization of environmental problems. Instead policy makers must work with crosscutting concepts that allow all aspects of an environmental issue to be addressed.

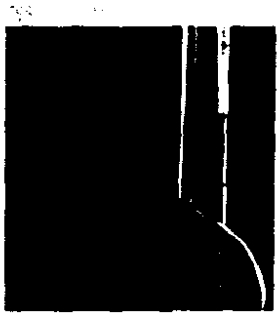
Voluntary action has been taken by many of the world□s major industries to reduce resource use and eliminate waste. The fact that these actions are in industry□s own economic self-interest does not detract from their environmental significance. On the contrary, the happy discovery that what is good for the environment can also be good for business may do much to reverse trends for which industry itself was originally largely responsible. This 'win-win□ situation bodes well for the planet."

Professor Klaus Topfer, Executive Director, UNEP

at the FICCI-TERI Global Conference "Green 2000 : Agenda for Business"

ENVIRONMENTAL STATUS REPORT OF CHLOR ALKALI INDUSTRY

INDUSTRY PROFILE



Raw Materials used

The raw materials used by the Chlor Alkali industry are Sodium Chloride, Barium Carbonate, Sodium Carbonate, Sodium Sulphite, Sulphuric Acid (98%), Flocculant, Alpha Cellulose.

Product Range

Main Product is Caustic Soda. Main by-products include Chlorine and Hydrogen. Other by-products include Hydrochloric Acid and Sodium Hypochlorite.

Products/By Products Application Areas

Caustic Soda is used in Aluminium, Paper, Textile, Soap, Viscose Staple Fiber, Dye Intermediates, Pharmaceuticals, Etc. Chlorine (for end-use Industries) is used in PVC, Paper, Textiles, Chlorinated Paraffin Wax, Stable Bleaching Powder, Pesticides, Water Treatment, Hydrochloric Acid, Etc. Hydrogen is used in Hydrochloric Acid, Hydrogenated Vegetable oils, as Fuel, Etc.

chnologies Used

Caustic Soda is manufactured by Electrolysis of Brine in Electrolytic Cells falling in the following three categories:-

Mercury Cells

- Formation of Chlorine and Amalgam of Sodium with a flowing stream of Mercury which also serves as Cathode.
- Amalgam is subsequently reacted with water in a Secondary Cell (Denuder/Decomposer)
- Formation of Caustic Soda and liberation of Hydrogen in Secondary Cell

Diaphragm Cells

- Insertion of porous diaphragm of Asbestos between electrodes to prevent reaction of Chlorine liberated at the Anode with Caustic Soda formed at the Cathode.

Membrane Cells

- Anolyte and Catholyte are separated by a Cation Exchange Membrane
- Transfers Sodium Ions but Supresses migration of Hydroxyl ions from the Catholyte into Anolyte and Chloride ions from Anolyte to Catholyte.

(Remarks: Capital cost of Conversion of Mercury and Diaphragm Cells into Membrane Cells is very high but the Environmental Hazards of Mercury and Asbestos are eliminated on Conversion. Membrane Cell Technology is State of the Art Environment Friendly Technology.)

KEY ENVIRONMENTAL PROBLEMS

Liquid Effluent/Wastewater: The liquid effluent and wastewater problems arise due to Mercury Contamination in Mercury Cells, High TDS (Total Dissolved Solids) Streams, Residual Chlorine, Alkaline Stream from Evaporator House, Acidic Stream from Hydrochloric Acid: Washings; Leakages/overflowings from Vessels/Pipes, and Asbestos fibre from Cell Renewal Section of Diaphragm Cells.

Air Emissions: The air emissions problem arises due to Mercury Contamination due to Hydrogen Venting and due to Cell Failure/ Power Failure; Chlorine Contamination; and Hydrochloric Acid Mist Emissions from absorber cooler and during start up of plant.

Solid Waste: The solid waste problems arise due to Mercury in Brine Mud in Mercury Cells; Calcium, Magnesium and Sulphate Concentration in Brine Mud; Chlorine in Brine Mud; Used Asbestos from Cell Renewal Section; and Spent Membrane from Membrane Cells.

Noise Pollution: It is mainly due to operation of Chlorine Compressors used in liquefaction of Chlorine.

CURRENT COMPLIANCE STATUS

Air Pollution Control System with regard to WAD (Waste Air Disposal) has been set up in each unit mostly through use of Lime as absorbtion chemical for Waste Chlorine. Due to difficulties in discharge of Calcium Hypo Sludges, the system is being replaced with an improvised system based on Caustic Soda as absorption chemical. All the industries receiving Environmental Clearance after Environment Impact Assessment (EIA) notification of May 4, 1994 are setting up WAD capacities according to calculations arrived after dispersion modelling of various rupture scenarios.

