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TECHNOLOGICAL INNOVATION AND INTERNATIONAL DEVELOPMENT: OPPORTUNITIES IN THE ELECTRIC POWER SECTOR

March 24, 1987

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1. Overview

Science and technology, effectively linked to industrial innovation and the solution of practical problems, have played a central role in the economic and social advancement of the industrialized nations. The widespread awareness of this role of science and technology has resulted in policies and financial commitments by some developing nations such as Brazil, India, and Korea that have made it possible for them to acquire impressive capabilities in science and engineering.

However, many less developed countries (LDCs) find it difficult to apply these capabilities to create the modern industrial technologies required for sustained economic growth and international competitiveness. In part this is because in many developing countries research and development (R&D) is often not relevant to the realities of the market place or to the needs of the country. Collaborative links of scientific institutions with industry and commerce are often weak or non-existent. However, most LDC industries lack significant R&D capabilities, and could benefit substantially from such links.

The 19th and 20th Century industrial revolutions in Europe, the United States, and Japan have dramatized how profoundly new genres of science and technology-based industries can affect development. If such collaborative links can be forged between the science and enterprise sectors in developing nations, drawing on contemporary science and technology, the consequences could be even more dramatic, transforming the lives of several billion people in a few generations.

In the electric power sector in developing countries, inadequate links between science and the enterprise sector have contributed to the acute shortages of electricity that seriously constrain economic growth. Correcting these shortages by relying primarily on vast capital investments in traditional electric power technology is not feasible. The required investments would exceed the financial resources available to the power sector from the developing nations and the international donor community. The World Bank estimates[1] that the developing nations will require annual investments in the energy sector of $ 130 billion* for the next ten years, about half of it in foreign exchange. The electric power sector share of this is approximately $ 65 billion. Yet in 1982 the flow of external capital to finance all energy investment in developing countries was only $ 25 billion.

Nowhere do these problems of constrained power supplies and limited investment capital appear with more urgency or greater extent than in India. Recent power deficits there have led to staggering losses of several billion dollars annually to the economy. The projected capital requirements to keep pace with growing electricity demand during the Seventh Five-Year Plan (spanning 1985 - 1990) will cost approximately 728 billion rupees ($56 billion equivalent); however, the power sector has been allocated[2] only 354 billion rupees ($28 billion), half the projected requirement.

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* 1982 dollars

Investment in *traditional* technologies to meet projected electricity demands is not enough. The widespread use of new technology will also be required. This in turn will require far greater indigenous capacity for technological adaptation and innovation than now prevails in India and most other developing countries. Even some well-established technologies such as gas turbines and industrial cogeneration are relatively untried in the developing world. Use of these technologies in developing countries requires adaptation to local conditions rather than technological innovation. However the institutional and policy changes required for effective adaptation may themselves be innovative.

Important developments[3,4] in electricity technologies incorporate recent advances in micro- and macro-electronics, telecommunications, computers, and advanced materials. New power generation technologies include atmospheric fluidized bed combustion (AFBC) and integrated coal gasification combined cycle (IGCC) systems, solar photovoltaic systems, fuel cells, and (in the longer term) the modular gas cooled reactor. An especially significant aspect of many of the new generating technologies is that they are modular, designed for shop fabrication under stringent quality control conditions, and can be deployed with very short lead times, typically one to two years.

By contrast, large field-erected facilities power plants are custom designed and built, and are not amenable either to the economies of mass production or to the high standards of quality control possible under industrial manufacturing conditions. The new options also permit the efficient use of indigenous energy resources including biomass, coal, and renewable energy flows, as well as oil, natural gas, and uranium.

New techniques for extending the life of older power plants and for increasing overall power system efficiency are well-proven, economically attractive, and capable of significant impact. The widespread use of these techniques in developing countries would represent an important institutional innovation.

Peak load and total electricity consumption can be reduced significantly without compromising productivity or comfort[5]. This has been demonstrated in North America, Europe, and parts of Asia through the use of such innovations as energy efficient building design, new technologies for lighting and air conditioning, off-peak energy storage, heat pumps, energy-efficient motors, and computer-controlled appliances. For a given capital investment, these new options, compared with present practices, are cheaper, more efficient, and more reliable for power generation and are for tasks such as heating, air conditioning, lighting, and running machinery.

