POVERTY-ORIENTED ENERGY STRATEGIES FOR SUSTAINABLE DEVELOPMENT[1]

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Amulya K.N. Reddy[4]

1 Industrialized Countries and Global Environmental Degradation

The developing countries with three times more population (1) have been far less responsible for "polluting" the global atmosphere with greenhouse gases, and (2) are even now polluting less than the industrial countries. But, the contribution of these countries to the concentration of greenhouse gases in the atmosphere is rising! For example, a general consensus exists that, "...during 1988, almost three-quarters of the CO_2 from fossil-fuel combustion was released in industrialized countries. But when non-industrial sources are included (e.g., burning of forests and other land-use changes) the contribution of industrialized countries was about 56%. ... Analysis of the available data suggests that the historical fossil-fuel related emissions from developing countries represent only about 14% of the global total, as compared to 28% of current fossil-derived CO_2 emissions..."[1] Thus, in a world stratified into rich and poor countries, the bulk of the degradation of the global atmosphere has originated primarily from the rich industrialized countries but the contribution from the poor developing countries is increasingly rapidly.

2. Environmental Degradation in Dual Societies

Most developing countries, however, are internally stratified. They consist of dual societies with small elites living in little islands of affluence amidst vast oceans of poverty inhabited by the more populous masses. The elites and the masses differ fundamentally in their consumption patterns and therefore in their impacts on the environment. But, environmental degradation is evident at both ends of the income spectrum[2] -- the rich pollute due to the wasteful over-use of resources and the poor degrade the environment by surviving at its expense. Thus, the global phenomenon of non-uniform and skewed contributions to atmospheric degradation is mirrored within developing countries.

Further, attention is now being drawn[3] to the fact that the nature of the environmental degradation caused by the elite and the masses is also different. For example, the rich are responsible for pollution due to CO_2 from automobiles and electricity generation, CFCs from refrigerators, etc. In contrast, the poor are responsible for deforestation in those countries and regions where cooking fuel is obtained by felling trees and where forests are cleared for agriculture because land ownership is highly skewed. In addition, the kerosene burnt by the poor for illumination contributes to CO_2 emissions.

Thus far, the contribution of various income strata to the national emissions in developing countries has not been scrutinized. In fact, these emissions have not even been disaggregated crudely into the contributions of the rich and the poor. The basic problem seems to be that there is no information on the emissions from various end-use devices such as automobiles, two-wheelers, three-wheelers, buses, trucks, electric lighting, kerosene lighting, etc. Nevertheless, an impressionistic conclusion is that the poor in developing countries contribute only marginally to

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the greenhouse gas emissions from these countries. This has an implication of major significance -- an emphasis on basic-needs-oriented development with a direct attack on poverty involves virtually no conflict with global environmental concerns.

3. A Developing-Country Perspective on Environmental Problems

Most developing countries view the challenge of development to be far more important than the threat of climate change. Thus, if at all they address the problem of climate change, they would like to tackle it along with the advancement of, or as bonus from, development. This bonus principle, which is the other side of the coin of the no-regrets principle, requires that the short-term measures that advance development in developing countries must also yield the bonus of combatting climate change.

This does not mean that developing countries can ignore all environmental issues. Invariably, local environmental concerns and developmental tasks are intimately intertwined. Business-as-usual economic growth in developing countries with dual societies has led neither to basic-needs-oriented development nor to environmentally sustainable patterns.[4] Economic growth catering to the elites and neglecting the poor, involving a variety of subsidies, price distortions, inefficiencies, etc., has resulted -- as pointed out -- to environmental degradation from both segments of the dual society. Environmental degradation impedes and frustrates sustained development. More directly, the worst victims of environmental degradation are the poor not only because they cannot commute away and space-condition themselves from pollution but because their poorer health status makes themselves more vulnerable. Thus, an attack on poverty has necessarily to include environmental protection.

The relative lack of responsibility of the developing countries for the degradation of the global atmosphere and the environmental degradation arising from elitist growth patterns suggests a step-by-step environmental approach for developing countries[5]:

Step 1: Address local environmental problems such as unsafe rural water supplies or kerosene consumption for lighting or indoor particulate pollution due to smoke from fuelwood stoves, and urban vehicular pollution due to two-, three- and four-wheeler personal transportation.
Step 2: Tackle regional environmental problems such as acid rain or river pollution.
Step 3: Attend to national environmental problems.
Step 4: Pay heed to global environmental problems such as GHG accumulation in the atmosphere.