WAD Towers are well maintained to control chlorine emission standard of 15 mg/Nm3 in the vents by taking care of the system during design stage. However, WAD systems are generally not tried through actual simulation of design conditions for destruction of Waste Chlorine.

Chlorine utilisation in India for the last three years is cent percent.

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Mercury emissions are still problematic but field studies are being taken up for Mercury Stabilisation so that Environmental Contamination is avoided.

Hydrochloric Acid Plant tail gases are controlled to achieve the emission standard of 35 mg/Nm3 by most of the industries through scrubbing with alkaline water in one or two stages.

Asbestos Fibre for use in Diaphragm Deposition in Diaphragm Cells Manufacturing Process is handled in the Industry in a mechanised manner to avoid body contact and the exhausted fibre is dealt with in the industry as per guidelines of Hazardous Waste (Management & Handling) Rules, 1989.

Chlor Alkali Industry is not a water intensive industry and therefore the liquid effluent discharge parameter (4T/T of Product in Mercury Cells and 1T/T of product in Membrane Cells) is well complied with. The standard of Cooling Tower Discharge is not only being complied with but the bleedings from Cooling Towers are reused/recycled with in-plant systems or for maintaining Green Belts in most of the Industries.

SUCCESSFUL INITIATIVES

Liquid Effluent

General Control for all processes

- By Segregating and adopting treatment to various streams as under:- Mercury Bearing Streams; Chlorine Bearing Streams; High TOS Streams; Alkaline and Acidic Streams: Good Water Streams generally emanating out of bleedings, blow downs, condensation and evaporation processes etc.)
- Reuse/Recycling of effluents wherever possible with or without treatment within the plant
- Good house keeping and conservation of water through control on overflowings and leakages.

Treatment

Mercury Cell: The industry has adopted following processes to control the Mercury pollution:-

Amalgamation Treatment; Reduction Treatment; Sulphide Treatment; Ferrous Chloride Treatment; Magnetic Ferrite Treatment; and Ion Exchange & Chelating Resin Treatment.

Diaphragm Cell: Control of Asbestos is done by separation of Asbestos from Cell Renewal Section Washing (effluent) through Screening/Settling and Recycling of Supernatant liquor and then treatment/disposal of Asbestos sludge in closed system (without exposure) as per Hazardous Waste (Management & Handling) Rules, 1989.

Removal of Residual Chlorine from Effluent (for all processes): Chlorine escapes to liquid effluent from Chlorine Cooler Condensate and from some other sources. Treatment is done by Sodium Sulphite; and Liberation of residual Chlorine from liquid into gas by Acid and scrubbing it with Sodium Hydroxide (to make a by-product Sodium Hypochlorite).

Air Emissions

Mercury Emissions

Mercury emitted during excess Hydrogen venting or fugitive Hydrogen in Cell House is removed by first cooling the gas followed by one of following Demurcurization methods: Treatment with Chlorinated Brine or Water; Treatment with Activated Carbon; Absorption in Silver-Zinc Catalyst; and The Colomel Process. Mercury is reduced to as low as 0.0005 microgram/m3

End Box Venting is essential to remove any chance of formation of explosive mixture of Hydrogen and Air. Mercury is removed by mechanical methods of Sealing two end boxes and applying suction.

Prevention of Chlorine Emissions: It is achieved through Transfer of fugitive or residual or leakage Chlorine in a closed circuit to WAD (Waste Air Disposal) system; Complete emptying of Vessels/ cylinders before cleaning it internally with connection to WAD; Proper neutralization of Sniff Chlorine; Keeping minimum joints/ valves in Chlorine pipeline; and Regular Preventive maintenance of joints/valves etc.

Hydrochloric Acid Mist: Emission takes place from the Absorber Cooler of Hydrochloric Acid Plant due to failure of suction pump or the water sprinkling system which supplies water both for Cooling & Acid gas absorption. Control is achieved by regular preventive maintenance, avoiding overloading of Cooling/ Absorption system, and Scrubbing/Neutralisation with NaOH or Lime Solution in Tail Tower.

Asbestos from Cell Renewal Section

- Shredding of Fresh Asbestos for replacement in closed system fitted with suction system.
- Treatment/Disposal as per Hazardous Waste (Management & Handling Rules) in Closed and Sealed system.

Solid Waste

De Brining of Brine Mud

- It has been achieved to prevent contamination of land and also to affect recovery of brine
- Brine mud contains Sodium Chloride (Salt) which can be washed out by water. If the mud is filtered in a rotary filter, a mud of high consistency is achieved and filterate can be recycled.

Demercurization of Brine Mud

- Demercurization is done to stop spreading of Mercu: Contamination of very serious type.

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- Addition of Sodium Hypochlorite keeps the Mercury in Soluble form so much as to maintain Mercury levels in Sludge as low as 10 mg/l.

The above process is repeated and Mercury from washings is removed as carried out in liquid effluent.

