5 Policy issues

Introduction

Any environmental discussion paper in the Indian context remains incomplete without reference to the **Environment Action Programme** (EAP) document, which was prepared by the MoEF in 1993. The goal of the EAP is to improve the provisioning of environmental services in India and to facilitate integration of environmental considerations into development programmes. Keeping in view these goals, the objectives of the EAP were been set out and are as follows:

a. assess the environment scene in India against the backdrop of the changing economic policies and programmes;
b. review the current policies and programmes which address the various environmental problems of the country;
c. identify the future direction and thrust of these policies and programmes to establish priorities and outline a strategy for the implementation of those priorities;
d. identify programmes and projects for a sustained flow of investment resources for improved provisioning of environmental services for better quality of life and for integrating environmental concerns into development projects; and
e. identify projects for organizational strengthening for better environmental management.

These objectives would be realised by appropriate economic instruments, overcoming of organizational gaps and effective programme implementation. The Action Programme would strengthen capabilities in the areas of environment assessment, increase environmental awareness and further facilitate the process of association of NGOs (Non-Governmental Organizations) in the tasks of sustainable development. The objectives, when realised, would enhance the quality of life of the citizens of India by improving the physical environment in terms of air, water, land and land-based resources such as forests and biodiversity regimes.

EAP covers, *inter alia*, the relevant issues in the energy sector and proposes many solutions for alleviating the deleterious effect of energy use on the environment: conservation of natural resources, use of clean coal technologies, reduction of transmission and distribution losses, promotion of energy efficiency in supply and demand, development and promotion of renewable energy technologies, and retrofitting and modernization of existing power plants. But the EAP does not differentiate among these activities in terms of their short-term and long-term impacts, nor does it prioritize the solutions in terms of their environmental impacts.

The immediate priority for solving short-term environmental problems is targeted action in coal-based power generation. The most important technologies for environmental protection are coal washeries, retrofitting and maintenance of existing power plants, demand-side management reduced losses in transmission and distribution, and advanced-technology power generation projects. These measures must be accompanied by a strengthening of the environment divisions within the SEBs to ensure sustained environmental improvement. In addition, fiscal policies that encourage the efficient use and conservation of natural resources are required. Measures to raise the standard of indigenous coal also are needed; these could take the form of reduced tariffs on imported coal and the improvement of coal transportation infrastructure to enable the supply of imported, good-quality coal. From the financial standpoint, lending for retrofitting and maintenance projects should be facilitated.

Intersectoral linkages between energy and other sectors are quite fundamental to how energy is used and affects the environment. Energy and transport, energy and industry, and energy and construction industry standards are all linked. For example, industrial policies that promote clean technologies (as opposed to end-of-pipe technologies) also foster energy efficiency. Strategies to improve transport sector efficiency (through, for example, emission standards, road-use fees, and investments in public transport) also reduce energy-related emissions.

In general, the least-cost, most-balanced approach to minimizing the impending growth in emissions is to simultaneously increase both supply-side and demand-side of efficiency, and to promote clean energy technologies on the supply side. These goals can be achieved through combined policy measures (particularly full-cost pricing), technical and operational improvements, and institutional strengthening in regulatory agencies and utility companies

Policy and institutional barriers are the principal impediment to successful implementation of an ambitious power sector strategy in India. The combined price reforms and management practices required to bring about supply-and-demand-side efficiency will lead to the adoption of higher-efficiency technologies.

Major issues

An alternative energy plan is one of the seven priorities noted in the EAP. The main issues facing the energy sector are:

- Absence of an integrated long-term energy policy.
- Lack of rational pricing for energy.
- Increasing foreign exchange outflows as a result of oil imports.
- Low levels of available energy.
- Increasing energy demand.
- Inefficient use.

The EAP describes two strategies to tackle these issues. First, the efficiency of energy production, conversion and use should be improved; energy demand should be managed; and technology and process changes should be encouraged. Second, India should move toward more environmentally benign energy forms, that is, renewable energy resources.

Dominance of coal

The Government has decided to use coal as the main source of fuel for the power sector in the foreseeable future, based on the large quantity of coal reserves in India. Thus, coal will continue to be the main source of pollution in the power sector, and short-term efforts to alleviate environmental pollution should focus on this source. The development rate of renewable energy will have little effect on the magnitude of pollution and related environmental impacts imposed by the use of coal. The suggested mitigation measures – fiscal, administrative, or physical – will not altogether prevent these impacts, but they will moderate them to some extent.

Generation capacity by the end of the Seventh Five-Year Plan was 69,100 MW, of which coal-fired thermal power plants accounted for about 46,000 MW. Coal-fired thermal power plan capacity is expected to increase by 81,000 MW by 2010, to a total of 144,000 MW.

By comparison, renewable power generation capacity is estimated at 180 MW (mainly hydro power and wind), and the total installed capacity by 2010 is expected to be no more than 2,000 to 3,000 MW. Furthermore, the ultimate potential of renewable energy for India is estimated at 50,000 MW – well below the coal-fired capacity in 2010. Thus, renewable energy will not replace coal-based power generation in the foreseeable future. From an environmental point of view, this is an issue of concern, which needs to be addressed at the earliest.