This paper explores the application of science and technology to the needs of the power sector (and more broadly to the entire enterprise sector), and the need to use the resources of the international donor community with greater effectiveness. We describe a specific approach to mobilizing and linking indigenous scientific, technological, industrial, and financial resources in the developing world, through the formation and support of new *research and development consortia.* We believe that such consortia could play significant, perhaps pivotal, roles in the electric power sector in India and other LDCs, where it is increasingly difficult to mobilize the financial and human resources to meet rapidly expanding demands for reliable and affordable power.

The U.S. Agency for International Development (AID) and the Government of India (GOI) have recently established a new collaborative science and technology program to address some of the issues confronting the Indian electricity sector. A central goal of this new collaboration is the accelerated development of innovative energy and electric power technologies and their diffusion into the marketplace. A novel aspect of this collaborative program is the use of market-oriented R&D consortia as a mechanism to achieve this goal. This paper focuses on the potential role of such consortia in the Indian power sector, although this and other approaches that can mobilize science and technology for development are relevant for other LDCs as well.

2. The Science/Enterprise Linkage: Models for Technology Innovation

Science, Technology, and Industry in India

The Government of India understood early on that a strong science and technology program is critical to sustained economic development, and made the rapid expansion of its research capability a major government objective from the beginning of the development planning process in 1950. Today in India there are over 100 engineering and technology institutes and over 600 polytechnical and industrial training institutes. Among the most distinguished of these are the Indian Institutes of Science and Indian Institutes of Technology. Almost 2.5 million Indians have graduate or postgraduate degrees in engineering, science, agriculture, and medicine.

Equally impressive is the scale of industry. India manufactures automobiles, aircraft, ships, large-scale power plants, and a remarkable array of commercial and industrial products. Yet few of these products can compete internationally because production technology lags that of international leaders. Moreover, because of the limited interaction that takes place between government laboratories (where 90% of R&D expenditures are made) and the industrial sector, many of the products and processes developed are often irrelevant to the demands of the marketplace. The lack of indigenous technological innovation in the industrial sector and the lack of relevancy to domestic markets presents a serious obstacle to India's economic growth and development. India's noncompetitive posture in the international marketplace, especially for high technology goods and services, is a further consequence.

A central premise of this paper is that technology innovation requires greater interaction among scientific institutions, industrial and commercial enterprises, and end-users. This interaction can increase the relevance of research and development programs by adding a market-driven focus. New mechanisms are needed in India and other LDCs to create effective working links between the scientific and enterprise sectors, especially in areas where advanced technology is crucial to economic growth.

What kinds of institutional arrangements will be required to permit science and enterprise to join forces for technological innovation and commercial success? Partial answers may be found by examining the U.S. and Japanese experiences.

The culture of research and technology development in the United States has been created and fostered by several distinct but interrelated approaches: a system of government-sponsored contract research in universities, national laboratories, and private industries, in-house industrial research and development, and user-supported research and development consortia in several critical high technology areas. The models of sponsored research, corporate laboratories, and R&D consortia are directly relevant to the challenge of linking the science and enterprise sectors in India. High technology R&D consortia appear to be effective vehicles for accelerating the pace of technological innovation.

The particular success of Japan in gaining major and often leading positions in key industries over the past 15 years or so reflects the success of that country's establishment of goal-oriented market-focused R&D consortia. Japan's Ministry of International Trade and Industry (MITI) has organized and underwritten large, vertically integrated multi-company consortia[6] in key industries. These include the steel, automotive, microelectronics, and machine tool industries. In these consortia, a group of companies bands together, sometimes in collaboration with university and government research institutions, and focuses on a specific development and commercialization goal. This eliminates duplication of effort, promotes standardization, and provides financial resources far beyond the capabilities of all but the largest corporations.

Until recently, joint R&D ventures on a similar scale were difficult to establish in the United States, due to their ambiguous status under antitrust laws. This situation has changed dramatically with the passage of the Joint Research and Development Act of 1984. This legislation shelters R&D joint ventures from action under the antitrust laws if the participating companies have significant market shares in the particular area in which R&D is to be carried out. This shift in attitude by government reflects the views of both the current Administration and the Congress, which favor joint research ventures that are organized, financed, and carried out by the private sector.

Market-Oriented R&D Consortia in the U.S.