Recovery of Mercury from Discarded Carbon anodes, cell bottom scrappings, secondary cell blocks by washing and treatment.

The best way to solve the problem of Brine mud is to produce Chlor-Alkali grade salt which can be added to depleted brine. The replenished brine then requires no further purification.

- Better quality control salt.

Evaporation of Purified Brine in Salt Fields

The ideal solution of the problem is to produce Chlor grade salt in the salt works by seaside.

Control of Waste Asbestos from Diaphragm Cell

The best way is to treat and dispose the waste asbestos in closed system as per Hazardous Waste (Management & Handling) Rules, 1989.

SCOPE FOR INTRODUCTION OF NEW TECHNOLOGIES/UPGRADATIONS TO IMPROVE ENVIRONMENTAL PERFORMANCE

Optimization of Power Consumption

Mercury Cell Based Plants

- The size of the cells can be varied within a broad range to give desired rate of chlorine production.
- Intensifying R&D work on Mercury Extraction Stabilisation processes.
- Strictly following Automatic Gap Adjustment between Anode and Cathode for achieving lower power consumption.

Diaphragm Cell Based Plants

The optimisation for higher efficiency with lower inputs is being worked out as under:-

- Higher Cell liquor caustic strength and lower steam usage in caustic evaporation versus lower cell efficiency and higher power consumption.
- Lower current density, lower voltage and lower power consumption versus additional cells and higher capital costs.
- Lower feed brine temperature, thus decreased steam usage for brine heating, versus higher cell voltage, lower efficiency and higher power consumption.
- High brine pH and reduced acidification costs versus lower chlorine efficiency higher power consumption and lower product purity.
- Use of Baked Diaphragms prepared by mixing plastic with Asbestos has potential to achieve Lower Power Consumption with the use of lower current density and lower voltage.

Each diaphragm cell chlorine plant must determine its own optimum conditions for the most economical operations.

Membrane Cell Based Plants

Membrane is the key component of a Membrane Cell. The energy requirement and the quality of Caustic and by products Hydrogen and Chlorine produced in a membrane cell depend on membrane performance. General requirements for selection of material of construction for membranes are as follows: Durability under the conditions of Chlor-Alkali electrolysis, High Selectivity for Sodium ion transport, Low electrical resistance and Sufficient mechanical strength for practical use. There is wide scope of updation of membranes for better performance and longer durability.

During New capacity addition in India, only Membrane cell Installation is permitted. Mercury & Diaphragm Cells are also being replaced phasewise by membrane cells due to Environmental Considerations. During changeover the existing facilities such as rectifiers, equipment for brine purification and product treatment are being utilised as far as possible. During conversion, monopolar electrolyzers should preferably be adopted so that the capacity of existing rectifiers and the Bus work is matched simply by adjusting the number of cell units in each electrolyzer.

There is still need for further development work on Demercurization Technologies for reducing Mercury content of 10 - 15 ppm in Brine Mud to low levels as shall be progressively prescribed by the Regulatory agencies as acceptance limits for Dumping Purposes. (At present there is no limit for Mercury in Brine Mud based on concentration level). Only the quantity of Mercury Waste has been prescribed under Hazardous Waste (Management and Handling) rules 1989 as 5 Kg per Annum.

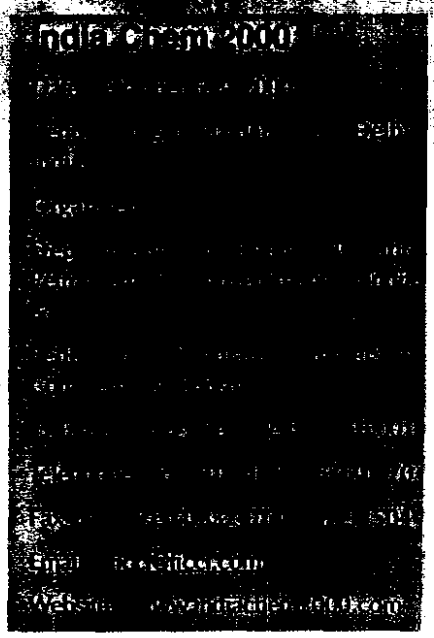
The following technologies need to be adopted to control Mercury Pollution of Brine Mud:

Mixing of Brine Mud with lot of cement and clay to make bricks and bake them in Kilns.

Incineration of Mud to recover Mercury from vapours.

Conversion of total mercury to HgS by treating with Sodium Sulphide and then using it as landfill.