Using fiscal incentives to improve resource use

Fiscal incentives and tax-based environmental protection measures are outlined as part of the strategy in the EAP. Current fiscal incentives are in the form of corporate tax exemptions for natural resource conservation and accelerated depreciation for energy-conserving devices. The tax-based measures emphasize water conservation. A levy on water consumption is confined mainly to thermal power plants and other large-scale process industries. The water levy is the main source of revenue for the SPCBs in India: the amount collected during 1991-92 in thirty-one states was Rs.76.3 million (about $2.5 million). It seems, however, that the costs of collection exceeded the amount collected.

The current fiscal measures have little effect on the power sector. The fact is that coal-fired thermal power plants are responsible for a massive abuse of natural resources (land, water, and air). The main reason is that the use of these resources is not charged at real value, and no incentives are offered for their conservation. While the power sector is not in a position to pay the actual costs of natural resources, it can be encouraged to conserve them.

Energy Pricing

Low energy pricing is the major barrier to long-term financial stability in the power sector. It also has major environmental implications. Virtually all Asian countries have complex pricing policies that differentiate the energy market by product and end user. (Cross-subsidy issues complicate the picture, but only rarely, should energy sources be offered at below cost, which is now common.) Electricity prices are only half of long-run marginal production costs, indicating serious levels of subsidy in the market. Assuming an average energy price demand elasticity of minus 0.5, even a 10 per cent price change in the direction of removing subsidies would immediately reduce all emissions by five per cent – not even allowing for the effects of price reform on supply side efficiency.

Some Asian countries have made significant progress in the last few years in price reform, notably China and Korea. China's recent policy of "new-plant new-cost" has resulted in a steady increase that reached the level of long-run marginal cost (LRMC) by 1996. Most Chinese petroleum product prices are close to international prices, but some heavier petroleum products and natural gas are subsidized. In India, petroleum prices range from far above world prices for gasoline, to below world prices for kerosene and diesel although in the case of diesel the priniciple of import parity pricing has been accepted. Again, the rail freight for coal though high (as it cross subsidises food grains and passenger transport) is comparatively lower than the duty levied on imported coal. Hence the poor quality fuel (including transportation cost) when compared to better quality-imported coal is much cheaper (however the cost advantage is location specific depending on the distance transported inland by both domestic and imported coal). The coal prices are 15-40 per cent below world prices. This encourages use of poor quality domestic fuel.

In India, there is significant latitude for fostering energy efficiency through price reform in coal, electricity, and petroleum markets. Higher pricing would not only serve the immediate environmental objective of reduced emissions, it would have a major impact on strengthening the power sector and encouraging greater private sector participation – which would help foster, in turn, broader sectoral efficiency.

Energy Taxes

Energy taxes are an indirect mechanism for accomplishing energy-related pollution abatement. As noted, indirect taxes are often easier to administer than direct charges on polluters. One objective of such taxes is to internalize the environmental costs of emissions (based on carbon, sulphur, or particulate consumption) in the operating costs of fossil fuel for producers and users. Energy taxes are relatively easy to administer, since the number of transactions at the point at which fuels are first produced or enter the economy is relatively small. Although taxes on transport fuels are very common, more broadly based energy taxes – such as carbon taxes – are increasingly being adopted for environmental reasons in Europe.

Economic incentive instruments

The instruments that are used for environmental regulation can be classified on the basis of two criteria, (i) where fiscal incentives are used to dictate quantum of abatement and use of abatement technology, and (ii) where the emissions have to be monitored. The latter, which is the ‘command and control’ regulation needs to set standards for emissions. The former, ‘economic incentive’ or MBI (market-based instruments) use policies such as emission fees, marketable permits and environmental taxes to regulate the environment. These instruments can further be classified into ‘direct’ and ‘indirect’ instruments (Eskeland and Jimenez, 1992) as indicated in Table 5.1.

Table 5.1 Classification of environmental regulation

	Direct instrument	Indirect instrument
Economic incentives	**Emission fees Marketable instruments**	**Environment taxes**
Command and control	**Emission standards**	**Technology standards**

The commonly used environmental taxes are the carbon tax, sulphur tax and ozone tax as implemented in the OECD countries aimed at abating air pollution. However, these programmes are all in their infancy and, hence, their impacts are yet to be determined; only in Sweden a study by Bohlin (1998) claims that the carbon tax has significantly reduced emissions. The other instruments used are emission fees for air pollution again. Some of the countries implementing the same are, Canada (general air pollution), France (acidifying emissions), Sweden (nitrogen oxides), China (for 20 different air pollutants), etc. The fee structures are different. For example for China, the national floor on fee is around $280 to $700 per ton for particulate matter (depending on source) and $280 per ton for most commonly airborne pollutants including sulphur dioxide, nitrogen oxides and carbon monoxide (Yang *et. al.*, 1997)[a]. The other

Table 5.2 MBI in Latin American and Caribbean countries

[a] Allen Blackman and Winston Harrington, "The use of economic incentives in Developing Countries: Lessons from International experience with industrial Air Pollution", , Discussion Paper 99-39, Resources for the Future May 1999.pp 18.

	Barbados	Bolivia	Brazil	Chile	Columbia	Ecuador	Jamaica	Mexico	Peru	Trinidad & Tobago	Venezuele
Credit subsidies	♦		♦		♦	♦		♦			
Tax/tariff relief	♦		♦	♦	♦	♦	♦				♦
Waste fee & levies	♦	♦	♦	♦	♦	♦	♦	♦		♦	♦
Forestry taxation		♦	♦		♦						
Pollution charges			♦		♦		❑	♦			
Tradable permits		❑		♦				❑			
Eco labeling		♦	♦	♦		♦		♦			

♦ In place
❑ Being introduced

instrument, tradable permits are in use only in USA, Canada, Germany, Sweden and Australia. The three principal trading programmes in USA are the Emission Trading Programme, the Sulphur Trading Programme and the Ozone Programme. However, a pre-requisite for trading is integration in terms of policies and regulations among the neighbouring states/countries. Table 5.2[a] provides an indication of some of the MBI being applied in the Latin American and Caribbean countries.

