ENERGY FOR SUSTAINABLE DEVELOPMENT IN THE THIRD WORLD

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Abstract

The conventional paradigm for energy development in the third world today is the GROSSCON (GRowth-Oriented Supply-Sided CONsumption-directed) paradigm. However, energy development based on this paradigm is intrinsically unsustainable because it leads to environmental degradation, conflicts with the people located at project sites and mounting costs.

Economic growth is a necessary, but not sufficient, condition for sustainable development; in addition, the growth must be need-oriented, self-reliant and in harmony with the environment. To advance such a pattern of economic growth, energy must acquire (1) a development focus directed towards the satisfaction of basic needs, starting with the needs of the neediest, (2) an end-use-orientation to reveal what energy is used for, who benefits from it and how efficiently it is being used, and (3) a service-direction so that the true indicator of sustainable development is the level of energy services enjoyed by the population, particularly by its poorest sections, rather than the magnitude of per capita energy consumption. Hence, the estimation of energy demand has to be based on a DEFENDUS (**DE**velopment-**F**ocussed **END**-**U**se-oriented **S**ervice directed) paradigm. This paradigm must also include a rational rule-based approach -- least-cost and/or least-environmental-impact planning -- for arriving by a minimization process at a supply-mix involving centralized sources, decentralized sources and energy saving measures. Thus, if energy is to become an instrument for sustainable development a DEFENDUS paradigm must be used in place of the conventional GROSSCON paradigm.

Taking Karnataka State in South India as an example, it is noted that the conventional energy paradigm offers the gloomy promise that "..... energy shortages will continue up to, and even in, 2000, with little hope thereafter." In contrast, the DEFENDUS electricity scenario involving a development-focussed, end-use-oriented, service-directed estimate of demand and least-cost supply-mix of centralized sources, decentralized sources and energy saving measures, is cheaper, quicker, more environmentally sound and more equitable -- it is an example of an energy scenario for sustainable development.

Though the replacement of the GROSSCON paradigm with the new DEFENDUS paradigm can play a major role in making energy an instrument for sustainable development, such a shift is not taking place as rapidly as its potential would suggest.

Energy consumption patterns are shaped by the behaviour of a large number of individual/group/institutional actors, each of whom has to make many decisions relating to major energy-using activities. Thus, the implementation of a paradigm shift involves actors operating at various levels. Further,

action may be required at one or more levels -- from the microlevel of the consumer through the macrolevel of global agencies. But, barriers to the replacement of the GROSSCON paradigm with the new DEFENDUS paradigm exist or can arise at all these levels.

A detailed analysis has been presented of the role of international, multilateral and industrialized country funding/aid agencies in promoting the paradigm shift by overcoming the barriers created by the inefficient-technology exporters, the supply-biased, the financial institution with an anti-innovation attitude, the large-is-convenient funder, the project-mode sponsors and the self-reliance underminers (alias the dependence-perpetuators).

It has been concluded that combinations of measures for overcoming barriers, combinations of measures at the strategic level and policy-assisted, market-oriented mechanisms are required. The DEFENDUS paradigm may be difficult to implement, but the conventional GROSSCON paradigm is impossible to sustain; hence, the paradigm shift is very likely.

Finally, it is necessary to have a grander vision than a paradigm shift for energy. The real goal of an energy system is sustainable development. Only then will energy become a means to an end rather than an end in itself.

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1. Conventional Paradigm for Energy Development[1]

Virtually all energy thinking in the third world today is dominated by the GROSSCON (GRowth-Oriented Supply-Sided CONsumption-directed) paradigm. This energy paradigm guides the views of governments, the approach of energy institutions and the thinking of decision-makers and planners.