Calendar of Events



Enviro International'2000

2nd International Trade Fair + Seminar on Technologies For Environment

Date : September 27-29, 2000

Venue: Pragati Maidan, New Delhi, India

Organiser:

Tm Services Ltd

Oil And Gas Consultants

48 PORTLAND PLACE

London W1N 4AJ

United Kingdom

Telephone No : 44-71 636 9156

International Meeting On Chemical Engineering, Environmental Protection And Biotechnology Exhibition

Date : May 22-27, 2000

Venue: Germany

Organiser:

Dechemda Dt

Gesellschaft Fur Chemisches

Apparatewesen Chem

Technik , Germany

Telephone No : 069-75640

Fax No : 069-7564-201

email: info@dechema.de

3rd Water Asia 2000

Date : September 18-20, 2000

Venue: Pragati Maidan, New Delhi, India

Organiser:

Interads Ltd.

Conferences & Exhibitions

A-113, Shivalik

New Delhi – 110 017 INDIA

Telephone No : 91 –11 – 6283018/ 6283019

Fax No : 91 – 11 – 6228928

email: info@interadsindia.com

Entsorga

Int□l Trade fair for recycling & waste disposal

Date : June 26-29, 2000

Venue : Cologne, Germany

Organiser:

Indo German Chamber of Commerce

PO Box 11092

Mumbai – 400 020 INDIA

Telephone No : 91-022-2186131

Fax No : 91-022-2180523

email: igcc@giasbm01.vsnl.net.in

Envirotech 2000

Date : June 5-7, 2000

Venue: Metro Toronto Convention Centre Toronto, Ontario, Canada

Telephone No : 416-385-2030

United Nations Environment Programme's Sixth International High-level seminar on cleaner production

Date : October 16-17, 2000

Venue: Montreal, Quebec, Canada

Telephone No : 519–337-3423

Fax No. : 519-337-3486

Email : c2p2@sarina.com

website : http://c2p2.sarina.com/summit

Sixth World Congress on Environmental Health

Date : June 5-9, 2000

Venue : Oslo, Norway

Organiser : Norwegian Ministry of Health and Social Affairs and The International Federation of Environmental Health

Website : www.fmh.no/ifeh/English/ start.htm

Publish Environmental Events in Cleantech India bulletin and www.cleantechindia.com

Write to EIC with details of events or mail to eic@bisnetindia.com

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Environmental Technology Focus at "India-Chem, 2000", Pragati Maidan, New Delhi, October 6-8, 2000

"INDIA-CHEM 2000" is the only Chemical Industry exposition in India which has brought together on a single platform 13 Chemical, Petrochemical 8. Pharmaceutical Industry Associations of India. The fair will spread over 20,000 sq.meters area. Over 60% of the exhibition space is already committed to leading companies from all over the world and India. USA, UK, Taiwan, Austria and Thailand are setting up special pavilions.

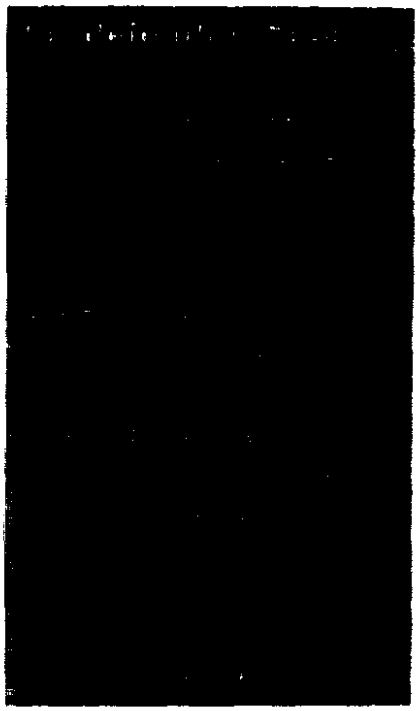
United States of America, is participating as the Partner Country. The US partnership with India Chem 2060 was formally announced by the Us Ambassador to ''a, H E Richard F Celeste at the launch function held on December 13, 1999. The US Embassy in India is actively engaged in promoting this event. A large number of American Companies will take part in this event. The US Participation is being coordinated by US India Business Council.

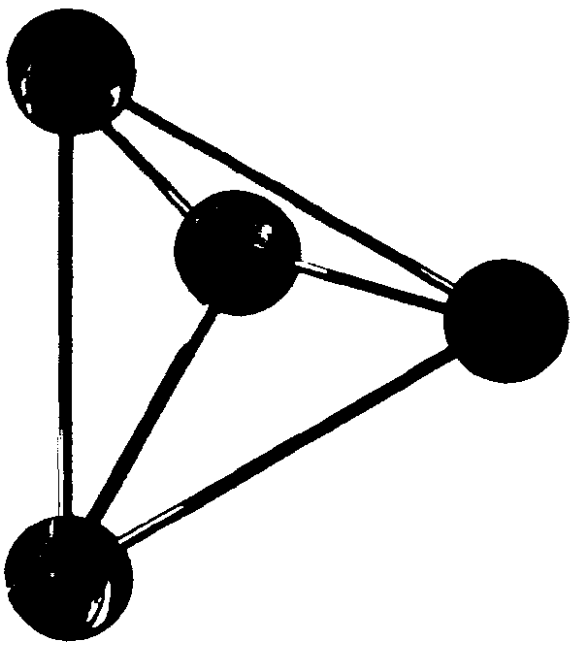
Environment and pollution control technology will be an important aspect of this event. A good number of companies and organisations working in the field of environment will participate in this event. In fact, UK is laying a special focus on environmental technologies at "India Chem, 2000".