Such a step-by-step approach will be more politically saleable within developing countries because zeroing in on global environmental problems at the beginning o environmental awareness is often viewed as succumbing to a stratagem of the industrialized countries of getting the developing countries to fix a mess that these countries created. In addition, the equity pay-offs from this approach are substantial because the worst sufferers of environmental degradation become the first beneficiaries. There is also historical justice in this step-by-step approach because it demands that developing countries first address the problems that they themselves created and only then become environmentally altruistic by turning to problems that the industrialized countries created. Finally, an emphasis on the initial step(s) often yields as a bonus environmental benefits corresponding to subsequent steps, in particular, global environmental benefits. Thus, reduction of urban vehicular pollution due to two-, three- and four-wheeler personal transportation also results in reduction of GHG accumulation in the atmosphere.

4. The Crises of Energy Systems

Energy production and consumption is a major cause of environmental degradation. Hence, attempts to address environmental problems must lead to an analysis of energy systems.

But, the energy systems of developing countries are trapped in several crises if a crisis is defined as a situation that does not permit continuation of old patterns of behaviour.

At the outset, there is the environmental crisis which involves local and global impacts. The local impacts consist of submergence of forests from hydroelectric projects, acid rain and other forms of atmospheric pollution from thermal power projects and vehicle use, and radiation hazards from nuclear power plants. And the global impacts are through rising concentrations of greenhouse gases in the atmosphere, which have raised the spectre of global warming.

In addition, energy systems face a serious capital crisis, because the capital requirements of the energy systems are three to five times more than what can be provided by the suppliers of capital -- this unbridgeable gap first highlighted at the level of the whole developing world by the World Bank in 1989 also exists at the country level and within countries at the state level. In India, the energy sector has been compared to the demon, Bakasura, of Indian mythology who had an insatiable appetite and however much he was fed, wanted even more to eat.

The environmental and capital crises are related -- because the industrialized countries are pressurizing the developing countries to cut their emissions and are asking for environmental measures as quid pro quo for capital. This link between the capital and environmental crises of the energy crisis may be unfair, but it is realpolitik. It is interpreted by developing countries as a conflict between environmental protection and the advancement of development.

Then, there is the equity crisis because even though energy systems are expanded in the name of development, they tend to bypass the poor. For example, in the state of Karnataka in south India, estimates show that half the population does not benefit directly from the electricity system primarily because of unelectrified homes in electrified villages.

For the sake of completeness, one should also mention the performance crisis. The following managerial shortcomings of utilities have been identified: conflicts between the Government's role as owner and its role as operator of utilities; government interference in daily affairs; lack of financial autonomy; opaque command and control management; poor expenditure control and management; bloated and underpaid civil service; poor returns on the public funds invested; declining power tariffs; inadequate metering, billing and collection; uneven revenue collection; lack of enforcement; deteriorating quality of service; increasing technical and non-technical losses; high fuel consumption; poor maintenance of plants; weak capacity of core agencies to design and implement policies to address these problems. In addition, there are also technical shortcomings -- the low plant load factor (energy generated as a percentage of plant capacity) and high transmission and distribution losses.

5. Overcoming the Crises of Energy Systems

In the ultimate analysis, the crises threatening the energy systems of developing countries and the environment-development conflict stem from the conventional energy paradigm or mind-set determining the thinking of energy decision-makers. This mind-set is based on the so-called energy-GDP correlation according to which GDP increases can only be achieved by increases in energy consumption. In this paradigm, the magnitude of energy consumption becomes the indicator of development. And once projections are made of energy requirements in the future, the attention shifts to increasing supplies to meet the energy requirement.

The way out of the crisis is through a new paradigm for energy in which it is recognized that what human beings and their individual and collective activities require is not energy per se but the work that energy performs and the services that energy provides: illumination, warmth, "coolth" (to coin a word), mobility, etc. In this approach, development requires, particularly for the poor, a substantial increase of energy services. But such increases can be achieved, not only by increasing the supply of energy to the devices (lamps, heaters, air conditioners, vehicles, appliances, etc) but also by increasing their efficiency. It is such increases of services through efficiency improvements that led to the decoupling of GDP from energy consumption -- growth of

GDP associated with decreases of energy consumption -- that characterized the economies of many OECD countries particularly Japan during the 1980s.

