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ENERGY REQUIREMENTS IN THE DEVELOPING WORLD[1]

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ENERGY AND THE DEVELOPING COUNTRIES

Developing countries vary enormously in their resource endowments, infrastructures, levels of industrialization, technical capabilities and standards of living. But, they also have some features in common. Firstly, they are what may be called "dual societies" characterized by rich minorities living among deprived majorities in small islands of elite affluence amidst vast oceans of mass poverty. The elites and the masses differ so much in their incomes, wants, aspirations and life-styles that they can be considered, for all practical purposes, to be in two separate worlds.

The existence of dual societies leads to the second common feature of these countries -- the elites and the masses differ fundamentally in their use of energy. The elites emulate the life-styles prevalent in the industrialized countries and therefore have similar patterns of luxury-oriented energy use. Of course, their climate-determined energy needs are different -- space heating is usually not required in the developing countries located in the tropics. In contrast, the pattern of energy consumption of poor people is determined by their struggle for basic human needs. Their preoccupation is with energy for survival activities such as cooking and obtaining drinking water.

These survival activities are performed with both animate and inanimate sources of energy. Animate sources of energy, i.e., human beings and draught animals, play an important role in agricultural, transportation and domestic activities in developing countries. Inanimate sources consist largely of biomass in the form of fuelwood, animal wastes and agricultural residues. Since the bulk of this biomass is obtained by gathering rather than by purchasing; it is often called non-commercial. Fuelwood is the dominant source of energy in rural areas and cooking, the most energy-intensive activity.

Because the bulk of the population in a developing country is poor and this majority depends largely on non-commercial sources, the per capita commercial energy use in a developing country is much lower than in an industrialized country. But, even when non-commercial energy is considered, the overall level of energy <u>services</u> (heating, cooling, lighting, rotational and translational motion, etc.) is much lower particularly because efficiencies are low.

Thus, there are enormous disparities in the level of energy services enjoyed not only by the elites and masses within developing countries but also by the industrialized and developing countries. These disparities have led to a widespread pressure for stepping up the level of energy <u>services</u>. This pressure has thus far been understood by decision-makers as an imperative need, and manifested as a demand, for escalating the magnitude of energy <u>consumption</u>. In fact, this demand coupled with the growing population has led to a more or less <u>linear</u> growth in energy consumption which means that, if present trends persist, total energy consumption will reach the present level of consumption of the industrialized countries in about 20 years.

IMPLICATIONS OF ENERGY CONSUMPTION TRENDS IN DEVELOPING COUNTRIES

The economic implication of current energy consumption trends is that the capital requirements of developing countries for augmenting the supplies of energy are becoming increasingly difficult to procure in the capital-constrained world of today. The new demand for capital from Eastern Europe is only going to aggravate the problem. The World Bank quantified this problem at the 1989 World Energy Conference at Montreal by revealing that the capital requirements of the developing countries adds up to about $100 billion dollars per year for the electricity sector alone when only about $20 billion can be provided by the World Bank and other multilateral and bilateral funding agencies. Within these countries too, it is turning out that the capital resources that the electricity sector is demanding is three to five times what is available.

Current energy consumption trends also have serious environmental implications. The local impacts mainly involve the submergence of prime forests that invariably occurs due to the construction of hydroelectric dams, the atmospheric pollution including acid rain brought about by coal-based thermal power plants and the deforestation brought about by the urban, and sometimes rural, demand for fuelwood for cooking on woodstoves.

There is also an impact on the global atmosphere. Fossil-fuel consumption in the developing countries, which today contributes some 24% of all fossil-fuel-derived emissions, is growing steadily, and is likely to double over 20 years.

Deforestation is an additional factor responsible for the increase of carbon dioxide in the atmosphere. Forests act as carbon dioxide sinks by absorbing this gas and thereby play a positive role in the global carbon cycle. When, however, there is deforestation either by clearing forests or by felling their trees at a faster rate than that at which they grow, the result is an increase in atmospheric carbon dioxide concentration because the capacity of the carbon dioxide sink is decreased. This deforestation is now occurring primarily in the developing countries.

The causes of deforestation are not only manifold but vary with region and country. Most often, deforestation takes place for some non-energy purposes: to utilize the land for animal husbandry (ranching) and agriculture and/or to obtain wood for lumber and feedstock (for paper and rayon). The energy-related causes are submergence by the water-bodies created by dams and extraction of cooking fuel in the form of fuelwood logs or charcoal for <u>urban</u> households and for industry (tobacco curing, for instance). In most <u>rural</u> areas of the world, fuelwood gathering is done mainly by women and children who do not fell trees but depend mainly on fallen branches, twigs, etc. There are, however, parts of the developing world where the <u>rural</u> demand for cooking fuel also contributes to deforestation. The variation arises from the fact that the use of fuelwood for cooking does not <u>per se</u> lead to deforestation; it depends upon whether the rate of fuelwood extraction is greater than the rate at which the wood is regenerated, i.e., whether the fuelwood is being used in the renewable or non-renewable mode.

To appreciate the impact of fuelwood consumption on deforestation, consider the case of Africa. The total amount of fuelwood (both in the form of charcoal and fuelwood) consumed in Africa mostly for cooking is approximately 300 million tonnes. If this fuelwood is being obtained by felling trees in forests, at least 2 million hectares have to be deforested each year with serious consequences: soil erosion, loss of species and local climate change. The burning of 300 million tons of fuelwood would also contribute some 4% to the world carbon dioxide emissions.

Deforestation in the developing countries is a significant factor in changing the global atmosphere; it is responsible for some 19% of all carbon dioxide emissions and shows no signs of diminishing. When both fossil fuel emissions and deforestation are considered, a situation has been reached where, even if the industrialized countries stabilize their emissions of greenhouse gases, the developing countries can on their own degrade the global atmosphere.

ENERGY, ENVIRONMENT AND DEVELOPMENT

Current energy consumption trends are also generating conflicts within developing countries. The promoters of development (aid agencies, governments, planners, industrialists, contractors, etc.) proceed on the assumption that the per capita energy consumption is the energy indicator of development and therefore push for drastic increases in energy consumption. This increase, on the one hand, requires impossibly large amounts of capital, and on the other, degrades the local environment. Seeing this degradation, local environmental movements grow and argue that the degradation of the environment is making the development process unsustainable and that therefore the process should be halted. In response, the promoters of development argue that the environmental impacts have to be suffered in the interests of development -- they argue that the only way in which the impacts can be avoided is by halting development and denying the people the advantages of a higher level of energy services. This is the environment versus development dilemma.