Conventional Supply Based Paradigm

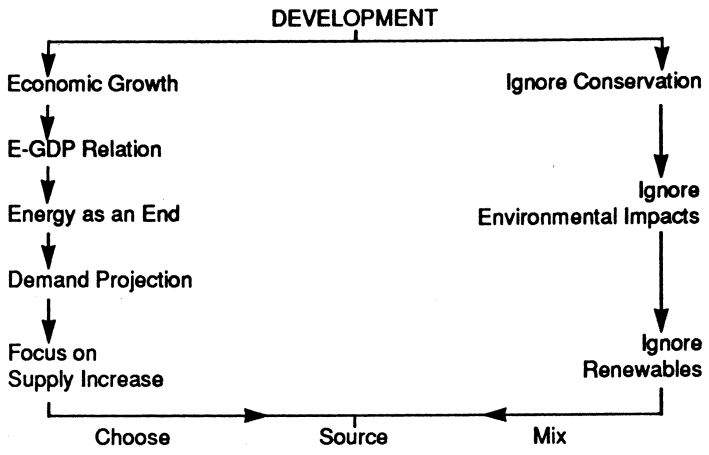

Figure 1

The conventional GROSSCON paradigm (cf. the left hand side of Figure 1) starts by equating development with economic growth, measured for example by the magnitude of the Gross Domestic Product (GDP). Next, the paradigm considers that the only way economic growth can be achieved is by pumping energy into the economy. So, growth in energy consumption becomes a necessary condition for economic growth -- this is the so-called Energy-GDP relationship. Then, the paradigm moves on to various energy carriers, electricity and oil. So, energy becomes an end in itself and once this happens, the main task is to make a demand projection estimating how much energy will be required in the future. After a demand projection is made, the main issue is how the supply of energy can be increased to meet that demand. Energy sources must be identified to supply the energy required to meet that demand.

On the right hand side of Figure 1 are all the things that have been ignored in this consumption-directed supply-biased process of energy planning. The possibility of using energy more efficiently, and therefore of saving energy, has been ignored. Also ignored are the environmental impacts and whether the sources of energy that are being used are renewable or

non-renewable, i.e., are they being stolen from future generations and depleted, or are they being used in a renewable way? Nowadays, the lay public has become aware of these issues so that no energy planner can get away with completely ignoring conservation and environmental impacts. So, what is often done by planners is to do the left hand side of the exercise first -- a demand projection followed by a scheme for supply increases. Then, after the whole exercise is over and all the budgets are drawn up, they write a chapter on conservation stating powerfully how important it is to use energy efficiently and another chapter on environmental impacts saying eloquently that we must be very careful about the only earth that we have, etc. But, conservation and environmental protection do not come into the budgets; they are afterthoughts and retrofits.

2. Unsustainability of Conventional Paradigm[1]

This GROSSCON paradigm that dominates current energy development has a number of serious defects. It is unwise because it emphasizes the consumption of energy. But, human beings do not want kilowatt hours and joules; what they want is light, heat, warmth, translational motion in transport, rotating shafts in machinery, etc. What is important is the services that energy provides, and not merely the consumption of energy per se. Conventional energy planning is unfair because it does not scrutinize the distribution of the benefits of energy among the different income groups in society, and whether this distribution is skewed against the poor, as is invariably the case. For example, in the state of Karnataka in South India, as much as 50% of Karnataka's population does not benefit directly from its electricity system. It is unfrugal (to coin a word) because it ignores efficiency improvements. Finally, it is unbalanced because it looks only at the supply of energy and not at how this energy is being used, i.e., it does not look at the demand side.

The conventional GROSSCON paradigm for energy is also responsible for the well-known environment-development trap (Figure 2). Groups of people who may be called developers propose their version of "development" to achieve which there must be economic growth. And in order to have economic growth, they must be increases of energy consumption. When, however, this energy is produced, there are invariably a number of side effects. But, like many modern doctors who prescribe "miracle drugs" without telling patients about the side-effects of these drugs, the developers do not tell the people about the side-effects of these energy projects.

One of the most important of these side-effects is environmental degradation. Concerned people who see the environment degrading foresee that the entire life-support system will be ruined, and because they object to this disastrous result, they oppose the energy projects thinking that such opposition is the only way they can prevent the environmental degradation. Thus, a conflict intensifies -- the developers say that the environmentalists are preventing development and progress, and the environmentalists say that the developers and planners are destroying the environment making further development impossible and the development process unsustainable. The two sides are locked in battle. This conflict cannot be resolved within the framework of the conventional paradigm (Figure 2).