The funds thus collected through these instruments are generally used in developing "environmental funds". These funds are thereafter arranged, whereby earmarked revenues are channeled into environmental protection or restoration. The revenues are channeled from those who pay into the fund to those who withdraw (temporarily or permanently) from the fund. Environmental funds serve many different objectives namely, preserve biodiversity; promote environmental research; build and maintain environmental institutions; invest in pollution abatement equipment and infrastructure; etc. China has a long history of using environmental funds, both at national and local levels. Apparently, the local environmental funds have been the pioneers.

However, one also needs to realise that these instruments can enhance environmental management and equity, rationalise markets, reduce social costs and

[a] Huber M., Ruitenbeck J., and Seroa da Motta R., *Market-based instruments for environmental policymaking in Latin America and the Caribbean: Lessons from eleven countries*, The World Bank, 1996. Pp 1.

increase institutional revenues if designed appropriately and implemented in the right circumstances. But there are caveats and restrictions here also, namely,[a]

- They impose high administrative costs.
- Historically, market-based instruments have been used for revenue generation rather than for improving environmental quality.
- Budget for environmental management is usually limited and resources are often poorly managed.
- Public awareness, of the costs of environmental degradation and of the management tools available to address it, is low.

Environmental mitigation

The EAP describes several programmes to address the short-term environmental problems arising from conventional energy. This section prioritizes these solutions based on their environmental impact. Assuming, for simplicity, that the level of greenhouse gas emissions is associated with other forms of pollution, environmental activities can be prioritized by their potential to reduce greenhouse gas emissions (Table 5.3). Reduced emissions are associated with more efficient operation, which eventually leads to a reduction in investment. The WB estimated that improvements in the efficiency of system operation could lower sector investment requirements by about 10 per cent through the Eighth and Ninth Five-Year Plans.

Table 5.3 Carbon dioxide emission reduction potential for conventional pulverized coal plants (millions of tons a year)

[a] Huber M., Ruitenbeck J., and Seroa da Motta R., *Market-based instruments for environmental policymaking in Latin America and the Caribbean: Lessons from eleven countries*, The World Bank, 1996. Pp 39.

Technology	1997				2010			
	No change in technology	Reduction due to change in technology	Reduction as per cent	Net emissions	No change in technology	Reduction due to change in technology	Reduction as per cent	Net emissions
Coal washeries		19	6.3			37	5.4	
Restructuring and modern-ization		15	4.9			-		
Demand-side management						85	12.4	
Reduction of transmission and distribution losses		14	4.6			25.5	3.7	
Advanced technology						12.5	1.8	
Improved pulverized coal plants						30	4.4	
Total	303	48	15.8	255	684	190	27.8	494

Source. ***Environment Study*****, Asia Technical Department (ASTEN), World Bank, Washington D.C. 1995**

The specific measures that should be undertaken to reduce pollution from coal-based power generation are listed below.

Coal quality

Higher and more consistent coal quality will increase generation efficiency and plant availability. Energy conservation resulting from reduced transportation load will be an additional benefit. Today, about 70 per cent of India's steam coal is transported 500 kilometers or more. The action plan found that coal washeries should be constructed for the benefit of power plants, which often receive large quantities of extraneous material as a result of poor mining methods. State electricity boards are willing to pay a premium for washed coal, or even for coal of consistent quality. Washed coal reduces carbon dioxide emissions from 0.983 to 0.866 kilograms per kilowatt-hour. Even a one per cent improvement in plant capacity as a result of coal washeries will improve generation capacity by 600 MW by the end of the Eigth Five-Year Plan– a saving of $720 million. Assuming 80 million tons a year of coal-washing capacity, the investment potential for coal washeries by 2000 is $256 million. By 2010 this potential could double. The equivalent annual generation from washed coal will be 320 million MW, which represents an annual carbon dioxide savings of 37 million tons by 2010.

Modernization

The Eighth Five-Year Plan estimated that restructuring and modernization of thermal power plants during the plan period would improve plant efficiency and capacity. The programmes also included retrofitting of the plants to upgrade their environmental performance. These efforts would have realized savings of 3,150 MW equivalent generation capacity, or about five per cent of total generation capacity, by the end of the plan period. These efficiency plans, however, never fully materizliaed.

The carbon dioxide savings potential is estimated as 5 per cent of the 63,000 MW coal-based generation capacity. It could have been 15 million tons (assuming 55 per cent plant load factor and 0.983 kilograms of carbon dioxide emissions per kilowatt-hour). The potential investment savings would have been $3.8 billion.

Demand-side management

The WB identified 26 end-use technologies that, if implemented, could have saved about 20 per cent of total demand and 30 per cent of peak demand. One can assume that these measures will not be applied during the Eighth Five-Year Plan and that, through 2010, only 10 per cent savings will materialize. Accordingly, the generation capacity savings potential is 18,000 MW and the equivalent greenhouse gas saving is 85 million tons a year. The investment saving potential is $ 21 billion.