U.S. global leadership position in a number of technological areas, from consumer electronics to super computers, has been eroding. In part this is due to the rapid growth in technology-based industries in Asia and Western Europe; the transition is well underway to a pluralistic international economy from one dominated by the United States. To gain insight into the potential development role of market-oriented high technology R&D consortia, we examined the research, development, and commercialization strategies of several U.S.-based consortia, including the Electric Power Research Institute and the Gas Research Institute.

A number of U.S. research and development consortia have been established in electric power and natural gas technologies, microelectronics, and computers. These include the Electric Power Research Institute (EPRI), the Gas Research Institute (GRI), the Semiconductor Research Cooperative (SRC), the Council for Chemical Research (CCR), the Center for Advanced Television Studies (CATS), and the Microelectronics and Computer Technology Corporation (MCTC).

All of these consortia are characterized by broad industrial and university participation. In virtually all cases the establishment of these consortia has reflected the need for scientific, technical, and financial resources beyond those of even the largest of the participants, and the need for risk-sharing in order to bring innovative science and technology into the market place. The SRC, CCR, and MCTC illustrate alternative consortium approaches in high technology areas outside of the energy sector.

The Semiconductor Research Cooperative was established in 1982 as a non-profit subsidiary of the Semiconductor Industry Association. The consortium has about 35 members, including industry giants such as IBM, Motorola, Hewlett-Packard, Intel, and others. The 1984 budget was $13.5 million, with corporate sponsors contributing a minimum of $60,000 and a maximum of ten percent of the annual budget, with fees based on actual semiconductor sales. The consortium in turn funds projects at university research centers. In 1984 there were 54 projects at 40 universities including MIT, U.C. Berkeley, and Stanford University. The focus is on a five- to ten- year period over which the information generated in the research projects will become commercially useful to the sponsors.

The Council for Chemical Research (CCR) was founded in 1982, and is a consortium of 43 major chemical companies and 142 U.S. universities that have doctoral programs in chemistry or chemical engineering. The CCR acts as a catalyst for interaction between industry and the universities, and has a small fund (less than $1 million annually) that supports university research.

The Microelectronics and Computer Technology Corporation (MCTC) of Austin, Texas is a major private consortium organized to counter the growing Japanese challenge in microelectronics and supercomputers. With some 20 major corporations as sponsors and a $70 million annual budget, the MCTC conducts its own research as a for-profit corporation. A broadly based R&D program that is considered comparable to Japan's Fifth-Generation Computer Development Program is being conducted. Proprietary rights are granted to sponsors, with three-year exclusive licensing agreements, followed by licensing made available to the general public.

Each of these consortia can, in principle, serve as models for similar kinds of industrial and scientific collaboration in developing countries. However in the energy sector, the most relevant examples from U.S. experience are the Electric Power Research Institute and the Gas Research Institute.

3. Market-Oriented Consortia in the U.S. Energy Sector

Two of the largest and most effective R&D consortia in the U.S. serve the electric and gas utility industries respectively. These are the Electric Power Research Institute (EPRI), chartered in 1972, and the Gas Research Institute (GRI), chartered in 1976. With annual budgets on the order of several hundred million dollars, these organizations have been effective in sponsoring research and development in new technology.

Much of the effectiveness of EPRI and GRI lies with their ability to establish consortia of manufacturers, utilities, R&D institutions, and universities to focus on the development of new technologies or on the improvement of existing technologies. The EPRI experience is especially relevant to the case of development of new indigenous capabilities for the power sector in developing countries.

The Electric Power Research Institute (EPRI)

The Electric Power Research Institute (EPRI) is a private nonprofit research and development institute[7] based in Palo Alto, California. It is the principal R&D management arm of the U.S. electric utility industry. Founded in 1972, EPRI has grown to a staff of roughly 750 people and an annual budget of $325 million.

The primary aim of EPRI's research and development efforts is to develop new or improved technology and knowledge for electric utility applications, and to assist in the commercialization of these technologies. EPRI's major divisions include Coal Combustion, Advanced Power Systems, Electrical Systems, Energy Management and Utilization, Nuclear Power, and Energy Analysis and Environment. EPRI's funding comes from a very small assessment paid by the individual utility members (typically a few hundredths of a cent per kWhe sold).

Virtually all of EPRI's research efforts are conducted through collaborative arrangements involving individual electric utilities, manufacturers, consulting companies, universities, and national laboratories. Many of these efforts are cofunded by EPRI[8] and the participants of these R&D consortia.