"India Chem, 2000 will encompass practically all the segments of the chemical, petrochemical, pharmaceutical and process plant & machinery, safety, health and environment related issues.

The event will lay before the participants, an interactive platform for strategic alliances, technology transfer, subcontracting and above all export-import tie-ups on a very large scale. The show will host a number of delegations from India and overseas for one to one business meetings with the participants making the entire exhibition a focused venue for total chemical related business activity

"India Chem 2000" is slated to be an important medium for promotion of business in this part of the world. The Environmental Information Centre set up jointly by USAID, ICICI and FICCI is actively involved in promoting the environmental technology show case at India Chem 2000.





Life Cycle Assessment and Environment Management Accounting Informs Sustainable Design

Dr. Will Gibson, Ph.D.(Chief of Party, USAID-CTI Project)

Design for the environment

If prices reflected underlying environmental impacts, there would be plenty of incentive to design products that were ecologically sound. In such a system, products that are associated with less greenhouse gas emissions, or minimal water pollution, or small quantities of solid waste generation would end up being cheaper, than their higher polluting competitors. Paul Hawken (1993) has proposed such a system in *The Ecology of Commerce*: "To create an enduring society, we will need a system of commerce and production where each and every act is inherently sustainable and restorative...Just as every act in an industrial society leads to environmental degradation, regardless of intention, we must design a system where the opposite is true, where doing good is like falling off a log, where the natural, everyday acts of work and life accumulate into a better world as a matter of course, not as a matter of conscious altruism."

The gap between economic accounting and environmental management accounting presents an exciting challenge for product designers. When minimizing environmental impacts coincides with saving money, as in the case of many energy and water-efficiency measures, the choice is clear. When minimizing impacts seems to require greater expense, as in the case of nontoxic paints, the choice becomes more complicated. How much money should be spent for what level of reduced impact? Design for the Environment brings these considerations to the forefront of the design process. It asks us to explicitly consider the environmental impacts of everything we include in a design, from its raw materials stage to manufacturing processes, to the use phase and then to final disposal.

Tools that support design for the environment

In the manufacturing world, it is well-ingrained that no design gets far without budget projections, flow charts and parts inventories that reveal the economic significance of the project. There has been little or no familiarity with a parallel set of accounts that links the designs to the health of ecosystems. However, the situation is changing. This is the result of rapid development of tools such as Life Cycle Assessment (LCA) and Environmental Management Accounting (EMA). LCA attempts to represent a "cradle to grave" accounting for products processes and services, recognizing that all life cycle stages have environmental impacts. EMA attempts to objectively interpret this information for strategic decision making by converting it to a common monetary base. We have a well-accepted method for comparing dissimilar entities such as apples and oranges—monetary cost. But, do we have a similar method for comparing functionally similar products, processes, or materials with regard to quality, aesthetics, safety and environmental impact? Not quite yet, but EMA aims to be this lingua franca of cross-functional teams, consisting for example of top management; human resources; public relations/marketing; R&D engineering, environment, health & safety, production; purchasing; legal; accounting; business development; distribution and communications. A common language is rapidly developing. The emergence of a discipline called Design for the Environment (DFE) relies on the development of LCA and EMA tools.

LCA and EMA—background, benefits and uses

Sustainable development is best understood as a dynamic process of continuous improvement, wherein allocation of resources, direction of investments, and orientation of technology, as well as, the formation of laws and institutions, are shaped not only to meet the needs of the present, but also to protect the ability of future generations to meet their needs. Sustainable development can only be achieve through step-wise incremental change. EMA and LCA are the important, practical tools that help us design products that bring us closer to a state of sustainable development.

Life-cycle thinking is implied in Design for the Environment. Given its early beginning as a mass and inventory, LCA has been adept at identifying material, energy source and process substitutions that increase efficiency and reduce end-of-pipe waste problems. The consequent act of optimizing resource inputs and reducing waste outputs has made both economic and environmental sense. LCA has also been used to address environmental problems that are more global and diffused. A prime example is its application to reduce the pollution that follows the product "through the factory gate". For many products the mi

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significant environmental burdens are ·ose that are linked to the product use ase and LCA [illegible] has been used to identify [illegible] cost-effective [illegible] subsequently reduce these [illegible]

To the extent that retail consumers have increasingly used "environmental-friendliness" in choosing their purchases, LCA has become an integral part of a market-incentive approach to natural resource conservation. This market-incentive approach to environmental improvement also functions at the manufacturing supply-chain level. Environmental performance looms ever larger as a purchasing criterion, along side of cost and quality.