Environment vs Development Trap of Conventional Paradigm

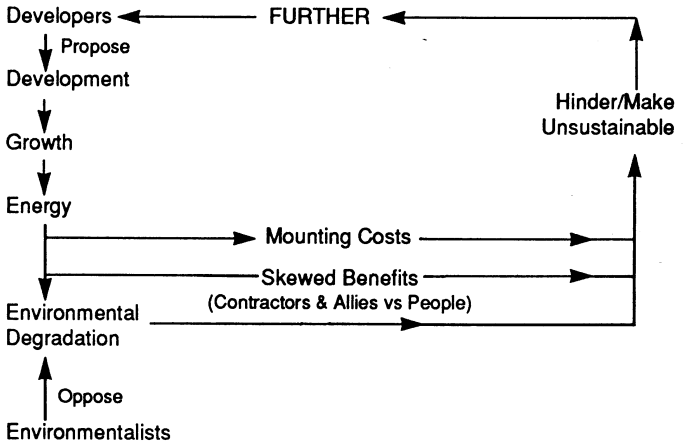

Figure 2

There are also other side-effects. First of all, there is the human dimension of the problem. The people who are located at the site of these development projects often have to be displaced or subject to pollution. They become the victims of development. Instead of seeing the projects as development, they see it as a process whereby a group of people -- the contractors and their allies -- benefit from these projects at their expense. The victims of development then begin to oppose the projects. This conflict is taking place in many parts of the third world, for instance, over the Narmada projects in Western India.

Then, there are the mounting costs -- the economic dimension of the problem. It is becoming increasingly expensive to generate the extra energy. Economists say that the marginal cost of energy is increasing in the sense that it is more expensive to produce the next kilowatt hour of electricity or tonne of coal or barrel of oil or than the previous one. That is because as the easy sources get exhausted, we have to turn to the more difficult ones. We have to go from the easy dams, mines and oil fields to the remote dams in mountainous areas, the deep mines and off-shore sources of oil.

The World Bank showed in 1989 that only about $20 billion was available in response to the request of all developing countries for about $100 billion to meet the requirements of their electricity sectors[2]. It turns out that a similar mismatch between the availability and demand for funds for the electricity sector exists within developing countries. The basic problem is that, in a country where the state makes the bulk of the investment on electricity infrastructure, both the size of the total state plan and the percentage of the total plan earmarked for electricity are not fixed by the electricity sector; they are fixed by the Government, which has the responsibility for a number of other crucial developmental sectors such as education, health, etc. As a result, the Government can make available only one-third to one-fifth the funds asked for by the electricity sector. It has been pointed out that, in this conflict between the electricity sector and the economy as a whole, the electricity sector is like the Indian mythological

demon Bakasura who had an insatiable appetite -- no matter how much he was fed, he always wanted more. For example, the share of the plan going to electricity has increased in India from 10% to 15% to 20% to 25% and now the electricity sector wants even more. This then is the economic consequence of the conventional paradigm for energy -- what the electricity sector asks for is several times more than it can ever hope to get from the Government. Consequently, it is economically impossible to persist with the GROSSCON paradigm.

The conventional paradigm has led therefore to environmental degradation, conflicts with the people located at project sites and mounting costs. Energy development based on the conventional GROSSCON paradigm is intrinsically unsustainable. It appears that the acronym GROSSCON is very appropriate, because according to the Oxford dictionary, "gross" means flagrant and "con" means confidence trick).

3. What is Energy for Sustainable Development?

It is perhaps worth stressing that energy for sustainable development is a grander objective than sustainable energy development in the literal sense because the energy system could be sustainable without the development of society being sustainable. Thus, the priority in the third world should be sustainable development, with energy coming into the picture as an instrument of sustainable development. Such a perspective begs the question: what is sustainable development?

Sustainable development requires economic growth but it must not be equated with growth. Growth is a necessary, but not sufficient, condition for sustainable development. In addition, sustainable development must advance three objectives:

(1) the satisfaction of basic needs,
(2) the strengthening of self-reliance so that people take control over their own destinies, and
(3) harmony with the environment since the development process must withstand the passage of time and survive over the long run -- otherwise, it will not be sustainable.

If energy therefore is to become an instrument for sustainable development, it must be development-focussed, and in particular, it must be directed towards the satisfaction of basic needs, starting with the needs of the neediest. To achieve this need orientation and this equity in distribution of benefits, it is essential to look at the end-uses of energy. What energy is used for and who benefits from energy become central issues. The emphasis has to shift from the consumption of energy to the provision of energy services. The true indicator of sustainable development must become the level of energy services enjoyed by the population, particularly by its poorest sections, rather than the magnitude of per capita energy consumption. Thus, both an end-use-orientation as well as a service-direction are required. Hence, the estimation of energy demand has to be based on a DEFENDUS (**DE**velopment-**F**ocussed **END**-**U**se-oriented **S**ervice directed) paradigm if energy is to advance sustainable development.

The next question concerns what mix of supplies will meet this demand. In this context, it is crucial to ensure that

(1) supplies are not restricted to the conventional centralized sources (coal, oil, nuclear and major hydroelectric plants),
(2) decentralized sources (wind, solar, biomass, small hydroelectric) are also included in the options, and
(3) energy saving measures (efficiency improvements, carrier substitution and alternative modes of energy usage) are treated as equivalent to energy-supply increases, and therefore as valid options for meeting the energy requirement.