Efficiency improvements have associated costs but very often the costs of saving energy are only one-third to one-half the costs of generation. Nevertheless, the costs of saving energy must be carefully compared with the costs of producing energy. Also, the magnitude of energy that can be saved must be taken into account. All this means that it is necessary to identify a least-cost mix of saving and generation options for energy.

Thus, the new challenge to the energy systems of developing countries is to reduce the coupling between GDP growth and energy consumption by identifying and implementing a least-cost mix of saving and generation options for increasing energy services particularly for the poor. Energy, therefore, must acquire a human face and become an instrument of development the crux of which must be poverty eradication. Energy planning must acquire a development focus and an end-use orientation directed towards energy services. Energy for whom? energy for what? Energy how (efficiently)? become central questions in the new approach. What is required, therefore, is a new paradigm for energy -- a development-focused end-use-oriented service-directed or DEFENDUS paradigm to defend us against the crises and to eradicate poverty. What is being urged is that a commitment to poverty eradication must guide the construction of energy demand and supply scenarios and the evolution of energy systems which in turn should become the basis of environmental protection and management. The slogan must be "From the needs of the poor to the design and implementation of energy systems to a better environment!"

The remainder of this paper will be devoted to illustrations -- at the village, state and national levels -- of this approach of advancing from poverty eradication via a development-focused end-use-oriented service-directed or DEFENDUS paradigm for energy to an improved environment.

6. How Pura Village triumphed over the Tragedy of the Commons

Pura is a typical village in the drought-prone part of Tumkur District in the Deccan part of Karnataka State in South India. It has a human population of about 470 in approximately 90 households and approximately 250 cattle. The traditional system of obtaining water, illumination and fertilizer (for the fields) in Pura village is shown in Figure 1. It implies a low quality of life characterized by poverty and environmental degradation in the form of unsafe water from the open tank, considerable effort to get this unsafe water and inadequate illumination from traditional fossil-fuel-based kerosene lamps or from unreliable, low-voltage grid electricity.

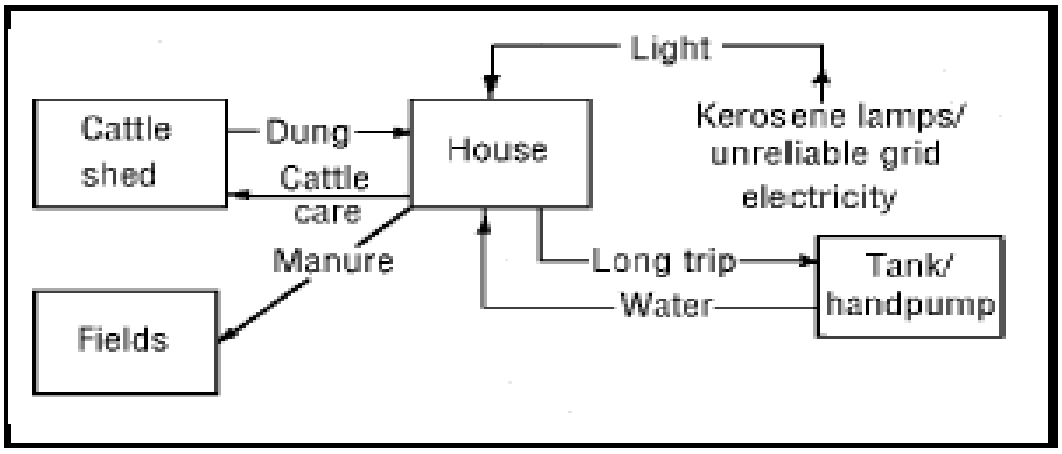

Fig. 1. Traditional system of obtaining water, light and fertilizer.

This traditional system was replaced in September 1987 with the present community biogas plants system[6] -- the main components and the flows of inputs/outputs of which are shown in Figure 2.

