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BACKGROUND PAPER ON INITIATIVES FOR ACCELERATED DEVELOPMENT OF RENEWABLE ENERGY SOURCES AND ENERGY CONSERVATION

Prepared for the National Security Council's
Interagency Task Force for Accelerated Energy
Production in the Developing Countries

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DS/EY: Alan Poole
Office of Energy
Development Support Bureau
Agency for International
Development

Introduction

This paper has been written in support of the Interagency Task Force for Accelerated Energy Production in the Developing Countries. It is intended as a supplement to the report, The Contribution of Renewable Resources and Energy Conservation as Alternatives to Imported Oil in Developing Countries which was commissioned by the Office of Energy in AID. Frequent reference is made to the report as the "E/DI Report."

The present paper reviews the state of the art of our current, rather sketchy, understanding of the potential impact of renewable energy sources and improvements in energy efficiency. It then proceeds to discuss possible actions and priorities in terms of:

1) type of program
2) type of technology
3) institutional options
4) country options

Given the nature of the original request, this paper takes a "what if" approach. That is, without deciding on the broader issue of whether we should dramatically increase assistance to cope with oil import problems, it discusses what might be done with renewables and conservation if such an assistance policy were established. In addition, the focus of this paper is on substitution of oil. Thus, for example, aspects of renewable energy development which might have an impact on rural development or of conservation which might influence employment have not been treated. While oil supply and substitution are the critical elements of energy policy today they are not the only elements.

In discussing oil substitution this paper also shies away from a systematic analysis of the more fundamental implications of the transition to a "post-petroleum era" which the E/DI report considers to be the basic challenge

to national energy strategy and to assistance policy. To have attempted to do so within the context of partial analysis such as this one would have been unsound. The author does however recommend that the Task Force consider explicitly the balance between longer term and shorter term objectives in overall energy assistance policy. This balance is a basic element of any strategy.

This paper is the work of one author and one heroic secretary. It does not represent the policy of AID or the Office of Energy.

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State of the Art of our Understanding of the Potential of Renewables and Conservation

The starting point for this brief review is the discussion of potential and constraints in the E/DI report.

Perhaps the most important conclusion reached in this report is that renewables and conservation are economically feasible* but institutionally constrained resources worth millions of barrels/day in LDCs by the year 2000. Four to nine million b/d are the figures in the report, equivalent to 18-25% of total LDC oil consumption in the year 2000 in the base case. The largely institutional and attitudinal nature of the constraints as described in the report can be seen in Exhibit 1 which quotes the executive summary of constraints.

This conclusion is important because it stands in contrast to most serious analysis of international energy options performed heretofore. If this major shift in perceptions is accepted by the development community the implications for assistance policy in energy are profound.

Such a shift is likely to be highly controversial. With most renewables the focus of dissent will be the claimed economic competitiveness of the identified technologies. Unfortunately this key issue receives only cursory treatment, both in terms of the micro-economics of individual processes, in terms of shadow prices for policy decision, and in terms of the possible

*This definition of potential is used several times in the report. For example on page 21: "It is important to recognize that we are dealing in this Chapter with rates of introduction of technologies that are technically feasible, considering economic competitiveness."

There is some ambiguity, however, because the figures are also claimed to represent "incremental savings that could be achieved over and above purely price-induced reductions" ... "In this section we discuss additional savings in oil demand that could be achieved through accelerated, rigorous conservation programs aimed specifically at displacing demand for imported oil." (p. 51) (emphasis added) Unfortunately the report gives no analysis of what the "base case" scenario would contribute anyway.

Exhibit 1: Constraints on Renewable Energy and Conservation Potential as Cited in the E/DI Report (pp vi-viii)

(1) A lack of institutions and organizations capable of developing and maintaining small-scale decentralized renewable energy systems, particularly in rural areas, and of coordinating such systems with agricultural and rural development activities.

(2) A lack of trained managers, technical experts and technicians to manage the selection, adaption, installation, operation and maintenance of renewable energy technologies.

(3) A lack of emphasis on renewables and conservation within the major lending institutions which have heretofore focused their energy-related financing primarily on rural electrification, large hydro and fossil fuel development.

(4) Inadequacy of existing mechanisms for the transfer and adaptation of technologies from industrialized to developing nations, particularly in light of changing (and sometimes apparently conflicting) aims and interests of both the producers and the consumers of such technologies.

(5) Policy confusion resulting from uncertainties in the outlook for conventional fuels - uncertainty, for example, about the future availability and price of oil, coal production and export potential in the nations with large coal resources, and the effect of energy problems on economic growth and balance-of-payments in all nations.

(6) Current orientation of energy RD & D programs in industrialized countries toward the large-scale, capital-intensive technologies that are more appropriate to industrialized than to less developed countries, combined with a serious lack of R & D programs within LDC's.

(7) Cautious attitudes toward both renewables and conservation on the part of LDC governmental and private sector policy-makers, partly due to a perception that these approaches have not been accorded high priority in the energy policies of nations urging them on LDC's, and partly out of concern that renewable and conservation strategies could simply replace oil-dependence with technology-dependence.

(8) A shortage of practical experience and information about actual performance of renewable and conservation technologies in the field, in order to clarify issues that must be faced in major investment decisions.

nature of the supply/cost curve. This is largely due to the dearth of available analyses and experience - as the report notes:

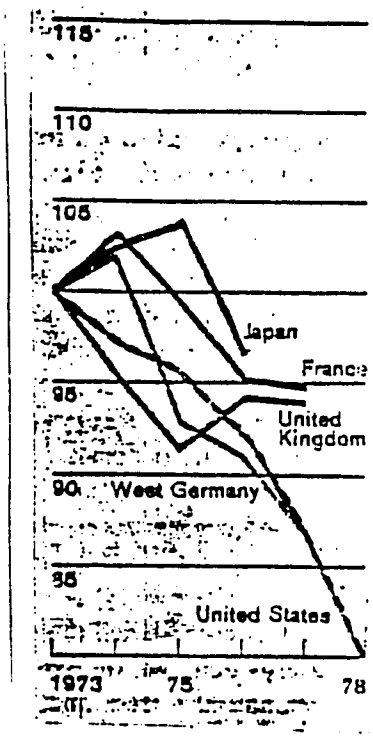
"At present little is known about 1) how specific units will operate under field conditions, 2) the requirements for maintaining their performance at satisfactory levels, 3) their operating characteristics compared to competing energy systems and 4) the impacts on other components of the national system of energy supply, distribution and utilization. The information needed covers the social, fiscal and managerial as well as the technical engineering and cost aspects of these technological interventions.