There is also an equity dimension to the current trends in energy consumption. In dual societies, a large fraction of the population does not benefit directly from energy supplies which cater primarily to the wants of the elites. For instance, a computation shows that only about half the population of the state of Karnataka in South India benefits <u>directly</u> from its electrical system; hence, electricity is of no direct relevance to the other half the state's population. This deprived section of the population is not likely to be as enthusiastic about the stepping up energy supplies as those who will enjoy the resulting energy services.

In addition, large-scale energy projects often require the displacement of large numbers of people, for instance a hydroelectric dam can displace people due to land submergence. These people at the site of the energy projects see themselves as the victims of development rather than as its beneficiaries -- this is the victims versus developers issue.

Finally, there are the global environmental impacts. As these global impacts increase in intensity, the sustainability of the world is threatened because environmental stability is one of the conditions for global sustainability. Thus, the energy vs development dilemma within developing countries becomes the energy vs sustainability conflict on the global scale. It is this conflict that is currently dominating international discussions on environmental issues. In order to restrict the degradation of the global atmosphere, the industrialized countries often seek to limit the increases in energy consumption of the developing countries, and in reply, the developing countries emphasize their need to step up energy consumption in order to enhance their low levels of per capita energy services. As long as the two protagonists are trapped in the conventional paradigm of viewing energy as an end in itself and energy consumption as the indicator of development, the conflict cannot be resolved without sacrificing either development or the global environment.

RESOLUTION OF THE DEVELOPMENT VS ENVIRONMENT AND ENERGY VS SUSTAINABILITY DILEMMAS

Both the energy vs global sustainability dilemma as well as the development vs local environment dilemma can only be resolved through a new paradigm for energy use. According to this new paradigm, energy must be viewed as a <u>means</u> to the end of providing energy services to perform tasks and thereby satisfy the needs of individuals and groups. The quality of life of people in a village depends more upon the service of lighting (measured in lumens) than upon the consumption of energy (measured in kilowatt hours). Hence, it is the extent to which energy services are satisfied that is the true energy indicator of the level of development, rather than the magnitude of energy that is utilized. Development must be based therefore on major increases in the per capita level of energy services.

Energy services, in turn, depend upon end-use devices to convert energy inputs into the useful energy required to provide energy services. Since useful energy is given by the product of the efficiency of the end-use device and the energy input, there are several options for achieving an increase in the level of energy services. The extreme options are those that depend exclusively on centralized sources or on decentralized sources or on efficiency improvements alone.

If the preoccupation is only with the <u>present</u> needs of developing countries, then perhaps conservation alone may be adequate provided that conservation in developing countries is clearly understood to mean increasing energy services with less energy consumption (more light with less kilowatt hours) and not making do with less services (less light) when the level of services are already low (Indian villages have been described as areas of darkness). But, development requires industrialization which in turn implies, as a necessary condition, growth of the infrastructure and of the quantity of goods and services (measured by the gross domestic product or GDP). Annual growth rates of 5-10% have become the standard goals although only a few developing countries have achieved such growth targets.

What growth rates in energy use are required to sustain these targets of GDP growth rate? When Western Europe and North America were industrializing, their energy consumption had to grow as fast as their GDP -- and even faster -- in order to build the infrastructure of roads, bridges, houses and heavy industry. However, if a developing country intends to implement the same process of industrialization today, the materials and therefore energy requirements can be dramatically less because of two achievements of the materials revolution that have taken place over the past half century: firstly, the same materials can be produced with far less energy, and secondly, far smaller quantities of modern materials are required to do the same job in a vehicle, bridge, building, etc. Consequently, developing countries need not repeat the energy history of the industrialized countries -- a much lower ratio of energy to GDP growth rates would be adequate for them to achieve comparable levels of industrialization. But, this does not mean that energy supplies are unnecessary for developing countries. Significant inputs of energy are likely to be essential for the development process and, therefore, the extreme option of depending on conservation alone must be rejected.

What is required is a balanced approach in which there is a holistic integration or mix of three types of energy technologies -- end-use efficiency improvements, centralized generation and generation from decentralized sources. The components of such a mix need not be identified in an ad hoc manner; a rational procedure can be used. One such procedure utilizes least-cost supply curves. Since it is invariably cheaper to save a kilowatt than to generate a kilowatt and to avoid transmission/ transportation and distribution costs by generating at or very near the point of consumption, it turns out that many conservation and decentralized generation technologies get included in the least-cost mix.

Technology mixes arrived at in this way make possible major increases in the level of energy services with far less increase in the supplies of centralized energy than is required with conventional energy systems which are based exclusively on centralized sources. In contrast, the least-cost mixes include significant contributions from conservation and decentralized sources. The contributions from environmentally benign efficiency improvements imply much less impact on the local and global environment; hence, the mixes advance development without jeopardizing sustainability.

There is also an economic implication: since efficiency improvements can increase GDP without a corresponding increase of energy, technology mixes that include conservation reduce the coupling between GDP and energy. As a result, the annual investment required for the energy sector goes down and becomes more manageable in a capital-scarcity situation.

Is there any precedent for such reduced coupling, if not total decoupling, of energy from GDP?. Indeed, there is, and in fact the observed decoupling of GDP increase and energy use has been an important factor stimulating a fresh analysis of the role played by energy in modern societies. Between about 1973 and 1985, the total energy consumption in industrialized countries had reached an approximately constant level even though the GDP continued to increase. For instance, in the USA, the GDP increased 36% between 1973 and 1986, but this was accompanied by no net growth in energy consumption. Thus, the ratio of energy use to GDP which may be called the energy intensity of the economy declined at an average rate of 2.4% per year in this period. During the same period, in the OECD countries, energy use increased 4% while GDP increased 38%, so that the energy intensity of these countries decreased at an average 2.2% per year.

Such decoupling has also been confirmed by studies of the long-term evolution of the energy-GDP ratio over time for a number of countries which show that the ratio has been decreasing steadily except for the period in which their infrastructure of heavy industry was being established. This decline in the energy-GDP ratio is due several factors: a saturation of the demand for consumer goods in the industrialized countries, a shift of economic activity away from heavy materials-processing industry in the direction of services, and the revolution in materials use based on less energy-intensive materials and less materials-intensive structures and objects.

AN EXAMPLE OF A DEVELOPMENT-FOCUSSED END-USE-ORIENTED ENERGY SCENARIO

The new paradigm has highlighted the importance of constructing energy scenarios that, on the one hand, focus on development objectives such as the satisfaction of basic human needs, and on the other hand, scrutinize the end-uses of energy to identify opportunities for efficiency improvements and other conservation measures. In other words, it is necessary to construct development-focussed end-use-oriented service-directed (DEFENDUS) energy scenarios that incorporate energy conservation and renewable sources and to implement least-cost mixes of energy technologies that will advance such scenarios.