With such an expanded list of options, a rational rule-based approach is required for arriving at a supply-mix involving centralized sources, decentralized sources and energy saving measures. One such approach is least-cost supply-mix planning which is a process of examining all energy-saving and energy-producing options to select a mixture of options that minimizes cost.

But, cost cannot be the only consideration in achieving sustainable development; environmental concerns are crucial. Where environmental impacts can be included in costs, they can be incorporated into least-cost planning. Alternatively, least-environmental-impact planning can be carried out. Very often, the least-cost solution is also the least-impact solution. But where this is not the case, environmental benefits may have to be traded off against costs. What is required therefore is a least-cost and least-environmental-impact supply mix.

Thus, if energy is to become an instrument for sustainable development a DEFENDUS paradigm that includes a least-cost and least-environmental-impact supply mix must be used in place of the conventional GROSSCON paradigm.

4. The DEFENDUS Electricity Scenario for Karnataka State in South India -- An Example of an Electricity Scenario for Sustainable Development[3]

The recent efforts at electricity planning in Karnataka State, South India, in particular the May 1987 report[4] of the Committee for preparing a "Long Range Plan for Power Projects in Karnataka 1987-2000 AD" (LRPPP), are clear-cut examples of the failure of the conventional GROSSCON approach to energy planning. The LRPPP plan demanded that, in order to meet its energy requirement of 47.520 TWh and 9.397 GW in 2000 AD, the state should spend an astronomical sum of about $17.438 billion, develop a great deal of infra-structure (better transmission lines, coal transportation linkages, railway facilities, etc.), construct massive centralized power generation facilities (including a 1 GW super-thermal coal-based power station and about 2 GW of nuclear power), raise funds from the World Bank and the Central Government, divert at least 25% of Karnataka State's Plan for power and appeal to private industry to set up generation facilities. In return, the LRPPP plan promised that "..... energy shortages will continue up to, and even in, 2000, with little hope thereafter."[4] In other words, conventional plans are no longer solutions; they are exercises in profligacy.

An alternative scenario for the electricity sector of Karnataka has, therefore, been developed on the basis of the DEFENDUS paradigm. This DEFENDUS scenario for energy demand and supply focusses on people-based development through the promotion of energy services, identifying technological opportunities for better utilization of energy through a scrutiny of the end-uses of energy, and using a least-cost approach to identifying the mix of energy supplies. The DEFENDUS scenario turns out to be as promising as the LRPPP and other conventional plans are gloomy. In particular, even though the DEFENDUS demand scenario involves the illumination of all homes in Karnataka, an emphasis on employment-generating industry, the energization of irrigation pumpsets up to a limit imposed by the groundwater potential, and the establishment of decentralized rural energy centres in villages, it comes out with energy and power requirements in the year 2000 AD that are only about 38% and 42% respectively of the LRPPP demand.

This reduction in requirement is only partly (41 %) due to the simple efficiency improvement and carrier substitution measures. These measures consist of the replacement of inefficient motors and incandescent bulbs with efficient motors and compact fluorescent lamps respectively, the substitution of solar water-heaters and LPG stoves for electric water heaters and electric stoves, and the retro-fitting of irrigation pumpsets with frictionless foot-valves and HDPE piping. As important is the 59 % reduction in requirement due to the development focus -- the total energy requirement goes down by directly addressing the energy needs of the poor. That is, it takes more energy to keep poor people poor.

To meet its energy demand, the least-cost supply-mix scenario involves a mix of efficiency improvements and electricity substitution measures, decentralized generation technologies and conventional centralized generation technologies in an approximately 40:40:20 ratio. The replacement of inefficient with efficient motors is the cheapest technology, and therefore, it comes out as the first element of the mix, then improvement of irrigation pumpsets, followed by small hydel, compact fluorescent lamps, cogeneration from bagasse fuel in sugar factories, biogas, producer gas and then natural gas.

As the energy requirement increases, i.e. as the demand escalates, the more inescapable do the environmentally malign and harsh technologies become. As the demand goes down, it becomes possible to avoid some of these harsh technologies. So, the technologies that must be invoked by the least-cost supply-mix are very much a function of the magnitude of the energy goal. This is the reason why the demand targets are often manipulated to high values, so that they justify some of the harsh technologies that would not come into the mix with lower demand targets. In the specific context of Karnataka, the reduced DEFENDUS demand for centralized generation technologies means that the technologies that have become environmentally controversial in the state -- nuclear power, coal-based thermal power and major hydroelectric plants -- can be avoided.