With few exceptions field demonstrations and studies involving renewables and conservation in the LDCs have yielded only meagre amounts of fiscal and management information." (p. 77) This problem is cited as a constraint (Exhibit 1, # 8) but it also casts doubt on the basic estimate of potential.

With conservation the problem is somewhat different, and the key issue at this point of the road may not so much be the comparative economics of specific changes as whether we can usefully accelerate a price-induced change which will occur anyway or permit a change in efficiency where none could have occurred despite being ultimately cost-effective. The first problem, however, is still formidable. For example, we do not even know whether industry in developing countries (which consumes 35% of their oil) is more or less efficient now than in the developed countries where dramatic improvements have occurred (see Figure 1) with little direct government intervention. Nor do we even have a clear picture of how the efficiency of oil use has changed in LDC economics over the past six years of qualitatively higher oil prices.

FIGURE 1

INDUSTRIAL ENERGY CONSUMPTION PER UNIT OF INDUSTRIAL OUTPUT



There are nevertheless reasons for the study's bullish view of the impact of decisive and sustained U.S. policies on renewables and conservation, though they may merely change the locus of argument somewhere else. A central, if not very prominent premise of the study is that "the economic viability of many of the measures discussed depends on the prevalence of high world oil prices.... The urgency of many renewable and conservation options, derives from the expectation of world oil costing $40, $50 or more a barrel in the future."

This view of the future is not common in official projections, and probably is not found in any of the sisters to this study. For example, the World Development Report 1979 was based on oil prices remaining constant at 1975 real prices through 1990. The fact that most governments do not plan around such high estimates of oil prices is cited by the study as a major factor constraining development of "economically competitive" technologies.

Perhaps what the E/DI study is really trying to tell us is that if the U.S. Government seriously adopted, say $45/barrel in the late 80's and early 90's as a planning basis for a determined and systematic energy assistance program starting soon, it could have a very significant impact on the momentum of renewables and conservation. If, in the early 1990's reality did somewhat match plan (admittedly a rare enough event!) LDCs would be far enough up the market penetration curve to be able to make large cost-effective investments that would bring them multi-million b/d savings in oil by the year 2000 which would not have been possible without the earlier momentum. Any attempt to assume a high oil price and apply that to alternatives to oil is likely to be very controversial. It is recommended, however, that the possibility of a

high planning basis oil price be seriously evaluated. Forty dollars ($40) a barrel is no greater a percentage jump higher than today than the real jump experienced in the last eighteen months.

From the point of view of the NSC attitude to assistance policy the cost of seriously underestimating the price rise(s) of the next five years must be very substantially more than the cost of overestimating. Indeed it is possible that in a time of generally escalating real prices it is appropriate that governments err slightly on the high side since they can afford to be more of a force of forward planning and adjustment than most parts of the private sector. Forward planning is especially important in energy because of the immense inertia of a system characterized by long lead times, slow turn-over of key investments, and demands for high reliability.

If such a high oil price were used then the definition and structure of U.S. energy assistance should rest heavily on how the rest of the world responds. It is one thing for the U.S. to use a high oil price as a planning basis (even if implicitly rather than explicitly for obvious reasons). U.S. assistance cannot be very effective if it is based on premises not shared by host governments, and of course U.S. influence on multilateral assistance would be reduced if not shared by other donor countries and organizations. It would be a fundamental misapprehension to think that by throwing around large amounts of money the USG can lead the LDCs. As discussed in the next section the approach should be to support LDCs' own policies to accelerate renewable and efficiency improvements after initial attempts towards general encouragement to study their potential seriously over the next several years. There is a good chance that many oil importing LDCs will concur more closely in using a high price for planning than other donors. However availability of assistance instruments

to effectively support the most useful LDC programs may be a constraint. This point is discussed in the next section.

Program Options and Issues - Market Interventions to Directly Influence Investment Decisions

Whatever the uncertainties regarding the potential impact of renewables and conservation, it is clear that if they are to have a significant impact (say five million b/d) very large amounts of capital will have to be invested in appropriate plant and equipment. How large that investment must be is clearly dependent on the technologies employed. If we exclude low-cost savings such as those due to "good-housekeeping" in industry, the accumulated investment* is likely to be at least $40-50 billion and possibly considerably more.

The scale of the investments required to have this kind of impact forcefully raises two questions. Assuming that such investments should be made (which we really don't know yet), then:

1) How can such a large development occur in reality?

2) What role for assistance can be justified or is necessary?

Since assistance is essentially a government to government relationship, it is perhaps useful to begin an evaluation of the options by considering briefly what governments (including our own) can do and are doing to stimulate the entry of renewables and conservation into the domestic marketplace. There is a diverse class of activities which might collectively be referred to as "infrastructure for market penetration." This class includes support for:

- technical research and development
- pioneer plants and instutional arrangements
- information systems
- training and institution building
- statistical compilation
- some forms of regulation and standards setting
- project-oriented analysis and technical assistance
- policy-oriented analysis.

Activities of this sort can be very important and currently account for essentially all funding for renewables and conservation with the possible exception of fuelwood/agro-forestry projects.* "Infrastructure" activities will receive attention later.

There is another class of activities which become more prominent where acceleration of market penetration is being strongly emphasized. These impose immediate incentives and disincentives on the market place, and include:

1) establishment of mandatory performance standards for energy efficiency;

2) tax disincentives for petroleum products (or removal of earlier subsidies);

3) subsidies for investment in renewables and conservation technology.

The subsidies in 3) can also be usefully divided between those which are of a more dirigiste nature and others which are more market driven. An example of the former is the subsidizing of specific large facilities after detailed bureaucratic review as occurs in Brazil with alcohol distilleries. An example of the latter is the investment tax credit for solar and conservation technologies in the U.S. or the waiving of federal tax on gasohol in the U.S. and ethanol in Brazil. These market interventions to directly influence investment decisions are generally regarded as crucial for any serious acceleration of the rate of penetration of most renewables and some conservation approaches, and it is this form of intervention which has the potential for

*In any case the possible impact of fuelwood/agro-forestry projects on kerosene and LPG for cooking, lighting and other petroleum products for small rural industries was not evaluated in the E/DI report which treated the interface between the traditional fuel sector and oil in a very cursory manner. Some analysis of the question is found in Annex A.

significant expenditures of government funds (Annex B) particularly as programs come closer to commercial impact. U.S. federal expenditures on conservation are already dominated by this type of activity.