Such a DEFENDUS scenario has been constructed for the electricity sector of the state of Karnataka in South India. This scenario was a response to the recent efforts at electricity planning -- in particular the May 1987 report of the Committee for preparing a "Long Range Plan for Power Projects in Karnataka 1987-2000 AD" (LRPPP) -- which are clear-cut examples of the failure of the conventional consumption-obsessed supply-biased approach to energy planning.

The LRPPP plan demanded that, in order to meet its energy requirement of 47.52 TWh and 9.397 GW in 2000 AD, the state should spend an astronomical sum of about $17.4 billion (which is roughly equal to 25 annual plans), develop a great deal of infrastructure (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 into, the next century. In other words, conventional energy plans are no longer solutions; they are becoming 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 adhering to a least-cost approach to the mix of energy supplies. The scenario turns out to be as promising as the LRPPP and other conventional plans are gloomy. In particular, even though the DEFENDUS scenario involves the illumination of <u>all</u> 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 which are only about 38% and 42% respectively of the LRPPP demand.

This reduction in requirement (compared to the conventional projection) is achieved partly (59 %) through a development focus and partly (41 %) through measures involving simple efficiency improvements and substitution of one energy carrier for another. 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.

To meet the total energy requirement in the year 2000 AD, the DEFENDUS supply scenario comes out with a mix of efficiency improvement and electricity substitution technologies, decentralized generation technologies (small hydroelectric plants, electricity cogeneration from sugarcane bagasse and biomass-based rural energy centres) and conventional centralized generation technologies in an approximately 22:22:56 ratio. The drastically reduced demand for centralized generation technologies means that the environmentally controversial technologies -- nuclear power plants, coal-based thermal power plants and hydroelectricity -- can be largely avoided.

The overall bill for the DEFENDUS scenario has been estimated -- it is only about one-third of the cost of the conventional approach which means that the latter would lead necessarily to a much higher unit cost of energy. 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, the DEFENDUS scenario is far more environmentally benign in terms of millions of tonnes of carbon dioxide pumped into the atmosphere every year.

The case study of electricity in Karnataka shows quantitatively that a DEFENDUS scenario can turn out to be cheaper, quicker and environmentally more benign (in terms of carbon dioxide emissions) than the conventional plan. It is not intended, however, to be viewed as a universal recipe. In fact, since the current energy consumption patterns and resource endowments of other regions and countries are bound to differ from those of Karnataka, both the conservation potential as well as the least-cost supply mix is bound to vary. But, the approach used for constructing DEFENDUS scenarios is replicable in other developing countries, and therein lies its strength.

TECHNOLOGICAL LEAPFROGGING

However promising the DEFENDUS scenario for Karnataka, it is, technologically speaking, quite timid and conservative. The scenario is based on off-the-shelf technologies that are in no sense futuristic; they are all proven technologies available today. Further, the scenario has not taken advantage of the fact that the state has not yet built as much infrastructure and industry as is in place in advanced countries. This infrastructure of the industrialized countries has already appropriated a great deal of capital -- it represents a sunk cost -- and therefore discourages further investments on technological upgradation. Since many of the vital industries, transportation systems, roads and buildings are not yet in place in developing countries, it is essential that they adopt modern energy-efficient technologies while establishing all this infrastructure. Then, retrofitting can be avoided and the problem of coping with large stocks of inefficient cars or buildings - which plagues industrialized countries today - can be avoided. Thus, the absence of a massive and entrenched infrastructure makes developing countries an environment that is much more hospitable to advanced technologies. In other words, developing countries are much more conducive to what may be called technological leapfrogging, i.e., to the adoption of advanced technologies even before they have spread in the industrialized countries. Technological leapfrogging must become a vital component of DEFENDUS energy strategies.

The alcohol program in Brazil which was an innovative response to the oil crisis of the 1970's is an excellent example of technological leapfrogging. Faced with an increasing deficit in its trade balance due to the enormous jump in petroleum prices, Brazil decided to adopt pure ethanol and gasohol (mixtures of ethanol and gasoline) as substitutes for gasoline in automobile engines. This decision was not only influenced by economic considerations but also by the technical advantages of ethanol as a fuel, viz., its higher octane ratio.

The production of ethanol from sugarcane by the fermentation of sugarcane juice increased from 0.9 billion liters in l973 to 4.08 billion liters in l98l, out of which l.88 billion liters were consumed as hydrated ethanol (9l-93% ethanol plus water) and the remaining 2.2 billion liters, as anhydrous ethanol mixed with 20% gasoline. In l989, l2 billion liters of ethanol were used in Brazil replacing almost

200,000 barrels of gasoline per day used by approximately 5 million automobiles. About 5 million hectares of land were used for sugarcane plantations (for the production of both sugar and ethanol) and the alcohol industry generated 700,000 direct jobs. The excellent performance of ethanol-fueled automobiles contributed significantly to the improvement of the quality of air in polluted metropolises such as Sao Paulo and Rio de Janeiro.

Above all, Brazil, a developing country, has established an entire fuel cycle from energy source (sugarcane) via end-use devices (alcohol-fuelled automobiles) to energy service (transportation) that does not exist in the industrialized countries. Like children vaulting over other playmates in the game of leap-frog, Brazil has leap-frogged technologically over the industrialized countries.

The average cost of ethanol produced in the southern region of Brazil is $0.185 per liter. At this cost, Brazil's ethanol could compete successfully with imported oil when the international price of oil was $24.00 per barrel. When, however, the oil price fell much below this figure in the mid 1980's, the Brazilian ethanol programme faced a serious economic crisis and had to be subsidized by the government. Besides, the general economic situation of the country provoked a pressure to reduce ethanol costs and remove the ethanol subsidies.

This pressure led to major efforts to improve the productivity of sugarcane agriculture. In addition, the conversion of stillage into fertilizer was achieved to improve the economics. Brazilian ethanol distilleries became the best in the world and have been competing strongly in the international market. All this has resulted in a reduction in costs of 4% per year.

There are still further possibilities of decreasing the cost of ethanol. In sugar factories, the main fuel is <u>bagasse</u> which is the residue left after crushing the cane and extracting the juice. This bagasse is burnt to produce steam for use in the crushing mills, juice evaporators, etc., and also to run turbines and cogenerate electricity. To prevent the bagasse from piling up in large quantities and creating problems of disposal, the practice has been to use it inefficiently in low-pressure steam-turbines that only generate about 20 kWh per tonne of sugar cane. Replacing these outdated steam-turbines with new ones operating on medium-pressure steam (21 atmospheres) would permit a 50% increase in the electricity generated. With even higher pressure steam (62 atmospheres), as much as three times more electricity can be generated. If <u>gas</u>-, rather than steam-turbine technology is used, the amount of generated electricity could be increased by more than a factor of ten.