An example of LCA is provided by Bahouth (1994) in his paper entitled "The North American Regional Report, or the Attack of the Killer Tomato." The tomato begins its life on Mexican farmland that ıs traditionally part of a cooperative. The seed was a hybrid, though based on a Mexican strain, now patented by a genetic engineering firm that relied on government-funded research by the University of California, Davis. The land was fumigated with methyl-bromide, one of the most ozone-depleting chemicals in existence. It was then doused with toxic pesticides. The production waste from the pesticide manufacturing process was sent to the world□s largest toxic dump in a town in Alabama, next to which financially poor human communities are situated.

Mexican farmworkers, displaced from their cooperative land, were given no protection from the pesticides they applied. Nor were they given any instruction in the proper application of these dangerous substances. The workers made $2.50 per day and have no access · health care.

The tomato was put on a plastic tray, covered in plastic wrap, and then placed in cardboard boxes. The plastic was manufactured with chlorine from a town in Texas. Residents of this town face manifold health effects from exposure to dioxins, by-products of the chlorine manufacturing. The cardboard began as part of a 300-year-old forest in British Columbia, was processed in the Great Lakes, and was then shipped by truck to Latin American farms. The transportation process was fueled by oil extracted from the Gulf of Mexico and processed in Mexico.

The boxed tomatoes themselves were artificially ripened by applying ether. These rather tasteless, nutritionally-impaired tomatoes were then sent by refrigerated trucks throughout the North American continent. The trucks and distribution centers rely on ozone-depleting CFC cooling equipment. Finally the tomato arrived, weary and watery, in the salad on your plate.

Bahouth□s tomato was not deliberately chosen as a particularly destructive product. But the life cycle enquiry begins to demonstrate the vast uncovered web of environmental side effects that end products more often than not represent.

LCA and EMA applications

LCA and EMA are being used to guide cross-functional teams in:

- Identifying the relevant processes, materials, or ingredients within a given product system that are major contributors to resource depletion, waste-stream impacts and associated environmental costs.
- Comparing options of different processes, materials used, or material sources in a product system in order to minimize environmental impacts and associated monetary costs. According to Kainz et al (1993) as much as 80 percent of the potential cost-saving opportunities can be realized during the design phase.
- Comparing functionally equivalent products with regard to environmental impacts and associated costs.
- Gathering information relative to customer environmental concerns.

LCA and EMA are effective at planning and prioritizing reductions in resource inefficiencies, in major sources of waste generation, and in compliance costs and legal fees. Amidst a climate of rapidly changing environmental management challenges, LCA and EMA are a welcome support to what is a very complex decision-making process. LCA and EMA are also increasingly bringing together separate disciplines wit in a company—the result being that companies discover new and better ways of doing business.

Role of LCA and EMA in the environmental management system context

The ISO 14000 series is the most ambitious international effort ever undertaken to guide global business towards more responsible environmental practices. Key principles of the Environmental Management Systems (EMS) Standard (ISO 14001) include:

- Encouragement of environmental planning throughout the product or process life cycle.
- Placement of emphasis on prevention rather than corrective action.

LCA provides the basis of implementing these principles. It is the only assessment methodology being formally standardized by ISO. LCA puts the flesh on the bones of the ISO 14001 EMS skeleton, by helping to identify the environmental aspects of an organization□s activities, products and

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services, and subsequently to evaluate the impact of these [illegible] Subcommittees of the ISO 14000 are grappling with the challenge of providing insight into the best, most objective way of interpreting LCA information. It is this last phase of LCA, the valuation/ interpretation phase, that is the realm of EMA. One approach that has been put forth is called Environmental Priority Strategies in Product Design (EPS).

The focus of EPS is sustainable product development. EPS is an "enviro-accounting" method that attempts to work in concert with the scale-setting of the environmental goals defined by the Swedish Parliament and the Rio Declaration of 1992. It represents a valuation scheme to facilitate the comparison of disparate environmental impacts by translating them to a single quantitative dimension (Steen, 1995). EPS is an early attempt at a comprehensive EMA approach that is applicable to improved environmental product design.

LCA and EMA in the context of life-cycle management

With many years of ever-increasing environmental regulation behind us, we are quite familiar with the processes for controlling pollution outputs from individual facilities. Until now we are not so well versed with regard to optimizing resources and minimizing pollution by designing the proper linkages that span the entire product life-cycle. However, as we move toward the design of whole product systems, including material uses, product attributes, recycling and disposal schemes, we are uncovering environmental benefits.