Instead of the DEFENDUS least-cost supply-mix, the conventional LRPPP plan starts with nuclear, coal and hydel and leads to what we may call "maximum-cost planning". When the cost of the DEFENDUS least-cost supply-mix is compared with the cost of the official "maximum-cost plan", it turns out that the DEFENDUS supply scheme is only about one-third of the cost of the centralized supply scheme even though it envisages providing more services to the people. The excess of the maximum-cost over the DEFENDUS supply-mix represents the squandering of public funds that results from adopting, not the least-cost mix of appropriate energy technologies, but an arbitrary mix of energy technologies that has obviously been arrived at by considerations other than cost.

Even allowing for a five-year preparation period before efficiency improvements and electricity distribution measures are introduced, the DEFENDUS scenario involves a shorter gestation time. This is because it depends largely on efficiency improvements and electricity substitution and on decentralized technologies that can deliver energy and power with short gestation times. And finally, as a bonus, the DEFENDUS scenario is far more environmentally benign in terms of CO_2 pumped into the atmosphere every year.

To summarize: the DEFENDUS electricity scenario involving a development-focussed, end-use-oriented, service-directed estimate of demand and least-cost supply-mix of centralized sources, decentralized sources and energy saving measures is cheaper, quicker, more environmentally sound and more equitable than the GROSSCON LRPPP scenario.

5. Role of International, Multilateral & Industrialized Country Funding/aid Agencies in promoting the New Paradigm[5]

There is growing appreciation of the role that a paradigm shift -- involving the replacement of the GROSSCON paradigm with the new DEFENDUS paradigm -- can play in making energy an instrument for sustainable development. At the same time, there is increasing realization that such a shift is not taking place as rapidly as its potential would suggest. Attention is, therefore, being turned to the factors determining the implementation, acceptance and spread of the new paradigm.

Energy consumption patterns are shaped by the behaviour of a large number of individual/group/institutional actors, each of whom has to make many decisions relating to major energy-using activities. Thus, the implementation of a paradigm shift involves actors operating at various levels. In particular, the following actors are involved:

- energy consumers (individuals, households, firms, farms, factories, etc.)
- end-use-equipment manufacturers and providers
- producers and distributors of energy carriers
- actual and potential cogenerators
- local/national financial institutions
- local/state/national governments
- funding/aid agencies of international and multilateral organizations and of the industrialized countries.

Further, action may be required at one or more levels -- from the microlevel of the consumer (residential, commercial, industrial, etc.) through the macrolevel of global agencies. But, barriers to the replacement of the GROSSCON paradigm with the new DEFENDUS paradigm exist or can arise at all these levels.

A detailed analysis of the various barriers, their origins and the measures that can contribute to overcoming them, has been presented elsewhere[5]. In this paper, however, attention is restricted to the following barriers at the international level.

5.1 The Inefficient-Technology Exporters: After the oil-price shocks of the 1970s, there has been considerable change in energy thinking in the industrialized countries, particularly with regard to improvements in energy efficiency leading to greater energy services for the same input of energy. In this process, a number of the old energy-inefficient technologies of the earlier cheap-oil era have been replaced with modern energy-efficient technologies. But, in the developing countries, the process of efficiency improvement has not taken place to the same extent. This is primarily because of the transfer of obsolete, often cast-off, energy-inefficient technologies to the developing countries, which have always depended heavily on technology imports from the industrialized countries.

Further, a basic difference between industrialized and developing countries must be emphasized here. Whereas industrialized countries had large stocks of inefficient equipment to be replaced, developing countries are very much more of a "blank sheet". Much of what the developing countries have, may be inefficient, but fortunately, they do not have too much of it. Hence, they can leapfrog technologically by adopting energy-efficient technologies without going through the intermediate phase of large-scale energy inefficiency.

The barrier to a paradigm change created by the energy-inefficient-technology exporters can be tackled by assistance with technology assessment, by favouring energy-efficient technologies in aid programmes and by supporting technological leap-frogging in developing countries.