Thus, enormous increases in electricity exports can be achieved by using modern cogeneration technologies. When this export of electricity is combined with the production of ethanol from sugarcane grown in plantations, the complexes become very attractive enterprises. But, the success of such complexes hinge heavily on the improvement of cogeneration facilities.

If DEFENDUS scenarios do not restrict themselves to currently available technologies but also resort to technological leapfrogging, they are likely to become even more attractive.

In this context, mention must be made of a thought -experiment to estimate how much per capita energy would be required in developing countries to achieve standards of living comparable to say Western Europe in the 1970s. It was found that, if the most energy -efficient technologies available today are used, then only about 1 kW p er capita (used continuously) is adequate which is 10% more than the per capita energy being used today. Such a dramatic improvement in the standard of living can be achieved with such a small increment because energy is being used extremely inefficiently in all sectors in developing countries and because it is envisaged that there will be an increase in the use of electricity and a shift away from traditional biomass fuels (fuelwood, cowdung cakes, and agricultural residues) and biomass -based end-use devices to modern biomass fuels (biogas, producer gas, ethanol, methanol, etc.) and devices (engines, turbines, generators).

NATIONAL AND INTERNATIONAL ENERGY PRIORITIES

Several priorit ies emerge from the DEFENDUS approach described above.

The first priority is that developing countries should assign overriding importance to the task of satisfying the basic needs of their populations, particularly the needs of the neediest. In do ing so, the second priority is that developing countries must cross the hurdle of the severe capital constraints that is frustrating conventional energy futures -- the energy sector is becoming unsustainably expensive and new approaches are imperative. Th e third priority is that of efficient resource utilization to get around the resource constraints. The fourth priority is an environmentally benign approach that minimizes the local and near -term environmental impacts of energy production and utilization that otherwise are becoming intolerable.

Should these four national priorities, which constitute the essence of sustainable development, be ranked in the above order? In the industrialized countries, environmental concerns intensified even before their problems of poverty were completely solved. For instance, in the United States today, increasingly large amounts of money are being spent on cleaning up the environment even though the problem of poverty of a fraction of the population remains unsolved. This does not mean that environmental concerns are separate from the problem of poverty and are attended to first because they are the concern of the rich. In reality, policies to protect the environment cut cross social categories and are clearly of in terest of all. It can even be argued that since the poor cannot run away from local environmental degradation as easily as the rich and have a lower health status, they stand more to benefit by an improvement in the environment.

The opposite argument -- poverty should be tackled before environmental problems are addressed -- is also fraught with danger.

Survival is a problem of such overriding importance to the poor that, if necessary, they survive at the expense of the environment. For example, in some parts of Africa, the remaining tree cover is being denuded at an alarming rate to extract wood fuel for the survival activity of cooking. This phenomenon provoked the former Indian Prime Minister, Indira Gandhi, to state at the Stockholm conference on the environment: "Poverty is the greatest polluter!".

The conclusion is clear: both the improvement of the environment and the reduction, if not eradication, of poverty are equally important and deserve simultaneous attention. Such a thrust emerges naturally from a view of development as a need-oriented self-reliant environmentally sound process.

In addition, there is the global priority of preventing energy from making the world an uninhabitable place -- a veritable hell on earth.

If the listing of the international obligation to the global atmosphere after the national priorities seems perverse, inverted and wrong, it is only because conventional supply-biased energy futures compel a trade-off between the priorities. The worst trade-off that can be recommended is one in which developing countries are urged to assign the highest priority to preventing destruction of the global climate at the expense of urgent national development tasks. The only response that such recommendations are likely to elicit is that the industrialized countries which are primarily guilty for the build-up of greenhouse gases must assume responsibility for warding off a possible climatic catastrophe.

Fortunately, such a head-on collision between industrialized and developing countries is quite unnecessary. The resolution of the development vs global climate dilemma is through energy-efficient futures that permit an emphasis on the urgent priorities of need-oriented, self-reliant and environmentally sound development whilst incidentally making significant positive contributions to the problem of global climate. It is only such strategies for averting the disaster of climate change that are likely to find acceptability in the developing countries. There is an analogous situation in the case of technologies -- it is only technologies that simultaneously solve several problems that find acceptability. Similarly, it is only those solutions to the problem of global climate that simultaneously address development priorities that are likely to find acceptability.

In conclusion, the main submission here is that energy futures compatible with the achievement of a sustainable world and of a sustainable development are achievable and within our grasp. The choices that are proposed require imaginative political leadership. But, they represent far less difficult and hazardous options for this leadership than those demanded by the conventional approaches to the world's energy future. Above all, this energy future is more a matter of choice than of destiny but the implementation of such choices depends upon many changes.

CHANGES REQUIRED TO PROMOTE A DEVELOPMENT THAT IS CONSISTENT WITH GLOBAL SUSTAINABILITY

Changes in the energy system involve many types of actors operating at many different levels: individual and institutional consumers, manufacturers, distributors and retailers of energy-using devices, companies and utilities supplying and distributing energy carriers, financial institutions, local, state and federal/national governments, bilateral, multi-lateral and international funding agencies, and foreign governments and inter-governmental international organizations.

To appreciate the viewpoint of domestic consumers, consider the activity of cooking in an Indian metropolis. Households have a choice of energy carriers -- fuelwood or charcoal or kerosene or liquified petroleum gas (LPG) or electricity. Since there may be more than one type of stove for some of these energy carriers, it means that consumers can have a choice of end-use devices. Finally, consumers vary with regard to the magnitude of the cooking energy service that they want because of what, how much and how many times they cook.

In the matter of efficiency improvements and other conservation measures, it is useful to distinguish between three categories of consumers. The first category consists of those who are unaware of the fact that cooking with LPG is more efficient than with kerosene. This category represents consumers who are ignorant about the improvements that are possible in the efficiency with which energy can be used. For such consumers, the answer is information, demonstration and education through the appropriate medium of communication.

The second category consists of those who are quite knowledgeable but do not have the inclination or the means to divert their scarce capital resources towards the efficient end-use device which usually involves a much higher first cost. In an Indian city, for instance, a maid in the home of an affluent family knows very well that her employers spend less on LPG cooking fuel than she does in her home on kerosene even though they may have families of the same size. Despite this, the maid does not switch to gas cooking because LPG stoves are twenty times costlier than kerosene stoves and even if she has the money there are other more pressing demands on this scarce resource.