Individual research areas are identified by utility industry members, and research advisory committees involving the interested utilities are then established. These committees develop research agenda and oversee the implementation of the work. If major technical demonstrations are involved, such as in the development of Atmospheric Fluidized Bed Combustion (AFBC) technologies, individual utility companies will provide the infrastructure for development, installation, and test of the equipment.

A typical arrangement will involve one or more major architect/engineering companies to carry out engineering design, cost estimation, and construction management. Research institutions including universities, national laboratories, and private R&D companies may participate in research and development efforts. EPRI historically has concentrated on research management, leaving marketing and commercialization functions to its contractors.

In recent years, however, EPRI has also focused on transforming[9] its research results into marketable products and processes. EPRI has introduced a new policy to link its professional and technical staff more closely to success in the marketplace. Since development of new products involves commercial and technical risk, EPRI conducts commercialization assessments designed to stimulate successful innovation.

As a non-profit organization, EPRI is required by law to make its products available to all interested parties. EPRI does recognize, however, that its ability to offer limited exclusive licenses is an important incentive for many firms who wish to commercialize EPRI research results. For this reason, EPRI will use such licenses, especially for technologies or products with limited market potential.

The Gas Research Institute (GRI)

The Gas Research Institute (GRI) research and development budget[10] for 1986 was $138 million. This is projected to grow to $184 million (in 1986 dollars) by 1990. The funds are raised through a surcharge[11] approved by the Federal Energy Regulatory Commission (FERC). A major portion of GRI's research program[12] has a near-term focus on products for the gas industry. Since GRI has no manufacturing capability, direct involvement of manufacturers is essential for commercialization.

Since the R&D required to reach the "proof-of-concept" stage at GRI typically requires less than 15 percent of the financial resources to commercialize the product, the manufacturers bear most of the financial risk, including the costs of marketing, product engineering, and production tooling. GRI involves the manufacturer in the design and verification of pre-production prototypes, establishing reliability, and test marketing. After its R&D sponsorship, GRI monitors the commercialization phase to determine the benefits of its research, to refine its market analysis capabilities, and to link contractors with industry trade associations. GRI has returned the gas industry's investment in the program many times over.

EPRI-sponsored R&D Consortia

Both EPRI and GRI have established or catalyzed new consortia to develop and commercialize specific new technologies. Two recent examples of coal conversion technology illustrate this approach. These examples are characteristic of high technology R&D consortia, in that:

- The projects represent a research and development effort in science and technology.
- The technology is relevant to the needs of the power sector of many developing countries.
- The potential users and suppliers of the technology assume a large share of the financial risk of development.

- A large share of the financing comes from private sources.
- A significant market exists for the technology.
- There are well-defined mechanisms to penetrate the market.

The EPRI Atmospheric Fluidized Bed Combustion (AFBC) Project

Atmospheric fluidized bed combustion (AFBC) technology represents a significant advance over conventional pulverized coal combustion systems. AFBC systems have superior environmental characteristics, high coal conversion energy efficiency, tolerance for high-ash coals, and the potential for modular construction.

This technology can meet prevailing U.S. power plant emission standards for oxides of sulphur and nitrogen without the further addition of emission control equipment. The relatively low combustion temperature (840C) permits the efficient use of limestone as an effective absorber of sulphur dioxide, and coals with high ash contents can be burned without slagging or fouling of heat exchangers. The low combustion temperature also means that nitrogen oxide emissions can be maintained well below U.S. federal standards.

These characteristics are directly relevant to the needs of the power sector of developing countries with significant coal resources, including China, India, Pakistan, and Indonesia. All of these countries have shown interest in AFBC technologies; there is an active AFBC technology development program underway in India, involving the Ahmedabad Electric Company, Ltd. (AEC) in collaboration with Bharat Heavy Electricals Limited (BHEL).

With the oil price rises of the 1970s and environmental concerns over emissions from coal-fired power plants, interest in fluidized bed combustion of coal was renewed. In the mid-1970s, EPRI decided that the AFBC technology had evolved to the point where a prototype unit could be built. A request for proposals was subsequently issued by EPRI to solicit joint venture partners in the design, construction, operation, and evaluation of an AFBC boiler. The contract was awarded to Babcock and Wilcox (B&W), and in 1977 EPRI and B&W constructed a 2 MWe pilot plant using a fluidized bed boiler.