5.2 The Supply-biased: Just as the producers and distributors of energy carriers and financial institutions within developing countries are obsessed with the supply aspect of the energy system, the international, multilateral & industrialized country agencies that provide the funds and aid are also supply-biased. Thus, of the $66.83 billions (constant 1991 dollars) given between 1980 and 1990 as energy sector loans by the multilateral development banks (World Bank - 67%, Asian Development Bank - 11%), "... less than 1% ... has been for end-use energy efficiency."[6]

The origin of this barrier is the conventional GROSSCON approach to energy followed by these international, multilateral & industrialized country agencies according to which the purpose of the energy system is to increase energy consumption, which means that the emphasis has to be on increasing the supply of energy. Hence, efficiency improvements become a separate issue that is automatically ignored because it does not lead to increases in supply and consumption.

This barrier has to be tackled at the conceptual stage by propagating a shift to the DEFENDUS paradigm -- instead of judging development by the magnitude of energy consumption, it must be measured by the level of energy services. But there are several options for improving energy services -- in particular, they can be increased either by increasing supplies or by using more efficient devices. For these agencies to know which is the best way of obtaining that service, the various options must be compared with each other. Hence, sound financial management requires that tenders must be called, not merely for augmenting supplies, but for providing the energy services that are necessary. In addition, efficiency improvement measures must be included in the options considered by the least-cost planning process.

Thus, the best way of contributing to the dismantling of the barrier posed by the supply-biased is to shift the emphasis from energy consumption and supplies to energy services, to include efficiency improvements in the list of options for providing services, and to pursue least-cost planning.

5.3 The Anti-innovation Attitude[7]: Another barrier is the reluctance of international financial institutions such as the World Bank to fund new-but-yet-unproven technologies. The reasons for this attitude at the international level are as follows.

The technologies underlying a paradigm shift are evolving rapidly, and at any juncture, there are promising but not-yet-proven technologies. These new technologies have not yet passed through the innovation chain -- the sequence of steps (such as basic research, applied research, design, engineering for manufacturing, manufacturing and marketing) from idea/concept in the mind to product/process in the economy.

It is well-known, however, that before a technology penetrates the economy, it has to pass through several stages:

(1) the technology must be "right" -- its technical potential should have been achieved through research and development and harnessed for production, and awareness of this potential should be widespread among technology-adopters through demonstration and experience, i.e., the R & D must be complete, the technology must be productionized and the technology must be proved and demonstrated;

(2) the costs must be "right" -- its economic potential should have been realized through cost-reduction involving mass production and organizational learning (in the case of modest-scale and modular technologies);

(3) the market must be "right" -- its market potential should have been realized by overcoming market imperfections and by surmounting market barriers and having all the policies, institutions, management, etc., right.

To get the technology right, the important steps of productionizing and demonstration, which are costlier than the research and development (R & D) steps, need to be completed. Unfortunately, technologies at this crucial stage of commercialization tend to fall between two stools -- the agencies that fund R & D do not support productionizing and demonstration as they are not considered R & D, and the financial institutions avoid supporting anything that is not-yet-proven.

To get the costs right, it is necessary to achieve improvements in the cost-effectiveness of the technology, for instance, through economies of scale in the case of mass-production or organizational learning in the case of modest-scale and modular technologies.

To get the markets right, it is essential to have pilot experiments that demonstrate how to overcome the barriers to the smooth and effective functioning of the market.

Unless financial institutions support productionizing, demonstrations, improvements in cost-effectiveness, pilot implementation experiments, achievement of scale economies in the case of mass-production, organizational learning etc., the innovation chain will not be completed. It is from this standpoint that the anti-innovation attitude of international financial institutions is a barrier against the development of the new technologies.

Of course, there is a rationale behind this conservative attitude of the international financial institution. Not all yet-to-be-proven technologies succeed in the marketplace. If, therefore, the banks want every new technology to be an assured financial success, no such assurance can be obtained. On the other hand, if the banks are looking for the success of a portfolio of technologies, rather than every single one, then this venture-capital approach can lead to financial success.

Allocation of small percentage of the funds of international financial institutions for venture-capital support of as-yet-unproven technologies is a contribution to overcoming the barrier of the anti-innovation attitude of international financial institutions.

The anti-innovation attitude results in even the most promising of these technologies being unable to find financial support for completion of the innovation chain. This is particularly the case with technologies for energy-efficiency improvement and for renewables especially for biomass production and biomass-based energy technologies.