Air emissions from a utility are significantly affected by the electricity system's load curve, whose shape influences how different generating units are dispatched (their deployment and duration of use). Each unit has different emissions characteristics. The system load shape is determined by the demand patterns of various customer classes, which in turn are determined by the rhythm and pattern of customer lifestyles and economic activity, electricity tariff structures, the efficiency and size of end-use equipment, and substitution between electricity and other energy forms.

The environmental effects of changes in load shape and end-use efficiency depend on when and where these changes occur. In general, the environmental effects of energy efficiency measures depend on total energy savings,[a] resulting in changes in the dispatch of different units at the margin, and generation emission

[a] Fenichel, Anita. *Impacts of Demand Side Management Programmes on the Environment.* Alliance to Save Energy, Washington, DC, 1993.

factors. The interplay of all of these factors makes it difficult to generalize and predict the outcome of a given measure without knowing specific power sector characteristics.

In most Asian and Latin American countries with similar characteristics as our country, there is a large potential for reducing the electricity required to serve a given level of end-use need. Potential environmental benefits from energy conservation measures are typically not realized, however, due to a combination of market failures (e.g., uninternalized environmental costs), government policy distortions (e.g., energy subsidies and regulatory distortions), and other barriers (e.g., inadequate information, high discount rates, unobserved costs, principal-agent slippage, heterogeneity among potential adopters). Estimates vary widely (0 per cent – 20 per cent) as to the size of the energy conservation gap (defined as the gap between potential and actual energy savings), partly because of differing definitions of conservation potential.[a]

Power sector decisions can affect electricity-using equipment and usage patterns by setting electricity prices and tariff structure, and by promoting changes through demand-side management (DSM) programmes. The roles played by the government and/or the power sector in overcoming barriers to achieving the conservation potential, vary from country to country. Some programmes simply provide information about energy saving opportunities to customers; others share the actual investment in an energy saving measure with the customer or help to finance it. In addition to such customer-focused programmes, market transformation programmes works with trade allies such as equipment manufacturers to upgrade the overall efficiency of the equipment stock entering the market. Some countries with ministries or power sectors that have begun significant energy efficiency programmes include Brazil, Pakistan, Thailand, Mexico, Jamaica, and the Philippines.

In a few countries, vertically-integrated utilities have begun to conduct IRP (integrated resource planning) in which the utility identifies a portfolio of generation (supply side) and DSM resources that meet the future need for power on the basis of least cost. When a utility practices IRP, different tests may be applied to determine the cost-effective level of investment in end-use efficiency measures. Each test has implications for which energy efficiency measures are deemed cost-effective. While these tests were developed in the United States,

[a] Energy Modeling Forum, *Markets for Energy Efficiency*. EMF Report 13, Volume 1, Stanford University, September 1996.

they are beginning to be applied in developing countries, such as India.[a] (These tests were designed for use with vertically-integrated utilities; new tests may need to be applied to various reform scenarios.)

Energy conservation and efficiency

Investments in energy efficiency, on both the supply side and the demand side, generally have high rates of return and are far more cost-effective than expanding energy use without putting such efficiency investments in place. Since many energy efficiency investments are financially viable without regard to any environmental benefits, they are called “no-regrets” strategies for reducing emissions. A recent WB paper cites several studies that illustrate how, at current relatively low energy prices and with the present state of technology, a saving of 20-25 per cent of energy consumed in many developing countries could be achieved without sacrificing the economic benefits of energy use. This average does not apply equally to all Asian countries, but would certainly apply to those with transmission and distribution losses above 10 per cent, and with energy prices below production or international costs.

An efficiency gain of only 10 per cent by 2000 would reduce the level of new capital investment required by 20 per cent, or by $90 billion (50,000 MW). Not only are these savings enormous, they are three times what is required to install cleaner technologies on the remaining facilities that would still need to be constructed. Clearly, energy efficiency on both the supply and demand sides is an essential ingredient to any cost-effective and environmentally sensitive long-term growth plan in the energy sector.

Once suitable pricing and institutional reform has been achieved, efficiency on the supply side becomes possible through improved operations at the power plant itself and in the electricity transmission and distribution grid (see the following section). Efficiency on the demand side becomes possible through the

[a] See, for example, Parikh Jyoti, Reddy Sudhakara, and Banerjee Rangan, *Planning for Demand Side Management in the Electricity Sector*. New Delhi: Tata McGraw-Hill Publishing Company Limited, 1994.

Box 1: Demand-Side Management

One aspect of demand-side energy efficiency is called demand-side management (DSM). DSM commonly refers to programmes, policies, technologies, and rate structures that reduce or shift electricity demand. Power companies promote DSM as a way to reduce high marginal costs of generation. High marginal costs may relate to high peak loads, high fluctuations, or high capital growth requirements.

In order to minimize energy costs (and energy-related emissions), industry and commercial users must be encouraged to examine where and how electrical energy reductions can be made on a least- cost basis. Then, by altering management practices and investing in more efficient equipment – often in response to incentives offered by the power company – both the industry and power company benefit. DSM technologies include:

- Cogeneration plants, for simultaneous electricity and thermal production, typically in industry, for both onsite use and for resale back to the power company;
- Load management systems, which offer substantial load control to the power company at the system peak times;
- Energy management systems, which lead to reduced loads through increased efficiency;
- High efficiency motors and variable frequency drives;
- More efficient lighting and fixtures; and
- Building improvements, such as windows and insulation.