There has been very little analysis of the sort of market intervention of this sort by LDC governments that would be optimal, nor do we have as yet a good idea how assistance could most effectively support different kinds of market intervention. These are issues which must be addressed in planning a renewables and conservation program, for ultimately foreign assistance must be in support of the policies of LDC governments to be effective in this area. Indeed as a general rule it would be sound policy for the U.S. to eschew most assistance projects in renewables and conservation that go beyond "infrastructure" unless there is a specific LDC government commitment to a wider policy of implementation that the project can support. Projects without such a policy context will simply become a series of "demos" of increasingly dubious value. The need to emphasize a supporting role should be apparent from the sheer scale of investment required - which would be beyond the means of world official development assistance - and the fact that non-OPEC middle income developing countries which consume most oil consumed in LDCs receive only about 5% of their net inflow of resources from world official development assistance. While this point may seem quite obvious, there has not yet emerged a clear emphasis on identifying how the U.S. can effectively support the policies of LDC governments to seriously accelerate forms of substitution. We have been pre-occupied with individual projects of an infrastructural nature and, it must be said, appear to have derived from this an exaggerated sense of our own leadership role. We would be ill prepared to respond intelligently to an LDC (or even worse an advanced developing country) which came to us and said

"we are on the verge of implementing a national policy to substitute for oil in industry and utilities with (say) an integrated program of char/oil slurries and direct combustion of biomass. What assistance can you give in support of this policy?"

Emphasizing a support role does not mean a passive role. Particularly if there is an excess of proposed programs the U.S. will have to exercise its own priorities and project screening criteria. Priorities and the criteria to develop them are now very poorly developed and quite general. Within this prioritization process there should also be established a "set" of technologies which as a group would be seriously considered (if not all at the same priority) thus stimulating LDCs to come forth with their proposals. The USG should seek early on to identify LDCs priorities and take account of them in developing its own. In practice, LDC and USG priorities should not differ much.

The project nature of sectoral loans and grants may have a significant impact on the kind of market incentive that ODA can support. Tax subsidies of the sort which have prevailed so far may be difficult to support effectively despite their attractive qualities which maximize market decision-making and minimize bureaucratic decision-making. In-country schemes offering subsidized loans for investment may be easier to support (but may unfortunately also have a higher risk of market distortion because this approach directly subsidizes capital investment). This could include support of "banks" designed to handle many small loans as well as direct investment in centralized government entities such as the electric utilities which are the traditional recipients of the vast bulk of energy ODA. It is not difficult to imagine that the form that ODA takes could have a profound effect on the evolution of institutions to support the development of renewables and conservation.

For example, the role of electric utilities as crucial implementing organizations could well be amplified to a surprising extent. Beyond experience in this country (where, however, their role in implementing residential electricity conservation and industrial co-generation is growing) to a point where they regard themselves as energy supply and demand management firms. The electric utility of São Paulo, Brazil is perhaps the most advanced example of this transition occurring (it now calls itself the Companhia Energetica de São Paulo). The severe problems which this sophisticated utility had in the first several years of this change are a sharp warning (and a good case study) of the need for institutional support in charting unfamiliar waters.

The innovation of the Sao Paulo utility is, however, exceptional with few immediate parallels. In general, electric utilities are noted for their inflexibility and conservatism, not as organizations to encourage innovation. It may be counterproductive to locate management of large areas of renewables and conservation development in institutions of this type.

By now it should be clear that unlike oil exploration, we are not yet to the point where we can propose specific options and instruments to directly influence the market for capital investment.

Many issues of the kind just discussed will emerge if we rigorously ask first what the governments of particular LDCs can do to accelerate renewables and conservation development and then what development assistance (and other U.S. Government action) can do to support this initiative and how constraints on this assistance support may influence LDC action to intervene directly in the marketplace for investment decisions. Such an inquiry should form a very prominent part of the activities of the next two years alongside work which seeks to outline the extent to which it would be in those countries' interest to accelerate such development. This task will be

Program Options and Issues - Developing the Infrastructure for Market Penetration

This class of activities should dominate assistance over the next several years and could be the only class of assistance through FY 1982. Building from our earlier listing of this class of government activities, we might define the following areas of assistance activity and support:

1) technical research and development
2) pioneer plants in the field
3) pioneer institutional arrangements
4) information systems
5) training and institution building
6) statistical survey and compilation
7) standard setting
8) project-oriented analysis and technical assistance
9) policy-oriented analysis (i.e. LDC-oriented)
10) integrated program policy analysis (i.e. donor program oriented)

All of these activities appear to have a place in both conservation and renewables. The balance of activities, however, may be quite different between them, while with renewables the optimal future balance may be quite different than it is today despite the fact that virtually all of these activities are represented to some degree now. With the possible exception of items 2) and 3) these activities are unlikely to represent a major allocation of funds. However the quality of this group can have a disproportionate impact on the effectiveness of later possible assistance, and insofar as these activities are bilateral (and most already are), on the judgement of the overall credibility and seriousness of the program. This justifies some attention here to a number of issues which might otherwise be regarded as too detailed for consideration in this paper.

The first activity, technical research and development is, surprisingly, one of the weakest links in assistance today. The E/DI report concluded that

"substantially greater efforts to make the renewable and conservation RD&D efforts in the U.S., Europe, and Japan more compatible with the requirements of the developing countries" could increase the cost competitiveness of these alternatives in a relatively short time. This view may be optimistic as a general rule. However, at present despite all the years of rhetoric about appropriate technology there does not exist any coherent institutional capacity to fund adaptive R&D in collaboration with technologists from developing countries. Correcting this situation, even with a modest program, deserves a high priority. Currently most attention is focussed on ISTC (Institute for Scientific and Technical Cooperation), but while ISTC can be helpful its unique mandate will attract many demands onto what is likely to be a very constrained energy budget.

Several institutional mechanisms should be sought including the review of DOE R&D recommended in the E/DI report.

Field testing of renewable technologies is somewhat more advanced. The key objective of such test projects should be to obtain a clear understanding of the micro-economics of these technologies in a practical environment, rather than to demonstrate their technical feasibility. The current generation of AID-financed projects should be examined for their effectiveness in this regard. These projects also have elements of adaptive R&D and in effect represent a very decentralized institutional response to that need whose cumulative role also needs review.