It is against this background that the Scientific and Technical Advisory Panel (STAP) to the Global Environment Facility (GEF) has developed criteria for project identification. These criteria permit GEF to take a technology with global environmental benefits that has not yet achieved its full technical, economic, and market potential and assist it to achieve this potential with GEF funding even though mainstream financing will not deem the technology ready for support. Thus, GEF support is intended to make the technology implementable because it would not be implemented without this demonstration and proof of implementability. GEF can also fund

(1) the demonstration and proving of technically feasible technologies that are not yet proven,
(2) the transformation of technically proven technologies into economically viable technologies by getting the costs right,
(3) the conversion of economically viable technologies into marketable technologies by getting the market environment right,
(4) technical assistance, training facilities and training to overcome the shortcomings of a country lacking in appropriate policies and legislation, institutional capability, managerial competence and skilled personnel to disseminate a technology that is technically and economically viable and also market-worthy
(5) the preparation of complete implementation packages identifying and specifying all the hardware as well as the "software" (policies, policy instruments, policy agents, institutions, financing, management, etc.).

Thus, the barrier of the anti-innovation attitude of international financial institutions can be addressed by reserving a small percentage of the funds of these institutions for GEF-type support and assistance of promising but as-yet-unproven technologies and helping them to complete the innovation chain.

5.4 The Large-is-Convenient Funder: The international, multilateral & industrialized country agencies that provide the funds and aid for energy projects are large expensive bureaucracies doing a great deal of paperwork. And the paperwork and administrative expenditures (site visits, for example) necessary to fund a project are roughly the same for a large project of $1 million as for a project of $10,000. So, if there is a $1 million budget and a choice has to be made between one large project of $1 million and 100 projects of $10,000 each, the bureaucracy tends to choose the large project to avoid hundred times more paperwork.

The way of helping to overcome the barrier of a funding bureaucracy that finds it convenient to support large projects is to arrange for funding a programme administered by an agency that bundles a large number of small projects and implements the bundle.

5.5 The Project-mode Sponsors: Financial support for energy activities from aid agencies has invariably been project-oriented, typically biased to large supply projects, e.g., the construction of massive hydroelectric dams. This tendency is partly because of the large-is-convenient syndrome described in the previous section. Aid in the project mode may be appropriate for supply-oriented energy strategies where the preoccupation is with massive energy plants. But this approach is a barrier to implementing, for instance, energy-efficiency programmes which emphasize a large number of diverse and often small-scale technologies to suit regional and local conditions. The implementation of a large number of small projects is impractical with project-type support in which the disbursal of funds is closely administered by the funding agency.

The barrier arising from project-mode sponsors has to be overcome by measures that include the reorientation of aid from specific projects to a bundle of projects or broad programmes for which the detailed allocation of programme resources is largely the responsibility of locally based institutions in accordance with the overall programme objectives.

5.6 The Self-Reliance Underminers (alias the Dependence-Perpetuators): A drawback of the policy of shifting from project to programme support is that most developing countries may not have the technological and management institutions and expertise to plan and administer such programmes. In fact, this is another reason why aid support has not emphasized programmes but instead has supported projects that are closely and narrowly defined at the proposal stage so that the aid agencies do not have to rely much on local institutions and capabilities.

The solution to this problem is to devote efforts to building institutions and strengthening indigenous capability. Even though the long-term pay-offs of such efforts are sure and enormous, aid agencies see this as a time-consuming and frustrating task. They cannot resist the temptation of achieving what they think are "quickie successes". In the process, they debilitate indigenous technological capability, undermine self-reliance and perpetuate dependence.

Special steps must be taken to build indigenous technological capability

and strengthen self-reliance. A portion of the aid should be directed to building the necessary energy-related institutions and enabling them to support staff who are familiar with local development problems and who are capable of carrying out the needed technology assessments, formulating the appropriate programmes, monitoring these efforts and improving programmes in the light of field experience.

The large utility companies of developing countries are particularly attractive candidates for "institutional renovation" through a reorientation of their technically competent staff from preoccupation with energy supply expansion to the administration of broad energy service programmes. As this institutional capability is developed, a greater and greater shift from project to programme support could take place.

Traditionally, aid has not been very effective in directly fostering and strengthening local technical capability. In part, this has been due to the emphasis on large projects for which highly specialized support services are required. The result has been that procurement and consulting arrangements are frequently left to foreign companies who become better and better at providing these skills. But, another and perhaps more important, reason is that most of the large loans and grants managed by international and multilateral organizations are given specifically to cover expenses involving foreign currency. Local expenditures are not covered by the loans. The aid money is, therefore, spent mainly on consultancy and engineering services and on machinery imported from abroad. Often, a sizeable fraction of bilateral support must be spent in the donor's country and/or on its personnel.