DSM programmes initiated by utility companies require that they fine tune their pricing (based on the time of day and season), initiate a DSM campaign, and possibly share the costs of energy efficient equipment through rebates to end users. Other measures include information centers to industrial and commercial consumers, and guaranteeing the purchase of excess electricity from private power generators.

DSM savings can be very significant. Two California (United States) companies have achieved efficiency gains of six-14 per cent over the past eight years (Nadel 1991). DSM programmes in the United States are projected to reduce demand by an average of three –seven per cent over the next decade. The projected U. S. savings are equivalent to 30 per cent of new capacity requirements over the same period and will reduce carbon dioxide emissions by about 150 million tons.

introduction of new technologies in the industrial, commercial, and residential sectors, such as new boilers, motors, electrical drive systems, motor controls, lighting, process modifications, and heating, cooling, and refrigeration improvements (Box 1). Minimum energy efficiency standards and energy awareness campaigns, have been effective in Japan, Korea, and China in achieving demand side efficiencies. Direct government involvement with industrial and commercial enterprises, supplemented perhaps by aggressive power company demand side management techniques, can help bring about efficiency changes that go beyond the effects achieved by market-based policies alone.

Advanced technology

Following improvements in coal quality and modernization of all coal-fired thermal power plants, the next logical step would be to introduce advanced power generation technologies. An additional 81,000 MW of coal-based production is envisaged by 2010. India is contemplating the installation of a 30-MW pilot project using integrated coal gasification/combined cycle technology. Assuming that 20 per cent of the additional capacity is using this technology by 2010, overall efficiency will improve by five per cent. Carbon dioxide emissions for this technology are estimated at 0.82 kilograms per kilowatt-hour; if 16,000 MW (20 per cent) are produced in this way carbon dioxide emissions will fall by 12.5 million tons (assuming a 55 per cent plant load factor). The five per cent efficiency improvement for conventional power plants will reduce emissions by 30 million tons a year.

Technical approaches to cleaner energy

After policy and institutional measures, the second basic approach to a cleaner energy sector is the pursuit of clean technologies on the supply side. As mentioned, pursuit of clean technologies is inadequate without the simultaneous pursuit of full-cost energy pricing. In the energy sector, clean technologies refer to a range of technical options, such as retrofitting existing plants, new conventional energy technologies, and investments in non-conventional energy.

Conventional thermal power

Whereas energy efficiency reduces all types of emissions, albeit on the margin, some level of emission specific investments in thermal power plants will be required to minimize energy emissions in Asia. The first three options listed below are fuel resource options, and the next few are power system options.

- *Coal beneficiation*: In India, some coals have such a high ash content (up to 40 per cent) that power plant thermal efficiencies have fallen to as low as 25 per cent, requiring the use of an additional 33 per cent coal to generate the power that would have been generated at more standard thermal efficiencies.

Coal beneficiation (i.e., grinding and washing) reduces the ash content significantly and removes other impurities to produce an optimal particle size for more efficient pulverized coal combustion. Other benefits include a lower moisture content and lower transportation costs. In China, studies have shown coal beneficiation to be cost-effective on the grounds of transport cost savings alone, quite apart from any environmental benefits.

- *Expanded development of natural gas resources and networks:* The use of natural gas instead of coal or a mix of the two reduces the quantity of CO2 emitted into the atmosphere. A 1,000 MW power plant fired with coal emits about 900 tonnes per hour (emission is 42 per cent less for a gas fired plant). Oil would emit 720 tonnes per hour (20 per cent less than coal). An added benefit of co-firing natural gas and coal is reduced NOx emissions. It is relatively easy and inexpensive to retrofit a boiler for natural gas – the principal issues are the cost and availability of natural gas.

There are large amounts of natural gas in India not being utilized for both economic and technical reasons. Strategies to increase the exploitation of these resources could have significant environmental benefits. The constraints to expanded gas utilization are its current lack of price competitiveness with coal, and partly as a result, the lack of investment in extraction and distribution.

However, as coal prices in India are raised to world market levels, and the environmental benefits of burning natural gas are considered, the use of gas for power production can be shown to be one of the least-cost strategies.

- *Pollution control retrofit*: To reduce power plant emissions, a wide range of options exists. Specific residuals call for specific technological interventions. For example, reducing acid rain emissions requires limiting the use of coal containing sulphur, and/or equipping power plants with flue gas desulphurization or similar sulphur removal technology. Removing NO_x emissions requires either catalytic reduction, which is 50–80 per cent effective, or more expensive atmospheric or pressurized fluidized bed combustion technologies. Reduced particulates are achieved through electrostatic precipitators, fabric (baghouse) filters, and wet scrubbers. Reduced greenhouse gas emissions require improved thermal combustion efficiencies, and cannot generally be achieved by add-on pollution control equipment.

The required level of investment in pollution control equipment depends on local standards, age of the plant and other plant-specific characteristics. For a typical coal-fired thermal power plant, the installation of the standard particulate control, desulphurization, and denitrification technologies commonly used in developed countries, add up to 20 per cent to the cost of electricity.

- *Power plant upgrades*: Power plant upgrades, or retrofits, usually mean the installation of new boilers, turbines and other major components to gain efficiency improvements, although less expensive improvements are also important. Low cost improvements imply the replacement of valves, gaskets, control sensors, conveyor belts and other items that frequently wear out. Taken together, these items can have a significant impact on overall power plant efficiency. Moreover, high-cost upgrades require major commitments of funds, including a major foreign exchange component.