Or, in the electrified Indian village of Pura in Karnataka State, the majority of households continue to use kerosene for lighting because they cannot afford the front-end cost of getting an electricity connection. In return they have to make do with a much lower level of illumination while spending roughly twice as much per month as they would have if they had switched to electricity.

Since the sensitivity of first-cost-sensitive consumers arises from the (un)availability of disposable income, one would expect this sensitivity to decrease with an increase in per capita income. That is, one would expect households to shift to more and more energy-efficient end-use devices with higher and higher initial costs as their per capita income increases. This is indeed the case -- as the per capita income of households in the city of Bangalore, capital of the Karnataka state in South India, they switch from firewood cooking fuel to kerosene to LPG with increases in stove efficiency in that order.

For this category of first-cost-sensitive consumers, the solution is for an agency such as the utility to finance the purchase of the efficient equipment with a loan which can be recovered through the consumer's monthly payments for energy. In fact, it can turn out that the consumer's savings in energy expenditures are greater than the cash outflow on repayments plus the new energy bills. Alternatively, the efficient equipment can be leased to the consumer and the leasing charges recovered along with the energy bill. Thus, financial institutions and utilities must promote proven financing schemes (designed to convert initial capital investments into recurring energy charges) so that individual and industrial consumers can surmount the capital constraints that inhibit them from adopting efficiency improvements. In principle, this method of converting initial capital costs into operating expenses can be extended beyond domestic consumers to commercial and industrial consumers thereby achieving both energy efficiency improvement and modernization simultaneously.

The third category of consumers consists of those who are aware of efficiency improvements and who can afford their initial capital costs but nevertheless find the energy component of their total expenditures either too small or too insensitive to efficiencies of energy use to be enthusiastic about implementing these improvements. For example, there is a regime of automobile fuel efficiencies --the so-called valley of indifference -- in which the operating costs of automobiles in the USA are relatively unaffected by their fuel efficiencies. This category of consumers cannot be enticed easily either by information or by fiscal incentives. In their case, interventions are required at higher levels. For instance, the government may have to intervene with regard to the manufacturers of energy-using devices and legislate efficiency standards or initiate regulations regarding the efficiency of end-use devices. The setting of fuel efficiency targets for the automobile fleet by the US government is a well-known example of this type of intervention.

The establishment of mechanisms for converting initial capital costs into operating expenses requires some basic changes in the traditional attitude of utilities, financial institutions as well as local, state and federal governments towards the energy system. The evolution of this energy system during this century was heavily influenced by the large initial investments on long-gestation projects for the supply of energy -- coal mines and coal-based power plants, oil fields and refineries, and hydroelectric dams and power plants. To finance the massive investments that were required, a number of special schemes were devised -- guaranteed state loans, direct government investments or public bonds. These schemes permitted payback over long periods and much lower rates of return on the investments than were prevalent in the business world. In developing countries, where capital is scarce, most of such investments are made by the government usually backed by loans from international banking institutions such as the World Bank. This approach to the financing of energy utilities is distinctly different from that customary in ordinary commerce and industry.

Many utilities have also been influenced by the fact that, by regulation, they are guaranteed a return on invested capital, after all expenses and allowable spendings are deducted, of about l0% per year. In effect, this is a "cost plus" type of financial scheme involving no risk at all. In contrast, investments in efficiency improvement and other conservation measures are treated just like any other business venture for which loans made by commercial banks have to be paid back in relatively short periods at high interest rates.

Efficiency improvements invariably require less capital than equivalent increases of energy supplies. The real problem, therefore, is not the magnitude of capital required for implementing efficiency improvements; it is the overcoming of institutional barriers and organizational hurdles. An idea of these issues can be obtained from a comparison of the ease with which $2 billion can be spent on a centralized power plant with the difficulty of spending the same sum on end-use efficiency improvements. Once a decision has been made to build the large power plant and the requisite clearances are obtained, the subsequent construction is a relatively straightforward task that can be carried out by a small and disciplined team. But spending two billion dollars on end-use efficiency improvements is a very much more complex matter. Assuming that each efficiency measure costs between $2,000 and $20 million, as many as one hundred to one million dispersed sub-projects are involved. The associated activities are also far more difficult to organize because of the large number of diverse factors.

In addition, the marketing of end-use efficiency improvements is inherently more complicated than the marketing of conventional energy supplies or end-use devices. It is not enough to be concerned just with producing the "hardware" of the new energy-efficient devices, there should be as much attention paid to all the necessary supporting "software". For instance, there can be a full spectrum of unusual marketing problems: diagnosis of the individual consumer's needs for cost-effective energy services; identification of the appropriate conservation technologies that will serve these needs; consumer education regarding the importance of these technologies in a situation where the expected savings are often ambiguous; financing of the new devices or the necessary contractor work; after-sales servicing; monitoring of the performance of the efficient devices in the field to determine the actual savings and to provide a feedback that can be used to modify energy conservation programme. All these aspects of the marketing of conservation should be addressed if the aim is to promote effectively energy end-use efficiency across a broad range of energy services in developing countries -- from cooking with improved fuelwood stoves to lighting with compact fluorescent lamps and industrial drives with efficient motors.

The electric and gas utilities are particularly well qualified to market end-use efficiencies. Already a number of the more progressive utilities in the United States have initiated energy conservation programs that include providing advice on investments in energy efficiency, arranging contractors to carry out the necessary work, financing the investments with low interest loans and providing rebates to consumers for the purchase of energy efficient appliances and/or to appliance dealers for promoting their sales.

Accustomed to accumulating large quantities of capital, utilities are also well-positioned to direct these resources to energy efficiency investments. Also, they have an administrative structure for channelling the capital to the extremely large number of consumers (households and businesses) with which they deal on a regular bas is. Moreover, the regular energy billing system offers the opportunity to customers to pay off loans from the utility through their utility bills, i.e., to pay "life cycle cost bills" as alternatives to fuel or electricity bills.

There are various ways in which such a comprehensive marketing of energy conservation could be achieved. One possibility is to convert energy utilities into energy service companies, that is, companies that market energy services (heating, cooling, lighti ng, stationary and mobile drives etc.) in much the same way they market energy carriers today. If utilities evolve in this direction, they would actually be discharging a function that was originally envisioned for them --when Thomas Edison invented the i ncandescent bulb, he proposed that utilities sell illumination, rather than electricity, so that would have a vested interest in providing this illumination in the most cost - effective way. Changing the charter of utilities from suppliers of energy carrier s to vendors of energy services is a process in which local and international financial institutions have an important motivating role to play.

Changes such as these can be implemented effectively only if local, state or federal governments follow new ap proaches to the formulation of energy policies.