These practices, which are de facto methods of recycling the aid back to the donor country, are not consistent with facilitating and strengthening self-reliant energy-efficiency efforts. They tend to be more of a zero-sum game (what the foreign consulting firm gains, the indigenous group loses) than a win-win situation (in which the foreign and local groups benefit synergistically). Much more in the interests of the aided country is a policy of strengthening of indigenous technical capability, one which stipulates that

(1) before foreign consultancy services are recruited, it be proved that they are both essential and unavoidable, and when they are hired, measures be taken to associate local groups with the project/programmes, and
(2) a significant fraction of the aid be spent domestically in the recipient countries so that it is able to contribute to building the local technical capability.

Thus, the sure way of overcoming the barrier created by the self-reliance-underminer and the dependence-perpetuator is to devote considerable and meticulous effort to the initiation/ establishment/strengthening of indigenous capability in the areas of energy analysis and planning and of energy technologies.

6 Conclusions

6.1 Combinations of Measures for overcoming Barriers: A one-barrier-one-measure approach must be avoided. In the first place, even a single barrier

may consist of a number of sub-barriers. Further, since two or more barriers can operate simultaneously and since, even if there is a single barrier, the corresponding measure may not be a sufficient condition for overcoming it, single-measure efforts are not likely to bear much fruit. Combinations or packages of measures increase the effectiveness of the implementation of energy-efficiency improvements.

6.2 Combinations of Measures at the Strategic Level: Quite often it is not sufficient to implement measures in an isolated way at the policy level. It may be essential to implement a comprehensive strategy.

DEFENDUS planning can be viewed as such a comprehensive strategy for ensuring a rightful place for energy efficiency improvements whilst guaranteeing consideration for decentralized sources and centralized supplies. It also necessitates a treatment of both the demand and supply aspects and a comparison of costs on the same terms. DEFENDUS planning may turn out to be one of the most powerful ways of improving energy efficiency.

6.3 Policy-assisted, market-oriented mechanisms: Another important issue concerns the power and limits of the market. Whatever the virtues of the market as an allocator of capital, raw materials and manpower, it has a poor record in safeguarding the crucial objectives of equity, externalities (in particular the environment) and long-term interests. Hence, special policies have to be devised to protect the poor, the environment and the long-term.

Also, many barriers to the paradigm shift result in an imperfect market for efficiency improvements. For instance, the market displays a negative feedback in the matter of energy efficiency -- the more effective the measures, the less the requirement of energy, the lower the price of energy, and therefore, the less the demand for energy efficiency. This means that price mechanisms alone will not work and market forces by themselves will not achieve the potential for energy efficiency. Since the spread of energy-efficiency improvements cannot be left to the market, there has to be an emphasis on policy-assisted, market-oriented mechanisms for promoting energy efficiency. Hence, the importance of marginal-cost pricing and regulations making conservation investments profitable to utilities.

It is useful to distinguish between three types of potential for energy-efficiency improvements: the market potential which is much less than the economic potential because of market distortions and high discount rates, and the economic potential which in turn is not as much as the technical potential because many technologies have not yet been made cost-effective and economically viable. Hence, the first major challenge is to intervene and assist the market to deliver economically viable conservation technologies, and the second challenge for public policies is to promote the flow of new energy-efficient technologies to the marketplace.

6.4. The Likelihood of a Shift to a DEFENDUS Energy Paradigms: The cheaper, quicker, more environmentally sound and more equitable DEFENDUS energy scenarios are so obviously superior that they (or some variant of them) should be chosen without hesitation if rationality prevailed. Energy decision-making, however, is not done on the basis of rationality alone; there are powerful vested interests that have grown along with the conventional GROSSCON

paradigm and the supply lobby associated with it. And there are many barriers to its replacement with the new DEFENDUS paradigm. But, it appears that the supply lobby can no longer procure the capital to carry through its exorbitantly expensive schemes as easily as before. This is because the bankability of these schemes is being eroded by rising costs and environmental safeguards. Further, the funders are being confronted with alternative scenarios presented in increasingly quantitative detail. Whether these funding institutions will be able to resist these more cost-effective and environmentally sound alternatives may well depend upon the fact that DEFENDUS paradigm may be difficult to implement, but the conventional GROSSCON paradigm is impossible to sustain. The shift to a DEFENDUS paradigm is very likely.

6.5 Development -- a Grander Vision: Finally, it is necessary to have a grander vision than a paradigm shift for energy. The real goal of an energy efficient economy is need-oriented, self-reliant and environmentally sound development, i.e., sustainable development. Only then will energy become an instrument of development, a means to an end rather than an end in itself.

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