- *Interregional transfer and dispatching*: Optimal dispatching and interregional energy transfer is not widely practiced in India. Improved dispatching can help reduce pollutants by putting on line, plants that pollute less, such as hydro power and gas fired facilities. In each country, additional study is needed to determine how much energy could be saved through improved transfer and dispatching, and to determine how this may be done on a practical basis.

- *Plant siting*: Zoning and site permits can minimize the local environmental impacts of power plants. In most Asian countries thermal power plants are located close to their load centers. The Singrauli area of India suffer from air pollution attributable to power plants. In China, nine new plants being built along the south-eastern coast will be located in part based on dispersion modelling, so as to avoid creating pollution “hot spots”. A strong environmental assessment process would provide a structured framework for due public and donor consideration before energy investments are made.

- *Private power*: Even though the power sector in India is mostly state-owned, there is a broad range of ownership and control. Some enterprises are direct government undertakings, some are government corporations under special statutes, and some are government companies governed by normal company laws. It can be assumed that power utilities in India will remain largely State owned for a number of years to come. Privatization will consist of partial rather than complete sale, such as divestiture of selected assets, or privatization of management and/or service functions. A main reason Asian countries are taking even these steps is to help mobilize the huge investment resources required for expansion.

There is a modest trend in India toward private power investments. Evidence shows that early private investors have succeeded in part because they introduced efficient innovations, such as “slip-form” technology in the construction phase, computer applications, and gas-fired turbines. Private power is, and should be, increasingly encouraged through laws and financial incentives. The incentives required to develop a private power industry are: (a) guaranteed purchase of the energy by the utility, and (b) a fair basis for determining the price paid by the utility.

In some circumstances, privately owned renewable systems – primarily wind farms and mini-hydro power – are cost-effective investments to feed directly into national grids. In India, for example, a non-subsidized fund designed to encourage investment in wind farms has already solicited 20 applications for installations ranging from 200 kW to 20 MW. As part of this effort, the Indian government has offered fair rates for purchased energy, and 100 per cent depreciation of investment in the first year. India is estimated to have a maximum potential of 20,000 MW of wind resources, equivalent to one quarter of its 1992 power sector installed capacity.

The benefits of private power from the environmental perspective are due to higher sectoral efficiency, not to any inherent private sector willingness to spend more on the environment. If regulations are not properly enforced, private power providers are not necessarily cleaner than public sector counterparts.

Renewable energy

Renewable energy sources are improving in cost competitiveness with conventional energy. For India, the most promising technologies are small and medium-scale hydro power plants (a few MW to 100 MWs, which are less detrimental to the environment than large dams), photovoltaics, solar thermal, wind, and geothermal installations. These technologies are well developed and there is a great deal of technical and economic experience upon which to draw. Renewable energy production is limited by the natural resources available, such as sunlight, rivers, wind, and biomass, and renewable installations are always very site-specific. Most renewable systems, other than biomass, have less environmental impact than conventional energy. Each kilo-watt hour of photovoltaic, wind, or hydro power avoids production of 1.3 kilogramme of CO_2.

Environmental implications of major types of reforms

Power sector decisions that effect environmental performance include the choice of fuel and technology for new power plants, operation and maintenance practices for the sector, investment in transmission and distribution equipment, tariff structure, promotion of customer end-use efficiency and load management, and investment in commercializing new power system technologies. Reforms have an impact on environmental performance as provided in Annexure 5.1.

When the environmental performance of a publicly owned and operated power sector is poor, reforms generally bring improvement. Still, environmental considerations are at best secondary when policy makers are deciding which reforms to adopt and how to implement them. Moreover, many developing countries lack the capacity for developing and enforcing environmental regulations.

Of the major types of reform, some have both economic and environmental benefits, while others represent tradeoffs. With some exceptions, the environmental benefits of commercialization, privatization and regulation appear to be stronger then those of unbundling and the introduction of competition.

Role of independent regulation

Integral to privatization is separating the regulatory/policy role of the government from its commercial/operational role through the creation of an independent regulatory body. Where the private sector assumes direct tariff responsibility, transparent approaches to price regulation are required. Independent tariff regulation over those components of the power sector remaining in monopoly control is commonly associated with any package of reforms that includes privatizing monopoly services. In addition, regulators may issue licenses for new generation and other assets, and establish rules governing the operation of wholesale or retail power markets.

The regulator's responsibilities depend on the political philosophy prevailing in a given country. At one extreme, the regulator's responsibility might be to simply get prices right, then step aside and let the market work. Here, the basic objective of regulation is to mimic the effects of competitive markets – ensure that utilities earn a return comparable to their cost of capital and have incentives to operate efficiently. Alternatively, if the view is that the power sector remains subject to market failures such as environmental externalities (which are pervasive in many developing countries), the regulator's responsibility might include correcting or offsetting such failures.

Several types of price regulation have evolved around the world, each of which creates a different set of incentives for utility behaviour. In the United States, rate of return regulation has dominated historically. Under this approach, utilities are allowed to earn a specified return on their capital investments. However, over the past ten years, various state public utility commissions have been experimenting with alternatives to rate of return regulation that seek to improve utility incentives for efficiency or meet other performance objectives. For example, some states have tried to give utilities equivalent incentives (revenue neutrality) to acquire supply- and demand-side resources.