In addition to pioneer technical projects, which should not need frequent repetition, tests of pioneer institutional arrangements are crucial before most of these technologies can have wide impact. In the case of conservation technologies this activity should predominate earlier than it has with renewables.

Information collection and transfer is an important problem for workers in this area. As with newer technologies in general, the access of LDC workers to pertinent materials is frustratingly limited. A high quality information system is generally acknowledges to be a key, if somewhat pedestrian, part of efforts to expedite technology transfer. However, there appears to have been rather limited thought given to how innovations in information systems could increase their practical value. Such systems run the danger of being archives.

An information system should, at a minimum, have the qualities of such large international repository/computerized citation search systems as AGRIS, the proposed DEVSIS, or the INIS system for nuclear energy operated by the IAEA. In addition, it would be very beneficial for the information to be more highly organized, based ultimately on a process of peer review and the relevance of the work to particular priority problems. An emphasis on screening information and reducing thresholds of access to it, rather than on attempting to be complete, is likely to increase the system's usefulness to LDC analysts and design teams. Indeed, such "active" information systems would be of considerable value for domestic U.S. application. Various approaches to such a system are possible. In Annex C one appraoch to an information system for conservation is estimated to require two years to full start-up with a total cost of $6 million over the first three years (allowing for some subsidy of operating costs in poorer countries). Inclusion of renewables should not increase costs by more than 50%.

In terms of priorities in analysis, it appears that the highest priority should be given to the development of <u>detailed case studies</u> of energy efficiency. These should include architectural and engineering analysis of specific

buildings, plants and fuel conversion units in cooperation with technicians and managers in developing countries. Institutional issues, such as the laws concerning co-generated power, are crucial and should be addressed as well.

A rationale for this early priority is that detailed case studies, together with broader surveys of energy end-use sectors (e.g., a survey of the scale and operating pressure of the nation's inventory of industrial boilers), are essential to understand the potential impacts of and constraints on different kinds of possible intervention. Very little of this kind of work has been done to date.

At present, while there is some evidence of potential, there is little basis for program design. Past work, such as the DOE country assessments, is of relatively little value for this purpose.

Within this general area, case studies of manufacturing stand out as being the highest priority initially. Preliminary estimates suggest that the cost per case study in industry should be on the order of $60-80,000 including integration of results for individual plant(s) to an industry sector as a whole.

As noted at the outset, programmatic priorities will vary from technology to technology. Renewables constitute a particularly mixed bag. It does seem possible to generalize somewhat about initial priorities in conservation, in part because we are starting from a zero-base. Initially conservation expenditures should be dominated by:

1) analytic work led by case studies as just discussed;
2) initiation of statistical survey work - 6)
3) initiation of development of an information system.

Slightly later (FY 1983 if not late FY 1982) of this period, experimental loans designed as much to test institutional arrangements as technical performance could become important, as could training and institution building. Technical R&D is likely to have a lower priority than with renewables - though it could be important initially in building design - an area where LDC conditions are perhaps most distinct in the modern sector.

Sectoral Options:

Conservation

A key conclusion to be derived from the E/DI report is the high priority which should be attached to conservation. This is in marked contrast to the virtual absence of assistance for conservation today. It is suggested that a significant impact from conservation measures can occur sooner and furthermore the impact is likely to be larger in the year 2000 than from all renewables combined. This conclusion is consistent with the mainstream of policy analysis in the developed countries. While direct evidence is limited now, there is sufficient similarity in the modern oil-consuming sectors of developing countries to justify its adoption as a working hypothesis for the rapid start-up of activities.

This is a conclusion of considerable policy and operational significance. It suggests that the funding requirements for infrastructural programs in conservation should take a clear precedence over renewables up to the level that can be usefully absorbed (perhaps $10-15 million in FY 1982), even if that requires a decline in renewable programs (which appears to be unlikely).

Some possible elements of programs for conservation have been discussed in the previous section. Here we shall define areas of work and some possible initial priorities.

The different sectors of energy demand involve distinctly different markets, both technically and institutionally. The industrial sector is, for example, very different than the residential sector in terms of ownership and the size, sophistication and (probably) cost sensitivity of individual consuming units. This distinction of markets means that an optimal assistance policy is likely to have programs which vary widely from one end-use sector to

another (just as the types of programs for different energy supply sectors may be very different).

It is proposed that the scale of effective intervention will vary drastically from market to market. It is likely, for example, that:

1) The lowest practical potential is probably in the residential sector.

2) The most favorable prospects for impact over the next ten years are in the commercial and industrial sectors; i.e., somewhat larger units of consumption.

3) The transportation sectors are the most uncertain. However, it is possible that assistance here may have the most fundamental long-term impact on development of any assistance program in energy conservation, particularly if it focusses on modal shifts. (Annex D).

Analytic work should be commenced, even at a modest level, in all sub-sectors of demand as soon as possible. However, the combination of large potential impact in the medium term, relevance of U.S. experience and institutional capabilities in the U.S. suggests that the initial priority should lie in the industrial sector, and that the first case studies and associated analysis should focus on industry. This work should not only look at the micro-economics of energy efficiency improvement but at the effect of scale and ownership on technology transfer. (Annex E)

Although we are primarily interested in increasing efficiency with a minimal social or economic impact in a cost-effective manner without curtailing people's use, it would probably be useful, given world realities, for there to be assistance (when requested) to develop short-term curtailment plans that involve the least economic or social disruption.

Finally, assistance for fuel substitution should be included with conservation per se where the major problems in the substitution are downstream with the end-user.

Renewables

The highest priority here is attached to bioenergy. This does not represent a significant shift in thinking either for bilateral or multilateral donors. However, an emphasis on oil substitution could significantly shift priorities within this field. The overwhelming bulk of funding for bioenergy goes for forestry projects which include an important component of fuelwood supply for traditional markets, principally for cooking. As may be inferred from Annex A, projects in this area may in fact have some effect on petroleum demand, though this impact may be hard to assess even after project completion (particularly in rural areas). Justification of fuelwood projects has been primarily in terms of environmental impact. It is possible that environmental and oil substitution objectives, as well as concerns with local incentives to make projects both more feasible and more easily replicable, will converge in many regions to shift emphases in traditional fuel supply projects from rural/subsistence markets to urban/cash markets.* Urban/cash markets appear to have a greater impact on deforestation in many regions while at the same time the substitution with petroleum products is more certain. The existence of a cash market also simplifies the problem of organizing incentives for investment and labor.