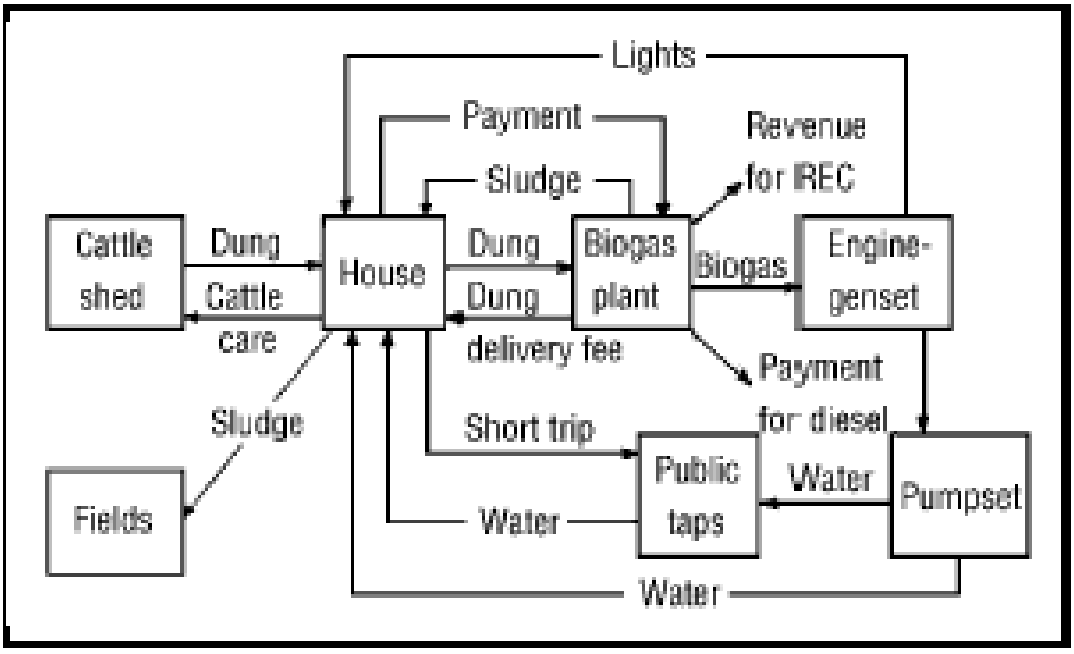

Fig. 2. The present community biogas plant system at Pura.

The operation of the system consists of the following activities (Figure 2):

- delivery of cattle dung by households from 0645 to 0800 hours in winter and in summer from 0500 to 0700 hours in the morning (24 % by women, 27 % by girls, 27 % by boys, and 22 % by men),
- weighing of the dung delivered by the households owning bovines and recording the quantities in their passbooks and in the ledger-books of the system,
- returning the processed sludge to those who want to withdraw sludge,
- mixing the dung with water in a 1:1 ratio (by volume) and charging the plants with the dung-water mixture,
- pouring the slurry displaced from the biogas plants by the charged dung-water mixture on to the sand-bed filters for filtration and production of de-watered sludge,
- releasing the biogas from the plants and feeding it to the engine, adding the requisite amount of diesel, and starting the dual-fuel engine and the electrical generator,
- supplying the electricity either for running the submersible pump and pumping the borewell water to the overhead tank or for the electrical illumination of homes,
- keeping the biogas plants and their surroundings clean,
- visiting the households to receive payments for the electric lighting and to make payments for the delivery of dung to the plants, and
- maintaining the system records and accounts.

Apart from the first activity, i.e., delivery of dung to the plants and withdrawal of sludge, all the other activities involving the operation of the biogas plants, the electricity generation and distribution sub-system and the water supply sub-system, have been carried out by two youth of the village who have been employed by the project.

- better and safer water than the water from the open tank,
- less effort to get this improved water,
- better illumination than the traditional kerosene lamps or even the unreliable, low-voltage grid electricity,
- cheaper illumination for the households using kerosene lamps,
- improved fertilizer which has greater nitrogen content and is less conducive to the growth of weeds compared to farmyard manure,
- a dung delivery fee to those (mainly women and children) who deliver the dung to the plants and take back the sludge.

Thus, there has been a significant improvement in the quality of life, a diminution of some characteristics of poverty and upgradation of the environment.