Above all, the level of energy services, rather than the magnitude of energy consumption, must be considered as the true energy indicator of development. In advancing develop ment by increasing the level of energy services, first priority should be given to those energy services that satisfy basic needs, i.e., there should priority for energy services that improve the quality of life of the poor, generate employment and reduce poverty, and influence criti cal sectors such as agriculture and industry.

Since the conventional approach emphasizes energy consumption, its attention turns to supply increases which are then differentiated into centralized and decentralized sources. Conservation becomes a separate issue. As a result, centralized and decentralized supply increases and conservation measures become separate decisions handled by separate offices or departments or ministries with separate budgets. In such a context, empires and satrapies develop. A nd, in the ensuing conflict over funds, centralized supplies (with the strongest lobbies) get the biggest budgets, decentralized sources, much less, and conservation has to be content with the leftovers.

But, any energy service, say, lighting, can be obtained either by increasing centralized or decentralized supplies or by using more efficient devices. To know which is the best way of obtaining that service, they must be compared with each other. Hence, sound management requires that tenders must be called, not for augmenting supplies, but for providing the energy service at the least financial cost with the least environmental impact.

If there is concern for least-cost environmentally benign energy planning, then it must be ensured that the competition between supply increases (of centralized and decentralized sources) and conservation measures is fair. Energy savings should be treated symmetrically with energy production. This might mean, for instance, that the expenses associated with conservation are considered as the cost of service and used for a "cost plus" method of charging customers as in the case of supply technologies. All three contenders -- centralized sources, decentralized sources and conservation measures -- must be compared on the same terms of credit (including interest rates), benefits, incentives, subsidies, etc. At present, the competition is certainly not fair -- the advantages are heavily weighted in favour of centralized sources and against conservation measures with decentralized sources in between. This means that there should specific policies for promoting this fair competition through the elimination of subsidies to energy supplies, "right" pricing of supplies based, for instance, on long-run marginal costs, and generation of sound databases for the comparison.

A variety of policy instruments are available for the implementation of energy policies:- market forces (operating through prices), subsidies, concessions of various types, administrative allocation of energy carriers, equipment and capital, taxes on energy carriers, regulations, standards, labelling of appliances to reveal energy performance, data and information, research and development, etc. Depending upon the area/sector and the region, each one of these instruments has its own degree of (in)effectiveness. Hence, it is important that a specific package of policy instruments is assembled for each energy efficiency measure.

The market as an excellent allocator of capital, raw materials and manpower, and therefore its power must be utilized to the full. But, market forces also have their limits; in particular, they cannot be depended upon to safeguard 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.

To summarize: if energy policies are to be consistent with the new paradigm, there must be a shift of focus from energy consumption to energy services, a priority for energy services for basic needs, a comparison of supply increases with efficiency improvements and other conservation measures, least-cost planning, the promotion of conservation, the development of packages of policy instruments, and a recognition of the power and limits of the market.

ROLE OF INTERNATIONAL, MULTILATERAL & INDUSTRIALIZED COUNTRY

FUNDING/AID AGENCIES IN PROMOTING THE NEW PARADIGM

In implementing a DEFENDUS energy strategy in developing countries, the international multilateral & industrialized country funding/aid agencies can help in a major way. But, some changes in their practices are required because today there a number of barriers at the international level.

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.

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.

The origin of this barrier is the conventional 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.

The Anti-innovation Attitude: 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 production-izing 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.

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.

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.

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.

IS THERE HOPE FOR SUCH CHANGES?

If DEFENDUS scenarios for developing countries are indeed as superior -- cheaper, quicker, more environmentally sound and more equitable -- as they have been shown to be for Karnataka, then one would expect them to be chosen on the grounds of rationality. Energy decision-making, however, is not based on rationality alone. Powerful vested interests have grown around the conventional energy supply industries. But, now the supply lobby can no longer procure the capital to carry through its exorbitantly expensive schemes as easily as before because the bankability of their schemes is being eroded by rising costs and environmental safeguards. This lack of funding support for new energy supply is likely to force a reassessment of supply-obsessed energy planning. This may lead to a more favourable consideration of the DEFENDUS approach and a more balanced approach to the problem.

There is an international dimension to the problem. Developing countries have made requests to the World Bank that add up to close to $1 trillion in the next 10 years only for new electricity supplies. Such an astronomical demand is clearly not feasible since the World Bank can finance at best only 10% of the request. World Bank reports also indicate that there are tremendous losses and inefficiencies - including extremely weak management - that should be tackled before any new investments are made. Further, energy analysts can now present alternatives with concrete proposals backed by numbers and not as emotional hand-waving arguments. As a result, it will become more and more difficult for funding institutions to reject cost-effective and environmentally sound end-use-oriented scenarios presented in increasingly quantitative detail.

Nevertheless, the changes required involve a fundamental shift away from the conventional supply-side consumption-directed approach to the energy problem to a DEFENDUS approach. Can such a transformation take place in the next few decades?

Apart from the possibility of international aid agencies finding the bill for the supply approach impossibly high and pushing for environmentally sound energy strategies, the hope for the requisite changes lies in the convergence of a number of other interests.

Industrialized countries which have hitherto collaborated with the elites of developing countries to pursue unsustainable growth patterns, are now threatened by the global environmental consequences of conventional energy strategies in developing countries. A historic shift in allegiances may take place -- industrialized countries might find it in their enlightened self-interest to support sustainable development involving DEFENDUS energy strategies.

Environmental movements are growing within developing countries because of the increasing degradation of the local environment, and these internal movements are forging alliances with counterparts in the industrialized world. Developmental activists are protesting against supply-biased strategies because energy is not trickling down to the poor. And, finally, the people are becoming restless with the energy systems of today that bypass them.

DEFENDUS energy scenarios may be difficult to implement, but the current energy systems are impossible to sustain.

THE NEED FOR NEW AND ADDITIONAL RESOURCES FROM THE INDUSTRIALIZED COUNTRIES

The note of optimism above should not lead the reader to conclude that the desirable change will take place spontaneously and that, therefore, there is no need for the industrialized countries to provide new and additional resources to pay the extra bill for environmental protection in the developing countries. There are good grounds for cautioning against such a conclusion.

Even if the industrialized countries stabilize their emissions of greenhouse gases, the growth of these emissions from the developing countries will increase the atmospheric concentrations of these gases to dangerous and unacceptable levels. Hence, the environmental impacts of energy consumption in the developing countries cannot be ignored even though these countries do not contribute the major portion of greenhouse gases <u>today</u>. Since the environment of industrialized countries will be adversely affected to a significant extent by the pattern of economic growth in the developing countries, the process of development is not merely a matter of concern to the developing countries -- it is an issue of central importance to the industrialized countries.