The traditional fuelwood sector also includes a diverse industrial market, as discussed in Annex A. Expansion of industrial applications may represent the most attractive strategy for substituting bioenergy for oil over the next decade. The capital cost should be considerably less than for the alcohol/transporation fuel option which has received much more attention.

*No breakdown of the market orientation of fuelwood projects is available. It is possible that urban oriented projects already predominate.

Despite the publicity however, there has been no bilateral and very little multilateral support for projects to substitute bioenergy for petroleum products in the transportation sector. This deficiency includes support for analysis of the very difficult questions of costs and benefits which must dominate policy in this area. Much will depend on the anticipated price of oil, the shadow price of imports and rural labor, and the country's longer term view of its agricultural/forestry potential and indigenous transport fuel alternatives. Alcohol fuels are being evaluated as a prime World Bank initiative in renewables outside of fuelwood despite the Bank's negative reaction to the Brazilian program several years ago. This evaluation should assist in early decisions, but its conclusions are likely to be negative in general unless the Bank modifies its traditional optimism regarding oil prices.

The United States can potentially make strong technical/scientific contributions over a broad range. There is however one crucial constraint in U.S. technical capacity which will not be amenable to short-term solution. This is a lack of experienced tropical foresters. As a general long-term goal, transcending the needs of a bioenergy program, the U.S. should take steps to build up and maintain competence in skills related to tropical forests.

After bioenergy, it is hard to discern a clear priority among renewable options from the point of view of oil substitution. Solar thermal systems for hot water (but not low pressure steam) with back-up probably represent the second renewable priority for oil substitution. The lack of seasonal variation in insolation compared to developed countries and the lower cost of labor to install systems may be important factors improving the economics of hot water systems relative to developed countries despite the disadvantage of higher discount rates for future benefits from lower operating costs.

Passive solar systems for building design are also important. In most LDCs space heating is not a problem and outside of commercial building space cooling is rare. However, building inventories will remain for many years and in many countries space cooling could increase later in century. If passive solar systems do not involve additional investment, it could be cost effective.

Geothermal and small-scale hydro are commercial technologies now and can be significant sources of power in localized regions. Small-scale hydro is primarily a power source for local application and tends to be found in regions of abundant large-scale hydro. To the extent that it is connected to the grid it will probably substitute for the latter rather than electricity. Off-grid applications, while very interesting from the point of view of providing power to small loads for rural/small town development will not substitute for much oil. Geothermal, particularly from more common resource types is a rather sophisticated technology for electric power. Economics will depend on location of substantial loads relative to geothermal site. Small local use will be less important than for small-scale hydro because of generally larger size of plants.

High temperature solar and solar electric sources cannot even be considered a viable source for substitution of oil until after 1985 at the earliest. Applications of photovoltaics are limited to remote very small-scale power use such as in medical clinics.

Institutional Options, Contraints and Absorptive Capacity

In general the primary constraint on the ability to expand funding effectively in renewables and conservation is likely to be the ability of the potential donor agencies to develop and manage well conceived projects. This is an additional reason to give issues bearing on the organization of assistance considerable attention as the program evolves.

An important dimension of the organizational issue is the degree of reliance on multilateral agencies, especially the multilateral development banks (MDB), as opposed to bilateral agencies. Given the nature of this early phase of programs, which is likely to be overwhelmingly the development of program infrastructure as described earlier, it can be argued that initially bilateral agencies' activity should predominate, though a strong MDB role in analysis and pioneer loans can also be expected. As "market intervention" grows in importance the role of the MDBs should grow with it. This division of labor is quite conventional in theory, for it emphasizes the role of the MDBs in mobilizing capital transfers.

One reason for emphasizing a relatively strong bilateral program in the early phase is that the experienced pool of talent for technical assistance is still small in the U.S. Building that infrastructure of U.S.-based skills is more likely to be achieved by a bilateral program, at least initially. Once there it will be available regardless of funding source.

The renewable program in particular still contains a major element of technology development, which is not the forte of the multilateral banks. Finally, if the objective of U.S. policy is to test the extent to which this aspect of energy development can be accelerated, it is more credible to begin where U.S. policy is in fact most decisive - i.e. the bilateral

program. Next to strong domestic commitments, a strong bilateral program is perhaps the most effective impetus the U.S. can give to strong multilateral programs. Unlike the proposed oil exploration fund, for example, there does not appear to be any strong countervailing political problems associated with bilateral action.

For the time being it may not be necessary to decide whether bilateral programs should eventually include substantial capital transfers. The paradigm used here assumes not. However, it is well to note that on-going rural electrification projects and projected fuelwood projects in fact are essentially capital transfer projects. If bilateral capital transfer projects exist in renewables and conservation it may be possible for the U.S. Government to speak of an action policy in the "market intervention" phases of these programs. If no such bilateral capacity exists U.S. policy would be limited by its influence in multilateral institutions.

The most difficult near term institutional issues concern the organization of the bilateral effort. The obvious operational agency, AID, is faced with a declining budget for development assistance, has a policy mandate that is hostile to effective action in the modern energy sector (the so called "basic human needs" policy), has extremely limited competence in energy matters among its personnel, and is dominated by a decentralized geographic power structure that exacerbates personnel limitations. Finally, despite the great importance of missions in the agency, it is not represented by missions in most of the important oil-consuming LDCs. None of this presents a favorable prospect for the rapid development of professionally competent, coherent energy program integrating a broad spectrum of concerns.

As a result of AID's severe limitations there is considerable interest in institutional alternatives taking a greater operational weight. Chief

among these is DOE. Yet DOE's problems, while different, are also severe. Energy policy initiatives, in order to be effective, must be embedded in the market, political, and planning realities of a country. As is true in this country the most difficult constraints on implementation of energy policy are not technical (though technical problems tend to be underestimated in policy analysis). This suggests that policy and operational leadership should go to the market-oriented agency, which today is IDCA/AID, though interagency cooperation must clearly intensify. Finally, the present guideline of OMB is that there is only one assistance agency in a country and in many countries that is AID. To have DOE take the lead in non-AID countries would not qualitatively change AID's problem in AID countries.*

Energy not only represents a severe institutional challenge to AID/IDCA, it may represent a watershed in the evolution of the agency, the beginning of a shift in assistance policy away from an overwhelming emphasis on basic human needs and rural development to issues higher on the agenda of the North-South dialogue, and to closer relations with "non-AID' developing countries. The severity of problems encountered by a country at <u>any</u> level of development would have greater weight relative to level of development as a criterion for action, than is now the case.