The 2 MWe pilot plant provided the experience and confidence necessary to design, build, and operate a 20 MWe AFBC pilot plant in Kentucky. This larger plant, with over 10,000 hours of operation, has confirmed the high combustion efficiency, flexibility in handling coals of varying quality, and low emissions anticipated for AFBC technology.

EPRI is presently coordinating[13,14] three utility-scale AFBC demonstration projects. Each of these projects will result in an AFBC power plant beginning operation in the period 1987 to 1989. These units are being built by Northern States Power with Foster Wheeler Engineering, Colorado-Ute Electric Association with Pyropower/Ahlstrom, and Tennessee Valley Authority (TVA) with Combustion Engineering. The plants will range in size from 110 MWe to 160 MWe, and represent three alternative variations on the basic AFBC technology.

The AFBC consortium is composed of EPRI, the three utility companies, and three boiler vendors mentioned above, together with other participants. EPRI worked closely with these utility companies in the development of the RFPs and in the evaluation of the resulting proposals. With Colorado-Ute, EPRI worked with the utility to develop the AFBC boiler specifications, but did not contribute financially. EPRI is functioning essentially as an unpaid consultant to the utility, with a major role in conceptual design, relatively minor roles in detailed design and construction, and a major role in plant operation, testing, and evaluation. TVA has established a separate consortium called the Atmospheric Fluidized Bed Development Corporation (AFBDC). The AFBDC is comprised of TVA, several coal companies, and a railroad, and acts in parallel with EPRI.

EPRI expects the successful completion of these projects to confirm that AFBC is a viable power generation alternative. In addition to these three demonstration plants, several utilities are planning to construct and operate AFBC boilers, and a number of large cogeneration projects using AFBC technology have been initiated. This project has demonstrated the effectiveness of the consortium approach in commercial development involving advanced technology, large capital investments, and substantial risks. A second successful example of a consortium-based high technology development in the power sector, also in the advanced coal combustion area, is that of the Cool Water Project, an advanced coal gasification system integrated with a combined cycle power plant.

The Cool Water Project

In June 1984 the Cool Water coal gasification combined-cycle power plant was successfully brought on line in Southern California. This 100 MWe facility is the first commercial-size integrated gasification combined cycle (IGCC) power plant. The Cool Water IGCC project had its genesis in conceptual studies conducted in the U.S. during the mid-1970s to find new ways of reducing utility dependence on imported oil by improved environmental methods of coal fired power generation. In this system coal is first converted to a clean-burning gas that can meet strict air pollution standards without the necessity for stack gas scrubbers. Efficiencies can be improved by recovering heat produced during gasification for use in a combined cycle system.

IGCC technology is a potentially important option in future mobilization of the abundant but low-grade coal found in China and India. The technology can use coal, natural gas, and biomass. The energy conversion efficiency is substantially higher than that of conventional scrubber equipped coal-fired power plants, but requires a high level of operation and maintenance skill. The plants can use high-sulfur coal, with the level of sulphur removal meeting U.S. environmental standards.
The IGCC technology is inherently modular, with commercial units projected in the range of 100 - 250 MWe. This range is especially suitable to the current LDC utility environment and coal infrastructure. This modularity implies improved financing and improved plant availability relative to larger (500 - 1,000 MWe) conventional coal generation units. The economics of mature commercial IGCC systems in the United States are projected to be competitive with conventional coal plants equipped with scrubbers, but present experience is limited to a single prototype plant.

The Cool Water facility was built as a highly successful cooperative effort[15] of an international consortium including EPRI, Bechtel Power Corp., General Electric Co., the Japan Cool Water Program Partnership (a group of Japanese companies providing technical assistance and support), and several other U.S. firms.

EPRI, Bechtel, GE, and the Japanese consortium each put up $25 million in addition to providing critical managerial and technical expertise. The plant itself was completed ahead of schedule (field construction required only 28 months) and below budget. The participants and their relationship to the project are shown in Table 1. This project has also demonstrated the effectiveness of the consortium approach in a high technology high risk area.