Fortunately, there are strategies of sustainable development that yield global environmental benefits as a free byproduct. This bonus is the result of projects which would in any case be included in the development portfolio, having the added benefit of not promoting environmental degradation. Thus, many projects that improve the efficiency of energy utilization are justified on grounds of cost-effectiveness alone, but they also do not increase the emissions of greenhouse gases, i.e., they automatically prevent further environmental degradation.

For example, if an approach such as that described in Section 4 is followed at the all-India level, it has been argued that, through 27 efficiency improvement measures for the electricity sector, all of which are cheaper than the marginal cost of generation, a saving of about 21% or 124 TWh/year is possible out of the 594 TWh/year projected by India's Central Electricity Authority for the year 2000. On the basis of coal and natural gas contributions of 64.6% and 8.4% to the energy source mix, this saving corresponds to a saving of about 100 million tonnes of CO_2/year.

However, not all the projects in the development portfolio of developing countries can yield this bonus -- there can be many projects in the development portfolio that are harmful to the global environment. For example, a coal-rich developing country may find it cheaper to generate electricity from coal-based thermal power plant than from a more environmentally benign geothermal plant of the same capacity, in which case the geothermal plant would be excluded from the development portfolio. Or, a developing country may have already invested in refrigerators using chlorofluorocarbons (CFCs) that are harmful both from ozone-destroying and global warming points of view, in which case the replacement of CFCs in existing refrigerators and of existing refrigerator-manufacturing capacity may have enormous benefits with regard to the global environment but do not provide more energy services than the "dirty" technology, i.e., they do not advance development any further.

Under these circumstances, it is unreasonable for the industrialized countries which have been overwhelmingly responsible for the accumulation of greenhouse gases in the atmosphere, to ask developing countries to desist from coal plants and opt for more expensive geothermal plants or to scrap their previous investments for manufacturing "dirty" CFC-based refrigerators and establish new capacity for "clean" refrigerators. The unreasonable character of such a request is accentuated by the enormous expenditures involved. For example, India has estimated that it would require between $1.2-2.4 billions to switch over to the use of clean CFC-substitutes. Clearly, the only way such countries can be induced to advance global environmental benefits is for the industrialized countries to provide the incremental funding necessary for the establishment of benign technologies or for the replacement of dirty technologies with clean technologies.

In demanding such benign technological changes in the developing countries, a necessary condition is that the recommended changes must advance developmental objectives to the same or greater extent, but not to a lesser extent. If this condition is not satisfied, developing countries will in effect be asked to promote global environmental goals by reducing the quantity of goods and services when the level of satisfaction of needs provided by these goods and servic es is pathetically low -- and this is their strong apprehension! Such a demand is, of course, unacceptable -- hence, developing countries must not be asked to curtail their development in the interests of the global environment.

In addition, there are -- as pointed out in Section 5.3 -- technologies which are not-yet-proven but are far more promising from a global environmental point of view than current technologies providing the same service. To benefit from these new technolog ies, they have to be assisted to pass through the innovation chain -- their technical, economic and market potential must be realized by getting the technologies, costs and markets "right" through productionizing, demonstrations, improvements in cost-effectiveness, pilot implementation experiments, achievement of scale economies in the case of mass-production, organizational learning etc. In this case too, of new technologies that are much more environmentally benign, the industrialized countries must bear the extra expense of making them implementable because they would not be implemented without demonstrations and proof of implementability.

The "good news" is that a number of industrialized countries -- but not all of them! -- have created the Global Environment Facility (GEF) to provide these new and additional resources for incremental funding

(1) to incorporate into the development process environmentally beneficial projects that would otherwise be excluded on economic grounds -- these are known in GEF terminology as "Type II" projects, and
(2) to make environmentally promising but not-yet-proven technologies implementable -- these are known in GEF terminology as "Type I" projects.

However, there is also "bad news". Firstly, the donors seem to be biased in favour of Type II projects and against Type I projects even though it is the latter that are likely to confer far greater global environmental benefits. Secondly, the GEF resources -- about $1.4 billion -- are a mere "drop in the ocean" and the colossal resources of the World Bank are outside the scope of GEF and under the control of the regular non-GEF part of the Bank which has yet to accept the innovative approach of GEF. Thirdly, after the GEF projects are selected, they are implemented by the same regular Bank operations staff that has in the past been quite insensitive to environmental issues. Indeed, if local and global environmental costs and benefits had been included routinely in the Bank's evaluation of projects, there would have been no need for a special mechanism such as GEF to include environmentally beneficial projects that would be excluded in a conventional evaluation process.

THE NEED FOR CHANGES IN APPROACH AND FUNCTIONING OF INTERNATIONAL FUNDING INSTITUTIONS AND INDUSTRIALIZED COUNTRIES

In addition, the note of optimism must not lead to the conclusion that there is no need for international banking institutions and industrialized-country donors to change the way in which they approach the process of development and the issue of environmental protection in the developing countries. In fact, several crucial changes are necessary.

Following from the discussion of GEF in the previous section, the donors must, firstly, promote both Type II projects that would otherwise be excluded on economic grounds as well as "Type I" projects to make environmentally promising but not-yet-proven technologies implementable. Secondly, GEF-type resources implemented with innovative GEF-type criteria must be augmented to a scale where they are larger than, or at least comparable to, the resources of the World Bank. Thirdly, the implementation of GEF projects is as important as their selection; hence, they must be implemented by operations staff that are sensitive to environmental issues. Finally, local and global environmental costs and benefits must be incorporated routinely into the evaluation of projects by international lending institutions and donor agencies.

A more fundamental change is required in the approach of lending and donor agencies. Thus far, these agencies have not distinguished between <u>sustainable development</u>, i.e., need-oriented, self-reliant and environmentally sound development, and <u>economic growth</u> that degrades the environment while its benefits are skewed in favour of developing country elites and its *modus operandi* accentuates dependence. A cynical interpretation is that this undiscriminating view and this blurring of distinctions prevailed as long as it was only the poor in developing countries who were the victims of economic growth. Now, the situation has been transformed by the fact that the industrialized countries will themselves become victims of distorted development via the degradation of the atmosphere. Hence, the lending and aid agencies will have to abandon their support for indiscriminate growth; they have to develop a vested interest in sustainable development. These agencies must stop being part of the problem; they must become part of the solution.

In order to champion sustainable development, these lending and aid agencies must delve into the basis of sustainability and implement its crucial components. When they move in this direction, they will find that basic changes are necessary in their approach and functioning.

Consider the efficient production and use of energy in particular which has to be an essential ingredient of sustainability. The record of the multilateral development banks is dismal in the matter of energy efficiency with utterly trivial funds going for such projects and the overwhelming share going for supply projects many of which are environmentally harmful.