How this shift may occur, if it occurs, is not now clear. There may be wrenching changes within AID or the creation of a new member of the IDCA family. Regardless of the ultimate resolution decision-makers must not assume that a successful bilateral energy program can be launched without systematic attention to organizational and management issues.

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*On the otherhand an arbitrary line must be drawn somewhere since DOE clearly leads with the OECD, Mexico, and most OPEC countries.

Country Options

Most of the oil consumed by developing countries is consumed in a small number of them, as shown in the E/DI report. A program with the single-minded objective to impact favorably on world oil balances would perforce concentrate on these few countries. The E/DI report recommends, however, that "the oil import problem of individual countries should take operational precedence over a concern with world oil balances." This recommendation is based on a sound reading of Third World politics and, one might add, the dynamics of bureaucracies with simple single-mided goals.

To say that we should not focus overwhelmingly on 8-10 countries does not mean we should ignore them and carry on with previous assistance priorities. We are, thus, left with the practical problem of establishing critiera for the kind of program relation the U.S. will maintain with different countries. The problem is made more difficult by the comparative lack of recent experience the U.S. has in collaborative relations at an official level on specifc technical-sectoral problems inside many of these countries,* which tend to be higher income LDCs. It is possible that the amount of bilateral involvement which would be truly useful might be quite modest in terms of funding in some of the most important of these countries - and might concentrate on specific "infrastructure" items such as scientific, technical, and analytical collaboration and institution building. These countries generally have the resources to launch their own programs to intervene directly in the market if they wish.

*In Brazil, for example, even scientific collaboration stopped through U.S. bureaucratic inaction during the wind-down of AID programs. The fact that difficulty has been experienced starting up again is of course a consequence of U.S. blunders on the Brazilian-German nuclear deal which might be cited as evidence of what is meant in the text by the "dynamics of bureaucracies with simple single-minded goals."

Specific countries have considerable experience with certain technical areas. In the case of biomass, the E/DI report's second priority, Brazil will probably soon have more serious development experience on a range of technologies than the rest of the world put together (including the U.S.). The design of research and development and the selection of pioneer projects should build heavily and explicitly on a detailed understanding of Brazil's own activities. The U.S. might seek to establish a supporting collaborative relation with Brazil towards other developing countries.

Another set of countries which deserve highlighting are small countries, those with populations less than a few million (not including city-states). The problems of such countries are likely to grow disproportionately in intensity during a transition to a post-petroleum era. It is possible that some modest sustained involvement with technical training, and policy problems should be made on a generic basis for small countries as such.

ANNEX A - The Interface Between Traditional Fuel Use and Petroleum

As is now commonly understood, and as indicated in the E/DI report, biomass is an important part of the energy supply of most LDCs. It is used primarily as a traditional fuel for cooking, lighting and some industries. From the perspective of the current review this only becomes pertinent if we accept the hypothesis that there is an elasticity of demand for oil with respect to the availability of biomass (particularly wood) fuel. This thesis is controversial, particularly in situations where biofuel is used for cooking in rural areas. Some argue that with shortages of wood fuel people will simply cook less rather than use kerosene. This Annex argues that there is some elasticity, though it cannot be proved since there has been little analysis of wood-kerosene substitution for cooking. A rather large amount of fuelwood enters the cash market, primarily for urban cooking and small industries (both urban and rural). Given the cash nexus it is reasonable to expect some substitutability as relative prices change. That part of fuelwood demand which is supplied by purchases of fuelwood would appear to have the closest substitution relationship with oil, and this sector would appear to be high priority for intervention under a policy to substitute for oil. Two other features make this sector promising for intervention. First, purchased fuelwood appears to play a disproportionate role in deforestation caused by fuelwood collection -- which makes this sector of great interest from an environmental point of view as well. Second, it is far more straightforward to devise an incentive structure for producing fuelwood on a sustainable basis when the product can be sold.

The "latent" petroleum demand filled by fuelwood for cooking is significant if not awesome. A family cooking with kerosene consumes approximately 2.7 - 3 Gj of kerosene (75 liters) per capita per year. If all the 2.1 billion people who use woodfuel, dung, and crop wastes were to shift to kerosene, it would increase demand by about 6 GJ or 2.7 million barrels per day. Such a massive shift is not in prospect, nor are all of the shifts which are likely to occur necessarily amenable to change.

This latter point appears to be clearest with respect to the effect of income on woodfuel and residue use for cooking. Only 24% (50 million) of the urban poor in LDCs as a whole are estimated* to use "commercial" fuels for cooking, while 88% (335 million) of the urban non-poor use commercial fuel.. This income effect raises the question of the extent to which there might be resistance to a shift back to woodfuel from kerosene. Such a shift might be associated with downward mobility. On the otherhand, while the move from rural to urban areas is associated with a shift to commercial fuels, the current estimate (going from 12% of rural to 24% of urban poor) is not as strong as one might expect.

Approximately 200 million people (255 if we include Asian communist countries) use wood and residues and live in urban areas. This represents a clear potential "swing" population with a total latent demand of 250-300,000 barrels/day. More than 3/4 of these are urban poor and the number of urban poor is likely to increase during the century, at least, affecting any shift by the non-poor away from biofuel, so in one sense this estimate is a minimum.

*D. Hughart, Prospects for Traditional and Non-Conventional Energy Sources in Developing Countries, World Bank Staff Working Paper No. 346

In another sense it is high, particularly as an estimate of the magnitude of the impact of policies to keep the cost of fuelwood down. First, not all the urban population is likely to leave woodfuel and residue within 25 years. Second, it is not clear that all of those who do would be influenced decisively by a lower relative cost of fuelwood. Waving our arms a bit we may find an urban swing market of 150-400,000 barrels/day which might either stay with solid biomass or go to "commercial" fuels by the turn of the century and may, to some degree, be influenced by assistance action. In countries where kerosene is heavily subsidized it is not clear that unsubsidized fuelwood produced on a sustainable basis can compete, so assistance may be necessary.