Table 1

COOL WATER PROJECT PARTICIPANTS AND THEIR ROLES

Participant	Financing	Role
Southern Calif. Edison	$25 million	Equity
EPRI	$65 million ($100 million potentially)	Equity
Texaco	$45 million	Equity
Bechtel	$30 million	Equity
General Electric	$30 million	Equity
Japan Cool Water Program	$25 million	Equity
Synthetic Fuel Corp.	$125 million max.	Price support
Empire State Electric Energy Research Corp.	$5 million	Contribution
Sohio Alternate Energy Development Co.	$5 million	Contribution
Mellon Bank & Mitsui	$24 million	Loan

4. Facilitating Innovation in the Indian Power Sector

Energy and the Economy in India

To address the pervasive problems of poverty and unemployment, the Government of India's Seventh Five-Year Development Plan (1985 - 1990) estimates that the annual rate of economic growth must increase from the recent level of 3.5 - 4.0 percent to a new level of 5 percent. A serious constraint to economic growth has been the uncertain availability and often poor quality and reliability of electric power. Acute power shortages, characterized by frequent power cuts, voltage and frequency fluctuations, and frequent load shedding have been especially troublesome, with some states experiencing power deficits of ten to thirty percent. India has urgent needs to expand and modernize its energy sector. At present, constraints on availability, quality, and reliability of delivered energy, especially electricity, are hampering agricultural and industrial development.

Commercial energy use in India grew at a rate of 5% annually between 1978 and 1983. This growth rate was much faster than that of GDP, which grew at an annual average rate of 3.3%. Electricity use increased during this period at 5.8% annually. This growth in electricity use occurred despite the fact that electricity use in India is supply-constrained and is generally not available in the quantities demanded, or at the quality and reliability generally required for industrial and commercial purposes.

Sixty percent of India's electricity is consumed in industry. However, agriculture, together with the residential and commercial sectors, accounted for more of the electricity demand growth than did industry from 1978 to 1983. In part this was due to the higher priority placed on rural electrification, and in part due to the industrial supply constraints. The years ahead will undoubtedly strain the capabilities of the energy sector as it strives to meet the needs of the economy. A greater capacity for technological innovation and commercialization is needed to address these problems.

The Energy Research and Enterprise Project in India

In recognition of these problems, the U.S. Agency for International Development and the Government of India have launched the *Energy Research and Enterprise (ERE) Project*, a major new initiative to develop, introduce, and test models for indigenous technology innovation and development in the Indian power sector. The project approach, presently untried in the Indian context, is to catalyze linkages between the science and industrial communities, the creation and implementation of goal-oriented, market-responsive high technology consortia, and sponsored research by universities and industry.

These consortia will bring together research and industrial institutions from the Indian public and private sectors with U.S. companies and research institutions. Established as new operating entities that cut across the traditional and relatively non-interactive strata of R&D institutions, utilities, and industry, these consortia will focus on the development and widespread commercial application of advanced energy technology products and processes. The activities of the consortia will be

supported by a competitive research awards program and by activities designed to analyze and disseminate information of relevance to commercializing technology innovations.

Commercialization of new power technologies may include applications in both centralized and decentralized systems and will involve both public and private sector markets. Electric demand management techniques in the industrial and commercial sectors, where the private sector has a major role, may also be included. The projected budget for this effort is approximately $20 million with an equivalent Indian contribution in local currency.

The ERE project is the second of several projects designed to promote technology innovation in India. The first project was the Program for the Advancement of Commercial Technology (PACT). PACT is designed to promote Indo-U.S. joint ventures in technology development, and to heighten the enterprise sector's interest in establishing effective research and development programs. It has attracted wide attention in both the U.S. and India. Variations of the PACT model are now being rapidly developed by Indian financial institutions, are being supported by public and private organizations including the World Bank, the International Financing Corporation, and Grindlays Bank.

The PACT focuses on joint ventures between U.S. and Indian companies in a variety of high technology areas, whereas the ERE Project focuses on sponsored research and technology development in the energy sector. A third project, currently under development, will further promote the link between technology innovation and enterprise in a specific city or state.

The principal accomplishment of this project will be the successful development of technology innovation and commercialization in the Indian energy sector. From this experience a deeper understanding of the innovation and commercialization process in India will emerge. Because some of the models for development and diffusion of advanced technology have not been tried in the Indian power sector, there is no assurance that the ERE project will be successful. However, the enthusiasm with which the ERE project concept has been greeted by Indian public and private decision makers suggests that this is a fruitful direction to pursue.

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