Life Cycle Management is the cooperative effort by actors at different stages of the life cycle of a product to redesign product systems to reduce their overall environmental impacts. It is the movement of normal industrial management practice away from linear mechanistic thinking and towards wholistic systems thinking. It is an expansion of perspective from cradle-to-gate, to cradle-to-grave, and eventually, to cradle-to-cradle. LCA and EMA are the primary methodologies that underly the concept of Life Cycle Management.

LCA and EMA will most likely be necessary interim accounting tools that stand between a period when ecological burdens were no where to be found on the balance sheet, and a time when ecological burdens are insignificant, because the industrial systems, like the natural system, cyclically metabolizes all outputs.

Case studies

Economic and Environmental Benefits at Dow Chemical□s Salzburg Landfill. The Dow Chemical Company has been an international leader in hazardous waste management. Dow uses a hierarchical approach to waste management elimination (avoid producing it whenever possible); reclamation (waste is a resource, recycle whenever possible); treatment and destruction (if recycling is not possible, treat and destroy); and secure landfill (final option – less than one percent of waste) (Popoff & Buzzelli, 1993):

As important component of this hierarchical approach is Dow□s integrated waste treatment and disposal system. This system incorporates on-site incineration, waste water treatment and landfill facilities. Dow Chemical Company is also practicing full cost accounting to account for true environmental costs, not subsidized ones.

Practical application of full cost accounting is demonstrated in the management of Dow□s Salzburg Landfill in Midland, Michigan. This landfill was constructed for disposal of solid, hazardous waste in 1982. The Salzburg Landfill was named one of the ten outstanding engineering achievements in the United States for 1985 by the National Society of Professional Engineers. When it was constructed in 1982, it had a life expectancy of 25 years. Dow initiated environmental management accounting in 1990. This resulted in Dow charging the full cost of the landfill to the plants who used it, including projected replacement costs. In this case the Dow Corporation has itself been the scale-determining entity and the users of the landfill facility have been the accountants who have been optimizing the extent of environmental burdens. The result has been:

- □ An intensive effort to reduce the amount of waste going into the landfill.
- □ Over doubling of the life expectancy of the landfill to 53 years.
- □ A good example of a "win-win" situation for the environment and economy.

Company Policy to pursue EMA at Ontario, Hydro – Ontario Hydro has adopted a mission of making Ontario Hydro "A leader in energy efficiency and sustainable development, and providing its customers with safe and reliable energy services at competitive prices". Ontario Hydro has begun to use EMA in a step-by-step, pragmatic way to help accomplish this mission. They rely on it as a tool to integrate environmental considerations into planning and investment decisions. The advice to other companies interested in pursing environmental management accounting includes (USEPA Office of Pollution Prevention, 1996):

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- EMA is an approach that promotes the integration of environmental and business [illegible] in the light of making good business sense".
- Greater attention should be given to the potential avoidance of future environmental liabilities.
- Executive Members of the organization should champion its value and use for business decisions.
- EMA supports business decision-making, it is not the decision making process.
- EMA should be implemented in stepwise process of gradual change.
- Because of EMAA□s multidisciplinary nature, agreement is needed on common terminology.
- Linkages must be established between external and internal costs.
- Cost and environmental data must be analyzed consistently to promote sustainable development.
- Broad – based staff training is essential, building bridges between environmental and financial staff.

Ford Motor Company□s Process and Environmental Improvements in Heat Exchanger Design and Manufacture. By applying DFE tools and principles Ford evolved over the period of thirteen years an improved automotive heat exchanger (radiator). In 1973 copper-brass radiators with silver and lead solder clean with trichloroethylene (TCE) were being installed. This product was subsequently improved by the use of aluminum, but still cleaned with TCE and coated with iron cyanide and chromium. In the late 1980□s the iron cyanide coating was eliminated. This was followed by the use of an *improved aluminum alloy* that *did not* require the toxic coating, however TCE cleaning was still being practiced. After 1995 the TCE cleaning was replaced by a water and detergent cleaning process. *This example demonstrates a better and* more efficient heat exchanger (product improvement), improved manufacturing processes, reduced part weight, reduced costs, and simultaneously significant environmental benefits.

Diamler Chrysler□s Elimination of Mercury in Convenience Lighting.

Diamler Chrysler□s redesign of *"convenience lighting packages" illustrate* how LCA and EMA can influence decision making. The function of setting the scale of material flow was provided in this case by several state legislatures that have restricted mercury use and disposal. As Kainz (1993) notes the restriction and bans on mercury create numerous potential costs for manufacturers, including;

- Costs of identifying products that contain mercury and accompanying them with instructions for removal and/ or disassembly.
- Increased disposal costs resulting from landfill and incineration bans.
- Increased service complexity due to label and content requirements.
- Increased reporting complexity.
- Potential hazardous material liability for mercury.
- Potential permit requirements for mercury use in nonessential applications.