How large the rural "swing" market is, is a question-mark. It may be quite large. While 10% commercial fuel use in rural areas is the roughly estimated LDC (including communist Asia) average; in Latin America it is 45%.* Shifts of this order by the year 2000 suggest more than half a million b/d potential impact. However, it is not clear from this example how policy could effect possible shifts of this magnitude in other regions. On the one hand, Latin American probably has less "expensive" fuelwood in rural areas (even in terms of labor required for collection) than LDCs in general so the cause of the shift may be consumer preference and higher income, which is something we can do little to countervail.

On the other hand, while Latin America has probably not subsidized its kerosene more than in the other regions...it is quite possible that the subsidy has had a major impact on rural consumption as the cash economy penetrated rural areas. Theoretically, elimination of the kerosene (or bottled gas)

*D. Hughart, op cit.

subsidy is possible and from the point of view of income distribution may even be beneficial, but significant subsidies are likely to remain a political fact of life for years.

There is another important traditional fuelwood market which does not compete with kerosene and bottled gas but with fuel oil and to a less extent diesel oil. This is the industrial market, which is perhaps even less understood than the cooking market. It is an extraordinarily diverse market, and though it is counted as a "traditional market," (lumped together with primitive cooking) industrial fuel applications in some countries are evolving in ways that compete with fossil fuel use in more modern kinds of enterprises. Thus, we find small kiln, blacksmiths, bakeries, and other small-scale tranditional industries as well as larger scale enterprises of more recent origin (being dependent on the steam engine) - steam locomotives, sugar mills, rice mills, wood processing and pulp plants. The larger scale enterprises generally tend to be in industries processing the output of the agricultural and forest sectors of the economy. Substitution for oil in these industries is occurring in both LDCs and developed countries in broadly comparable ways.

Both in the U.S. and in many LDCs it is of more interest to inquire whether such substitutions can be carried on outside of these special industries. Since often they fortuitously provide their own biofuel from process-generated residues, these industries represent a special and rather limited case for any country with ultimately substantial industrial development, presumably a target of most LDCs. In the U.S. and the more modern sector of an LDC this can only occur with demonstration and confidence in the logistical reliability of a fuel supply system capable of concentrating rather large amounts of biofuel at a competitive cost within government guidelines.

While this is true, experience in countries like Brazil suggests, and future analysis is likely to confirm, that in the industrial market it can be counter-productive to think of "traditional fuels" in one box and bright new modern "renewable biomass applications" in the other. One reason in particular that increased biomass use in the industrial market may be important sooner than most renewables is because increases mean incremental changes in existing patterns and flows rather than qualitatively new operations.

ANNEX B: Extracts on Solar Energy from the National Academy of Sciences Report "Energy in Transition 1985-2010" pp 419-423

These extracts are intended to illustrate the sorts of market interventions which one major study estimates would be necessary in the United States for rapid penetration of solar energy and bioenergy technologies.

SOLAR ENERGY SCENARIOS

To illustrate the potential contributions that solar energy could make in the intermediate term, this study developed two special scenarios of future use of solar energy. The first scenario embodies estimates of solar energy use under the assumption that the prices of competing energy sources remain near present levels and that solar energy is given no special incentives. The second represents the potential solar contribution under a policy of vigorous government intervention in the market for energy. More detailed information on how these scenarios were developed is given in the report of the Supply and Delivery Panel's Solar Resource Group.[1]

Low-Solar-Energy Scenario

This scenario is based on the assumption that no policy other than the current federal tax credits is implemented to assist the entry of solar energy into the energy market, that the costs of other energy sources increase only slowly, and that the costs of solar energy technologies remain high (i.e., follow the estimates of the Solar Resource Group without breakthroughs in the costs of advanced solar technologies). This yields a very small market penetration of solar energy by 2010 (Table 6-1). Solar heating systems do not achieve significant market penetration until after 2000, at which time it is assumed that the prices of electricity and natural gas have risen greatly. No solar electric technology becomes economically competitive before 2010, and municipal waste is converted to fuels only in major urban regions.

High-Solar-Energy Scenario

This scenario is based on the assumption that by 1985 a national policy decision mandates vigorous incentives to bring about the use of solar energy. This scenario is driven not by economic forces, but by government intervention in the energy market. It is assumed that this government policy mandates, independent of cost, adoption after 1990 of solar energy for heating all new buildings and for all industrial process heat where feasible; sets in force a mandatory schedule for deploying several solar electric technologies; and requires rapid adoption of technologies for converting municipal and agricultural wastes to fuels. This scenario leads to a solar energy contribution about equal to President Carter's announced goal of 20 percent solar energy in the year 2000. The 20 percent figure includes present use of hydro and biomass, estimated to be about 5 quadrillion Btu (quads), to which about 13 quads of solar energy would be added to form a total of 18 quads (or nearly 20 percent of the Administration's assumed total).*

TABLE 6-1 Solar Contributions in Low-Solar-Energy Scenario (primary energy displaced, quads)

Solar Application	1985	1990	2000	2010
Heating and cooling	0	0	0	0.3
Solar electricity	0	0	0	0
Fuels	0	0	0.1	0.3
TOTAL	0	0	0.1	0.6

TABLE 6-5 Total Solar Contributions in High-Solar-Energy Scenario (primary energy displaced, quads)

Solar Application	1985	1990	2000	2010
Heating and cooling	0.5	1.1	4.1	11.0
Solar electricity	0.1	0.6	3.6	12.4
Fuels	1.0	1.6	5.4	5.4
TOTAL	1.6	3.3	13.1	28.8

Combining all these estimates yields a total of about 29 quads of primary energy displaced in 2010 by solar energy in this high-solar scenario (Table 6-5).

The high-solar scenario was not intended to represent a recommended national strategy for solar energy development, but rather to indicate the upper bound of what is technically feasible. The total cost of implementing such a scenario, at today's costs for solar technologies, might be around 3 trillion dollars, perhaps 2-3 times the cost of obtaining equivalent energy from conventional nonrenewable sources. The increment, if provided as a subsidy by government, would be much larger than the total amount provided to date by government to stimulate energy production by conventional means (including nuclear), which was estimated recently at about one tenth of a trillion dollars.[7]

ANNEX C - A Preliminary Estimate of Information System Costs for Conservation

One approach to an "active" information system which is envisaged would involve groups of experts (U.S. and foreign) to identify and briefly review the literature (technical and non-technical) which they judge to be most useful. In the closely related fields of conservation, demand management and demand estimation, the appropriate level of disaggregation of groups would probably be in the range of 12-18 panels. As an example, at this level of disaggregation one might distinguish between distinct industrial unit processes (mechanical drive, direct heat, evaporation, distillation). or alternatively between industry groupings such as basic materials, fabrication, mining, with additional attention to certain groupings of conservation measures such as co-generation and control systems.