In addition, the village (as a collective) through its Grama Vikas Sabha (Village Development Committee) has gained in the following ways:

- training and skill upgradation for two of its youth in the operation and maintenance of the biogas system,
- challenging jobs for these two youth,
- revenue for the village to the extent that the total payment received for the system outputs delivered inside the houses exceeds the expenses for diesel and dung delivery fees,
- a powerful mechanism that initiates, ensures and sustains village-scale cooperation without which the village will revert back to a less pleasant way of life in the matter of water and illumination,
- a distinct improvement in the quality of life with regard to water (and therefore health) and illumination,
- a small but significant advance in checking the growing erosion of self-reliance, thanks to the realization that the current status and the future development of the energy system can be decided and implemented by the village, i.e., their future in this matter is in their hands.

Since Pura village has witnessed both increase of individual benefits as well as advancement of community interests, it is appropriate to refer here to the discussion of individual gain versus community interests referred to in the famous "Tragedy of the Commons" described by Hardin[7]. In that description, the personal benefits that each individual/household derives from promoting the further destruction of the commons (i.e., community resource) are larger and more immediate than the personal loss from the marginal, slow and long-term destruction of the commons -- hence, each individual/ household chooses to derive the immediate personal benefit rather that forgo it and save the commons.

The Pura Community Biogas Plants system illustrates a principle that may be termed the "Blessing of the Commons" -- the converse of the well-known "Tragedy of the Commons". According to the "Blessing of the Commons", the price that an individual/household pays for not preserving the commons far outweighs whatever benefits there might be in ignoring the collective interest. In other words, there is a confluence of self-interest and collective interest so that the collective interest is automatically advanced when individuals pursue their private interests. In the case of Pura, non-cooperation with the community biogas plants results in access to water and light being cut off by the village, and this is too great a personal loss to compensate for the minor advantage of being a loner.

With the growing experience and awareness of the defects of state control, operation and maintenance (regulation) of the commons, the privatization (deregulation) option with its emphasis

on the market is being offered as a solution to the problem of monitoring and control of common resources and facilities. The market may be an excellent allocator of men, materials and resources, but it does not have a very successful record at dealing with equity, the environment and the long-term. In this debate, it is invariably forgotten that the type of individual initiative subject to local community control necessary for the "Blessing of the Commons" situations is a distinct third option that has very attractive features. There must have been many examples of "Blessing of the Commons" that contributed to the survival of villages for centuries in spite of the centrifugal forces tearing them apart. Among those examples must have been the maintenance of village tanks, common lands, woodlots, etc.

In Pura, this third option has without external control successfully maintained and operated water-supply and electrical illumination systems for several years. It has ensured the careful husbanding of resources and enlisted the cooperation of every one of the households in the village. It has performed better than the centralized grid-electricity system in the matter of reliability of supply and of collection of dues. And above all it has shown that the path to environmental improvement must start with an attack on poverty via energy.

7. Karnataka DEFENDUS Electricity Scenario8

In 1987, a committee for the Long-Range Planning of Power Projects (LRPPP) set up by the government of Karnataka State in South India (19 million hectares and home to 37.1 million people) projected that the state would require a six-fold increase in electric supplies by the year 2000 from the 1986 consumption of 7.5 terawatt (billion kilowatt) hours of electricity and the 1986 installed capacity to 2500 megawatts. This six-fold increase to 47.5 terawatt hours of electricity and an installed capacity to 9400 megawatts required the construction of a 1000 MW super-thermal plant and 2470 MW of nuclear power facilities. The infrastructure also had to be expanded by constructing transmission lines, new rail facilities, etc. The bill for this projected increase in supply was an annual carrying cost of $3.3 billion which could be achieved only by spending more than 25% of state's budget and expected borrowing from the central government and international sources.

Despite this investment and expansion of supply, the committee was frank enough to warn that energy shortages would not be eliminated; shortages would continue into the next century, with little hope thereafter. In fact, that would be an appropriate epitaph for the conventional paradigm.

In response to the LRPPP projection, a DEFENDUS scenario was constructed with a different focus than just increasing supplies

- focus on poverty-oriented development through the electrification of all homes and a shift to non-energy-intensive employment-generating industries
- focus on end-use efficiency through efficiency improvements, replacement of electricity with other heat sources and load management
- focus on augmenting electricity supply through the reduction of transmission losses, implementation of cogeneration in sugar factories, use of non-conventional sources and decentralized electricity generation at the village level.