So, a crucial step is for lending and aid agencies to achieve a balance in their funding portfolio between efficiency improvements and renewable sources on one hand and environmentally degrading centralized supply technologies side on the other. This means that they must encourage least-cost energy planning in developing countries for it is intrinsic to the least-cost approach that efficiency improvements, renewable sources and centralized supply technologies have to be compared on equal terms. To increase the effectiveness of least-cost planning, lending and aid agencies should also assist developing countries to price energy carriers "right", i.e., equal to the long-run marginal cost and to promote renewable sources of energy.

Thus, the challenges are major and many, and time is running out. Fortunately, awareness is increasing and spreading rapidly. Therein lies the hope.

FILENAME: STRASBOU.RG October 13, 2005

POINTS THAT MUST NOT BE OMITTED

(1) Conservation must not lead to decrease in the level of energy services which are already low in developing countries.
(2) Developing country perspective but variety of examples (not only Brazil/India and Sao Paulo/Karnataka).
(3) Not only what should be be done but also what is possible (in terms of real life prospects).
(4) Do not neglect supply side.
(5) If important questions cannot be answered because research has not yet been done (e.g., what will be the supply mix for all developing countries or even for some large developing countries?), then state uncertainty.
(6) Authors must not hesitate to take a policy stance re: what must be done.
(7) Elaborate where change is going to come from and where the responsibilities lie.
(8) What is important is not whether fuelwood is used for cooking but whether it is being obtained renewably or non-renewably.
(9) Electricity use is greater in the 1 kW scenario.
(10) Role of multi-nationals.

ENERGY, ENVIRONMENT AND A SUSTAINABLE WORLD

The interaction between energy and the environment is intimate and inevitable, and therefore the increasing use of energy leads inexorably to escalating environmental degradation. The degradation is both local and global. As the global impacts increase in intensity, the sustainability of the world is threatened because environmental stability is one of the conditions for global sustainability. The other necessary and sufficient conditions are the satisfaction of the basic needs of the peoples of the world, the economic viability of the energy production systems and the self-reliant interdependence of nations, and current energy systems are jeopardizing these conditions too. The poor do not have adequate energy services to satisfy their basic needs and the conventional view is that the only way of providing these increased services is by stepping up the supplies of energy. When, however, this supply approach is pursued indiscriminately, no only does the economics tend to become unviable, but in addition, peace is endangered by the dependence on some countries for energy sources. Thus, when a purely supply approach to increasing energy services is pursued, the inevitable result is a combination of mounting costs, decreasing self reliance and endangered peace, in addition to increasing environmental degradation. It appears that there is an energy vs global sustainability dilemma -- the greater the energy that is necessary to provide energy services, satisfy basic needs and sustain the world, the more is global sustainability threatened.

JOBS TO BE DONE BY AMULYA BY MAY 15

(1) Table 1 to show differences between developing countries -- Source: World Development Report (1989)
(2) Table 2 to show income disparities -- Source: World Development Report (1989)

JOBS TO BE DONE BY JOSE

(1) Figure 1 : Pie-charts of end-uses of residential electricity in say Sao Paulo and a US city
(2) Doubling time for fossil-fuel-derived emissions from the developing countries -- Jose/Bob: Can you please help out with this number; my data sources are in India]
(3) Figures 5a: Pie-chart showing the causes of deforestation in the Amazon
(4) Figure 10 to substantiate the point that the energy-GDP ratio has been decreasing steadily except for the period in which their infrastructure of heavy industry was being established.
(5) How about the Feiveson Princeton protocol?

[BOX 2]

Note to Jose: The first level classification is obviously into options for generating and saving, but the second level consists of further classifying generation options either into centralized and decentralized sources or into non-renewable and renewable sources. Energy planners and implementors think virtually exclusively in terms of centralized options (large hydroelectric plants, coal-, oil- or NG-fired thermal plants or nuclear power stations), but environmentalists think in terms of the renewability and non-renewability of sources. Most centralized sources have environmentally negative impacts -- even large hydroelectric plants may be renewable in terms of the energy of the water, but they are non-renewable from the point of view of the prime forests that were irreversibly submerged to store the water behind the dam. And most decentralized sources are environmentally benign because it is mainly direct solar and biomass energy (and micro- and mini-hydroelectric energy) that is available locally. Hence, the presentation can be tuned to decision-makers by adopting a sub-classification into the options for generating it from centralized and/or decentralized sources and then bringing in the question of renewability]

In implementing an DEFENDUS energy strategy in developing countries, the international aid agencies can help in a major way. But, some changes in their practices are required. They must compare supply increases and efficiency improvements on the same terms and as part of the same decision-making process and provide financial support to conservation and renewables. In addition, international aid agencies must include global environmental impacts in their evaluation of projects. And their aid must be restructured by shifting the emphasis from project to program support, building and strengthening energy-aid-receiving indigenous institutions, strengthening indigenous energy-related technical capability and supporting technological leapfrogging efforts.

It is with respect to technological leapfrogging that the national and multi-national companies of the industrialized countries have a crucial role. It is these companies that are engaged in, or have the potential to engage in, technology transfer through collaborative ventures with manufacturing firms in the developing countries. Unfortunately, there are many instances where these companies have transferred environmentally malign technologies and even technologies that have been banned in the industrialized countries on environmental grounds. But, this need not be the case. Since, the se companies are also doing a great deal of the research and development on futuristic technologies, they are potentially powerful mechanisms for the process of technological leapfrogging vehicles.

If the developing world has the funds to implement DEFE NDUS energy strategies, the protection and improvement of the global environment will be greatly advanced. But, this funding can only come from the industrialized countries. These funds could be collected through a tax that is proportional to the contrib ution of different countries to the total carbon dioxide emissions. [How about the Feiveson Princeton protocol? -- Jose] Such a Carbon Tax would be consistent with the polluter -pays principle accepted long ago by the OECD countries. It is easy to show t hat a tax of one dollar per barrel of oil equivalent would permit collecting sums as large as $50 billion per year. To be successful, a Carbon Tax would have to be based on the self-interest of the advanced countries in avoiding the further degradation of the atmosphere and stabilizing its composition at present levels.

[FIGURE 5a: Pie -chart showing the causes of deforesta tion in the Amazon -- Jose and FIGURE 5b: Pie -chart showing the causes of deforestation in Karnataka based on following data: Cau ses of Loss of 203,913 ha Forest Area between 1956 and 1984 -- Power/Irrigation Projects (Direct) -- 29%, Clearing to Resettle people displaced by Power/Irrigation Projects -- 13%, Agriculture -- 33%, Mining -- 21%, Townships and roads -- 1%, Other -- 3%]