In contrast, the price cap approach fixes allowed electricity prices for longer periods of time than generally occurs with rate of return regulation. Price caps often include an upward adjustment each year to account for inflation, but also a downward adjustment to provide an incentive for the utility to improve productivity. The revenue target approach is similar, but focuses on controlling revenues rather than prices. Regulators set an allowed level of revenues based on actual costs for a test year. Over time, this level can also be adjusted for inflation and productivity. The allowed level of revenues may change to reflect increases or decreases in kWh sales levels.

Some other issues that can be addressed by an independent regulator are listed below. However, one need to be conscious of the fact that some of the issues enlisted necessarily require a much developed power market in operation, hence, might not be of immediate relevance to the Commission.

- ***Include environmental performance as criterion to select winners*** when weighing bids for transferring generation and other power sector assets to private ownership. If bids for privatizing assets are solicited through a competitive process, bid selection should include environmental criteria, such as investment in pollution controls. Poland's Ministry of Privatization considers environmental criteria in weighing competing bids for enterprises being privatized. If competing bids are roughly equal under financial criteria, environmental criteria could be used to tip the balance towards the more environmentally-friendly bid.

Including such criteria will increase the likelihood that the price paid for assets will reflect the future investment needed to address environmental problems. As a prerequisite, governments should require a third-party environmental audit of power sector assets to determine the investment required to bring the sector to national or international standards. In addition, the privatization entity could establish provisions that examine past environmental performance. A bidder for a privatization would be disqualified if it has a poor environmental record either in the host country or other countries, as evidenced by fines, prosecutions, etc.

Moreover, public access to information on the environmental characteristics of power system assets should be required prior to and after privatization. Without an independent regulatory body, the transition from public to private ownership may take investment and operational decisions out of the public eye. Full public disclosure of environmental information will help ensure that environmental criteria are included in these decisions.

- ***Use the privatization process to leverage improved environmental performance.*** The incentive that private developers and investors have to minimize risk could be used to improve the environmental performance of privately developed generating capacity. The need for formal contractual arrangements between private companies and governments means that various approvals and clearances (including environmental) will be required for power plants, even if they are not under government ownership. A pre-condition for private power development is the presence of stable and transparent policies. From the perspective of developers and their financiers, even stringent regulations may be preferable to an uncertain regulatory environment.

The incentive that strategic investors have to minimize project risk represents an advantage for environmental improvement. To use this leverage, new legislation may be needed to allow environmental ministries or other stake holders to become involved in negotiating terms of asset transfer with investors. The point of leverage at the time of divestiture is how responsibility for environmental problems will be allocated between the buyer and the government selling the asset, and the extent to which such problems will affect the company’s price or transferability.

In addition, more stringent environmental regulations imposed on new private generation should be exploited given their positive spill over effects on other power plants. Where a country’s generating capacity is to be owned by a combination of public utilities, private utilities, self-generators and IPPs, environmental requirements and incentives for complying with them should be consistent among all owners.

- ***Allocate part of the privatization proceeds to finance sustainable energy investments.*** While the new private owners may improve the environmental performance of the power sector as a side effect of overall managerial improvements, they are less likely to invest in environmentally superior technologies with long-term paybacks. Moreover, privatization officials are often reluctant to impose what they consider extraneous conditions on the buyer for fear of jeopardizing the price received from the sale. Developing country governments might, for example, allocate a portion of the proceeds from the sale of public distribution systems to an account that would become available to the new owners or other entities for using renewable resources to electrify rural areas.

- ***Draft model power purchase agreements to avoid bias against environmentally-superior technologies.*** Model PPAs can be drafted that provide incentives for the selection and operation of environmentally superior technologies. Provisions might include: 1) Premium rates for projects whose environmental performance exceeds national standards and/or penalties for poor performance, 2) Payment terms (such as front-end loading) that do not discriminate against environmentally-superior, but capital intensive generating options with comparable life cycle costs to environmentally-inferior options, between power suppliers and purchasers.

As one example of the last provisions, PPAs could specify which party to the agreement would bear the risk of possible environment policy changes, such as a carbon tax, which could increase a project's future operating costs. While the timing and nature of such carbon restrictions are still uncertain, this risk is quite real, especially over the 40-year lifetime of thermal power projects. Because this risk has an associated economic value, the choice of generation may be affected. With such a provision, if carbon restrictions are imposed in the future, both parties would have to agree to renegotiate the agreement.

- ***Enact laws and regulations that clarify and strengthen the responsibilities of private distributors for rural electrification.*** This will help encourage the development of distributed resource options (including renewable energy). Key decisions in privatizing distribution services include drafting the terms of the utility's sale, criteria for awarding bids, the distribution concession contract, and the subsequent regulation of the concessionaire. The sequence of decisions affects the new owner's technology choices for electrifying rural areas. Because the government retains more leverage over rural electrification prior to privatization of the utility, it should specify at least some fundamental rural electrification requirements in the privatization bidding documents it issues. Then all bidders could assess the associated costs and risks and factor them in to the dollar value of their bids. Beyond minimum requirements, bid evaluation criteria could include business plans for serving off-grid areas in a least-cost manner. Once the contract is awarded, the state could allow a higher return if the concession meets specified performance objectives relating to rural electrification.

Introducing wholesale competition

- ***Require wholesale power markets to consider the environmental characteristics of competing generators.*** Environmental and related operating characteristics could be explicitly included in criteria for evaluating bids for long-term power purchases in short-term markets. The wholesale purchaser could require competing bidders to specify how they would meet a set of performance standards. For example, a thermal plant efficiency standard would require wholesale power sellers to maintain specified heat rates (i.e., 10,000 Btu/kWh or below). If thermal efficiency falls below such a standard, the generation supplier would be required to offset the shortfall with other units that are more efficient than the standard.