This alternative scenario which resulted in the shelving of the LRPPP projection requires far less increase of supply -- only about 40% of the electricity and installed capacity (17.9 terawatt hours of electricity and an installed capacity of 4000 megawatts. Since the requirements of

electricity and installed capacity are only about 40% of those in the conventional LRPPP projection, the annual bill for the DEFENDUS scenario is only $618 million, i.e., one-third. It is very expensive to keep poor people poor; it is much cheaper to make a direct attack on poverty. Further, since centralized generation with its long gestation times has been reduced, the gestation time of the DEFENDUS scenario is significantly less. Finally, since the efficiency improvements, electricity substitution measures and decentralized sources are cleaner, the environmental impacts of the alternative scenario are much less.

Champions of efficiency and renewables have been arguing for the past decade or so that alternative scenarios are much quicker, cheaper and environmentally sounder than the conventional plans. But their recommendations have been ignored because they have been based on emotional pleas and hand-waving arguments. Now the situation is different. The mix of efficiency, renewables and clean centralized sources constituting the DEFENDUS scenario is the result of rigorous quantitative exercises which have survived presentations at local, national and international fora. Crucial components of the DEFENDUS scenario are now under implementation.

8. A Strategy for the Reduction of India's Oil Dependence[9]

It is not likely that India's current oil crisis will go away like the previous crisis of the 1970s. India is in a much graver situation today than ten years ago. The fundamental cause of the current oil crisis is the country's unchecked appetite for diesel and kerosene due to railway freight being de-emphasized, homes not being electrified and personal transportation being preferred.

India's transport sector is a major oil consumer, but, quite unlike the industrialized countries, the country's transport runs mainly on diesel which accounts for 70% of the oil used in the transport sector. Diesel consumption is mostly due to trucks which are far less energy efficient than railways in hauling high-bulk-density goods. Despite this, the share of total freight transported by trucks has increased enormously because of the low price of diesel which has been subsidized and pegged at a price slightly above that of kerosene. Diesel prices cannot be increased without roughly equal increases in kerosene prices because, if the price of kerosene is very much lower than that of diesel, trucks adulterate their diesel fuel with kerosene and immediately create a kerosene shortage. This shortage causes great hardship to the poor because kerosene is used almost wholly in the household sector. And, for the same reason, kerosene prices cannot be increased under present conditions.

Though electrical illumination is far more energy-efficient than kerosene lamps, the number of un-electrified homes in the country is increasing at the rate of about a million households per year. Under these conditions, the country has been forced to increase kerosene consumption at the rate of 7.8% per year.

India's oil problem, therefore, is primarily a problem of the two middle distillates, diesel and kerosene, in that order. Together, they account for as much as about half of India's oil consumption, and incidentally account for the bulk of the country's imports of petroleum products.

In contrast, gasoline is currently a small problem because it represents less than one-tenth of the oil consumption. But, it is a rapidly growing problem in India because the decision-makers have, not only failed to provide the funds necessary for public transportation, but also encouraged the proliferation of mopeds, scooters, motorbikes, cars, and three-wheeler autorickshaws. De facto, the planners and government have "chosen" personal and hired vehicles as the preferred mode of intra-city passenger movement.

On the basis of this analysis, a four-pronged strategy for resolving India's oil crisis has been suggested[10]. It is based primarily on reducing the demand for diesel, kerosene and gasoline.

The strategy consists of

- implementing efficiency improvements in the use of petroleum products
- shifting passenger traffic from personal vehicles to public transportation
- shifting freight traffic from road to rail through the electrification of homes, the replacement of kerosene as an illuminant, and the removal of subsidies on kerosene and diesel
- replacing oil with alternative non-oil fuels, particularly biomass-derived fuels.

Efficiency improvements in the transport sector can be achieved straightaway by better house-keeping and by long-term measures such as improvement in the fuel efficiency of the truck fleet. In the case of gasoline, the reduction of gasoline consumption also requires a change in the modal mix for passenger traffic away from personal vehicles to public transportation through overall measures that include steps such as massive investments on the infrastructure for public transportation. But, for intra-city passenger movement, special supplementary measures such as major increases in the number of buses, and where possible, suburban trains, are also necessary.

The crux of the third prong of the proposed strategy is a massive programme of home electrification. When all homes are electrified, kerosene becomes unnecessary as an illuminant. To make kerosene completely redundant, additional measures are required for replacing kerosene as a cooking fuel in cities. Once this is done, the subsidy on diesel can be removed and its price can be brought on par with that of gasoline.