Total costs associated with each task group (including the acquisition of the referenced literature in a central location) are likely to be on the order of $25-40,000 per group. Costs should, therefore, fall somewhere in the range of $400,000-600,000, with somewhere between 10,000 and 20,000 items registered (ranging from articles to books).

To transfer registered documents to microfiche should cost less than $200,000, assuming about 1.5 million pages of material.* If it were desired to obtain 4 microfiche copies for regional centers, this should cost $125,000-150,000.

If we imagine fairly intensive use of the 20,000 items (an average of 50 requests per annum per item), the cost of completely subsidizing use would come to about $1.8 million per year. It is, however, unlikely the full cost would be borne except in the case of some of the poorer countries.

*Based on a 50% inflation of the estimate in DEVSIS, the preliminary design of an international information system for the development sciences, IDRC, Ottawa, 1976, which yields a cost of $160,000.

The estimate for software development and other lead-on activities must of necessity be loose. For DEVSIS, these were estimated to be 7.0 professional man-years and $95,000 (1975). The system is not identical, so if we conservatively assume 10 man-years at $75,000 per man-year and $150,000, we obtain a lead-on investment of $900,000.

It should be possible to have such a system fully operational within two years. Judging from the estimates for the three-year start-up of DEVSIS (with its estimated 60,000 items compared to 20,000 here) for $1.8 million (1975) (including the investment in the previous paragraph) the annual cost during two years' start-up should be no more than $1 million (1979 $) excluding the cost of the selection task groups.

The cost of maintaining and updating the center thereafter for the service might be approximately $1.7 million (1979).* The cost of this center would be very little highter if it included energy supply technologies.

The central unit costs should therefore remain fairly constant at $1.5-1.7 million per year. Subsidy of terminals, microfiche readers, on-line time, regional centers, and microfiche copying and distribution could easily double or triple this figure. On the other hand, many users should be capable of paying their full marginal cost. $3.5 million (1979) might be a reasonable peak figure allowing considerable pump priming.

A possible budget cycle would be FY 1981, $1.0 million; FY 1981, $2.5; FY 1983, $3.0 million; FY 1984, $3.5 million; FY 1985, $3.0 million, assuming full operation in early 1983 and the availability of funds in FY 1981.

*Based on $1.0 million (1975) central operating costs for DEVSIS 50% inflation and $200,000 per year for updating tasks.

At least 50% of the total cost could justifiably be shared with a domestic agency if an arrangement can be worked out. On the other hand, more sophisticated software development could (as in the case of the MITRE fluidized-bed combustion matric)* raise annual costs by several hundred thousand dollars.

*See C. Bliss et al Data Base for an Assessment of the State of Fluidized-Bed Combustion, MITRE Corp, 1979

ANNEX D - Modal Shifts in Transporation

As observed elsewhere in the text, the issue of whether the U.S. Government should actively support the financing of investments to achieve modal shifts in transportation could have a very large impact on the scale of assistance for conservation. There are two areas where financial assistance could be crucial in influencing the modal distribution of traffic and the total amount of traffic. The first area is the shift from road to rail inter-city freight transport; the second is to prevent a shift from public or non-auto intra-city passenger transport to automobile transport. Both could absorb very large investments that might be unacceptably large for many countries without assistance. On the other hand, both could also have rather large impacts on the demand for liquid transport fuel in the longer term. Both are therefore controversial. Consider the second area -- intra-city passenger transport. Among the options is mass-rail transit. This can be a very capital intensive option, and hence does not appear to be very popular with development economists concerned with the transport sector. On the other hand, it could be argued that for many of the larger cities of the Third World, mass-rail transit systems (or their equivalent) eventually should be built.

Two particular questions appear to gain in imporatnce as a result of considering mass-rail transit from this perspective. How much more would it cost to build the system in, say, twenty years than now in constant dollars? Building a mass-transit system with its own infrastructure (that is, not sharing a public street with other private vehicles) should be much less expensive in a lightly-developed site than one that is heavily built up.

Second, there is the question of the extent to which mass-transit systems can in fact influence the development of the structure of a city. If the influence can be shown to be strong, the priority assigned to mass-transit systems in assistance might increase substantially.

ANNEX E - Technology Transfer of Conservation Technologies

It is likely that a large amount of commercial technical experience in the developed countries is directly applicable with modest adoption to improvement of energy efficiency in LDCs. This is particularly true in the industrial sector. What, then, may be the constraints on the transfer of this technology? Again, we do not know. Several points are, however, pertinent:

1) The variety of technologies is very large, so it is much harder to define the issue than with, say, technology for exploring for and developing an oil field. The institutional context of implementing the manufacture of engines with greater efficiency or of fibreglass insulation is clearly different than constructing commercial buildings with passive solar features or the decision to install more insulation for steam lines.

2) The U.S. Government investment in developing technology to improve energy efficiency is large. This may mean that patent availability is greater than is the case with industrial technologies in general. It is not, however, certain that the technologies of most interest to LDCs have been developed with DOE participation rather than the private sector alone.

3) A major part of the savings may be achieved without resort to new technologies. The ability to manufacture them will then depend primarily on the general capabilities of a particular country.

4) There may be an important distinction between situations where the main objective is to manufacture the device to save energy* and where

*Examples are: engine and vehicle manufacture, boiler manufacture, some appliances, forms of insulation, improved electric motors and lights.

it is to modify processes or energy use patterns with purchased equipment or design changes. The latter will likely be preponderant, and is also likely to involve far fewer institutional and proprietary barriers to transfer.

5) Within the industrial sector we find multi-nationals and large national firms. The access, particularly of the former, to commercial packages of equipment and energy audits/management from developed countries may be far highter than for smaller national firms. It is not clear to what extent an assistance program would accelerate action and technology transfer within multi-nationals; subsidiaries. From this perspective, information and demonstration activities oriented towards smaller national firms may be an area where assistance may make a greater difference.