Diamler Chrysler had already begun to phase out mercury use, but new regulations prompted Diamler Chrysler to undertake LCA/EMA to make a decision regarding the elimination of mercury from the lighting assemblies by 1997. The *result was that elimination did make* economic sense because Diamler Chrysler would be able to avoid the environmental lab costs, potential disposal costs, labeling costs (both labor for installation and the *labels themselves), and production* scheduling software changes. The financial savings of this option versus the gradual phase out were substantial. The LCA/EMA process resulted in a product system that was both economically and environmentally desirable.

Diamler Chrysler□s Antifreeze Choice. Using an LCA/EMA approach, DiamlerChrysler compared ethylene glycol to propylene glycol as a factory-installed antifreeze. Many factors were considered, including: consumer demand, regulatory direction, environmental burden, product warranty, recycling and product acquisition cost. The decision was to use ethylene glycol, even though propylene glycol is less toxic as a substance than ethylene glycol. Ethylene *glycol was chosen because of a number* of economic factors, e.g. the retooling cost of bigger radiators required by propylene glycol use; and product warranty problems with mixing the little-used propylene glycol with the more widely used ethylene glycol. Ethylene glycol was also chosen because of a number of environmental factors, e.g. the use of remanufactured ethylene glycol in the factory and at the service facility reduces waste and discourages indiscriminate disposal; the eight pound weight penalty of using a larger radiator; and the production of propylene glycol uses more energy, generates more solid wastes and creates more atmospheric pollution.

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INDIA'S FIRST PORTAL WEB SITE ON ENVIRONMENT

www.cleantechindia.com is a highly interactive, content rich web site providing environmental information relevant for Indian industry. It also offers dynamic features for environmental technology and service companies in India and abroad to register their product and services and keep them updated with the help of online forms.

Cleantechindia.com provides a large volume of textual information covering regulatory framework, technology options, best practices, check lists and environmental status reports. It offers a large database of technology profiles, sources of technologies and consultancy services as also environmental business directories in an easily searchable format using multiple parameters. Other features in the web site include discussion forums on different environmental subjects. There are a large number of hyper links to all important web sites on the Internet providing environmental information.

CLIMATE CHANGE INDIA WEBSITE

Climate change transcends all borders. It is a global issue that concerns all. The Climate Change India website (www.climatechangeindia.com) aims at generating greater awareness about this vital issue and the initiatives being taken at both national and international levels to enable industries to make decisions on mitigation efforts. The website provides information on topical environmental issues related to global climate change.

The website has separate sections on global climate change, Clean Development Mechanism, Indian Scenario, funding options, Events Calendar, Publications, Technology Sources and Project guide giving details of opportunities for GHG emissions reductions and how to develop projects towards mitigation.

The Climate Change India website has been developed jointly by Hagler Bailly Services Inc., the contractors of USAID for the Climate Change Outreach and Awareness Activity (CCOA) Program, and the Federation of Indian Chambers of Commerce and Industry (FICCI). The s[illegible] is maintained and operated by the Business Information Services Network (BISNETWORLD) of FICCI.

Cleantech India Annual Subscription

National [illegible] : 1000/-
International US $: 200/-

DATABASES ON CLEANTECH INDIA

[illegible] information on [illegible] Indian environmental regulations [illegible] and minimal [illegible] covering all [illegible] as well as state level regulations.

Environment News: [illegible] Indian and global environmental [illegible] and new [illegible] from [illegible] sources.

[illegible] contracts and [illegible] environmental [illegible] consultancy [illegible] best practices applicable to different sectors.

Checklists and Technology: Take quick steps with the help of Pollution Prevention Tips, Waste Minimization Tips and Checklists for different industries and sectors.

Indian and International Success Stories: Case studies of companies and organisations who have implemented environmental management practices and have demonstrated environmental excellence.

Technology Options: Get updated on various environmental technologies pertaining to different media and applicable to different industries.

Technology, Product, Service Sources: Listing of companies and organisations offering environmental technologies, products and services.

Business Enquiries: Search and register business enquiries for environmental technologies, equipment, instruments, products and services in the form of joint venture, marketing arrangements, export/import offers, technology tie-ups, etc.

Global Climate Change: A whole range of information on global climate change issues, [illegible] climate change treaties and [illegible] country reports, greenhouse gas inventory in India, ODS [illegible] measures, and clean development mechanism issues.

Contact Directories of Environmental Organisations worldwide: Get comprehensive mailing lists and merge lists of environmental companies, organisations and agencies arranged by country.

Calendar of Environmental Events: Get list of upcoming environmental events in India and abroad, which includes seminars, workshops, conferences and training programmes.

Publications Index: An index of environmental publications searchable through keywords.

Global Web links: Links to other sources of environmental information across the globe, provided in clearly sorted topics and searchable with keywords from the EIC database.

Under Hazardous Waste (Management and Handling), Rules 1989 and amendments of Environment Protection Act 1986 of Ministry of Environment & Forests.

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