The increase of diesel prices is a necessary, not sufficient, for decreasing truck freight; it would, however, create a favourable environment in which supporting policy measures can be adopted. For the railways to exploit the situation and increase their freight haulage, there must be substantial investments on the improvement of the railways' freight operations. These funds can come from the diversion of the implicit subsidies on kerosene and diesel.

The combination of this strategy of shifting freight from trucks to rail along with a strategy of shifting short-distance inter-city passenger traffic from diesel locomotives to buses can reduce the diesel demand in the transport sector from about 36 million tonnes in the year 2000 just projected by the Planning Commission of the Government of India to about 21 million tonnes which is only about 10% above the present consumption.

Even with this combination of strategies, the oil problem would not be eliminated. Intra-regional or short-haul traffic would still require road transport, and therefore, a considerable amount of oil. So, in order to advance the objective of sustainable development, the possibility must be explored of the dependence of road transport on non-renewable oil resources being eliminated completely. In other words, a comprehensive oil-reduction strategy requires, over the longer term, the much more radical solution of shifting to alternative fuels for road transportation.

Producer gas and biogas have limited scope for use in road transport. Since natural gas is more abundant than oil, much cheaper, far less polluting and as easily distributed, the compressed natural gas (CNG) option is an attractive alternative for urban fleets of vehicles -- buses, taxis, city delivery vehicles. Though, hydrogen produced by solar photovoltaics may well turn out to be the transport fuel of the future, it is only the liquid fuels -- ethanol and methanol -- that are widely applicable alternative fuels in road transport. They can be distributed through the nation-wide network already established for gasoline and diesel. Mixtures of ethanol and gasoline -- so-called "gasohol" -- can be used widely as gasoline extenders. And pure methanol, although never used extensively, is, like pure ethanol, an excellent fuel for internal combustion engines.

Producer gas, biogas, ethanol and methanol can all be obtained from biomass sources. A synergistic coupling between the transport sector and the agricultural sector is therefore possible whereby "fuel farms" can be established to supply fuels for transportation in the same way that rural farms produce food for urban demands.

The fuel-food conflict can be avoided by turning to non-agricultural land for cellulosic resources, particularly fuelwood, to produce methanol and/or ethanol. But, the

alcohol-from-fuelwood solution to the oil crisis can aggravate the domestic fuelwood problem particularly for the poor. Cooking fuel for homes, however, is one of the basic energy needs, and the satisfaction of this need has to be an essential feature of an overall development-oriented energy strategy. Hence, the solution to the oil crisis must be compatible with the solution to the fuelwood problem.

One way of achieving such a compatible solution is to extend in two steps the synergism between the agriculture and transport sectors to include the domestic sector also.

The first step is based on the fact that, if alternative high-efficiency fuels are provided for cooking, or the efficiencies of fuelwood stoves are radically improved, then the resulting drastic reductions in fuelwood consumption can free a vast fuelwood resource base for the production of liquid fuels for the transport sector.

Either the biogas or high-efficiency fuelwood-stove options or a mix of them can be introduced in villages. In cities and towns, the LPG option can be adopted since there is considerable scope for the expansion of LPG supplies. And, once the pressure on forests as a source of cooking fuel decreases, conditions become established for managing the growth of forests, and dramatically improving their fuelwood yields. In other words, silvicultural practices -- agriculture in the general sense -- can be implemented to increase fuelwood availability. This is the second step in the extension of the synergism; it consists of including agriculture in the domestic-transport synergism.

In all, therefore, the provision of high-efficiency cooking fuels and/or devices in rural and urban areas would make available large amounts of wood provided that all the firewood being used today for cooking can still be collected. This saved fuelwood can be converted into methanol. If diesel fuel in truck and buses is replaced with methanol, then the only small diesel demand from the transport sector will come from the railways.

In the case of India, it appears that the country has been engulfed by a grave oil crisis because it has ignored two crucial basic needs of poor households: efficient energy sources for lighting and for cooking. The oil strategy proposed here shows that by the provision of electric lighting and efficient cooking fuels/devices to all homes, India can move towards a virtually oil-free road transport system and reduce drastically its dependence on oil.

The lesson is simple: "Look after the people with the efficient production and use of energy, and the environment will look after itself!"

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