Incorporating the environmental characteristics of thermal plants into the operation of spot or short-term markets would require different approaches. One option, which focuses on prices rather than standards, would have the power system operator determine generation dispatch priority based on social marginal costs. Such calculations would include fuel, variable O & M, and external environmental costs (as determined by government regulators). Social cost dispatch would strengthen the incentives of merchant plant developers to choose technologies and fuels with low emission factors.

Retail competition

- ***Create incentives for retail electricity suppliers to promote demand reduction measures.*** For countries introducing retail competition, the new market rules should allow competition for energy service rather than kilowatt-hours. Under these rules, competing retail service providers could offer electricity supply combined with efficient end-use equipment and energy management services.

- ***Ensure that investments in commercializing environmentally superior technologies continue to be made in a competitive power sector.*** Regulators should create mechanisms that assure continued funding to bring environmentally superior technologies to commercial maturity. One policy being adopted in the United Kingdom and California is a system benefit charge, assessed on customers by retail electricity suppliers. Such charges have been proposed in order to recover "stranded benefits" – those investments providing benefits to electric customers that might not otherwise be undertaken by the separate firms in a reformed power sector, especially under retail competition. The objective of this charge is to recover certain costs from all retail electricity customers, regardless of the company from which they purchase generation services (non-bypassable). The charge may be used to fund low-income programmes, energy efficiency, renewable energy technology development, or other environmental initiatives. Explicit governments bodies may need to be created to carry out these initiatives. Such bodies have been created to act as policy advocates for energy efficiency in New Zealand, England, and Wales.

Unbundling

- ***Ensure equal access to transmission capacity among all types of generation where transmission services become common carriers***. Transmission rate structures should not be biased against intermittent renewable capacity. Comparable transmission pricing would help overcome barriers to intermittent or low capacity factor-renewables. If the demand component of transmission charges is based on the generation facility's capacity equivalence (e.g., an average level of coincident peak capacity output per month) rather than the maximum rated capacity, then intermittent resources would pay their fair share for transmission costs. The energy component of transmission costs should be based on some fraction of total investment in the transmission grid.[a]

- ***Create incentives for distribution and retail components of unbundled power sectors to fully consider distributed resource options for providing electricity services.*** Relative to a vertically-integrated utility, an unbundled power sector should ideally have an equal or stronger incentive to consider the distributed resource paradigm. To serve this end, regulatory authorities should

[a] Rosen, Richard, Woolf Tim, *et al.*, *Promoting environmental quality in a restructured electric industry*. Prepared for the National Association of Regulatory Utility Commissioners. Tellus Institute. Boston, MA, 1995.

require electricity distributors to analyze distributed resource options in resource planning and acquisition, on a least-cost basis. Doing so will first require distribution companies to collect information on area- and time-differentiated marginal costs of service, including generation, transmission, and distribution costs. Because most utilities do not currently have the capability to collect this information, regulators may need to develop model least-cost analytic procedures and provide training to utilities. This would allow a more accurate analysis of the cost-effectiveness of renewables, dispatchable DSM measures, and other distributed resource options.

- ***Consider adopting a renewable energy portfolio standard that is imposed on retail providers of electricity services.*** One type of initiative for encouraging the acquisition of renewables is to adopt a renewable portfolio standard. Under this approach, retail or wholesale electricity suppliers might be required to purchase a minimum amount of their generation needs through long-term contracts with renewable developers based on competitive bidding (the UK's NFFO – non fossil fuel obligation approach) or to use renewables for any generating capacity they develop themselves (the Bolivian approach). A version of this being debated in the United States would create a "renewable energy credit" each time a kWh of electricity is generated from a renewable energy source. All retail suppliers would be required to obtain these credits equal to some percentage of the power they sell.

- ***Adopt electricity tariff structures that provide appropriate price signals.*** The use of regulatory alternatives to price caps will reduce the retail supplier's incentive to maximize electricity sales. Undertaken in Northern Ireland and New South Wales (Australia), revenue capping in regulation would help remove the volume incentive for monopoly suppliers.

Regulators should also craft retail rate formulas that are at least neutral with respect to generation technology. For example, fuel cost pass-throughs should be avoided along with other practices that differentially treat the risks associated with different generating options. However, rate making could go further. Performance-based rate making can be designed to explicitly encourage the acquisition of target levels of renewable resources. Retail suppliers could be encouraged to develop a diverse portfolio of resources based on rate bonuses or penalties. Performance-based regulation can also create incentives for retail service providers to invest in demand-side management by decoupling profits from sales.

Finally, time-of-use and area rates would give appropriate price signals for end users to consider energy-and demand-reducing measures. Time-and location-differentiated rates could be used first in bringing service to unelectrified regions and phased in for grid-connected regions.

Annexure 5.1

Summary implications of power sector reforms on environmental performance

This table summarizes how different reforms affect generation choice and supply-side efficiency and the extent to which they reduce end-use consumption.

(⇑ = Environmentally favorable, ⇓ = unfavorable, = depends on implementation)

Reform	Effects on generation technology and supply-side efficiency	Effects on end-use efficiency
Commercialization	Better cost accounting reduces waste ⇑ Improved operation of generation, transmission, and distribution system reduces energy losses ⇑	Customer efficiency incentives strengthened by tariff reform and improved revenue recovery ⇑
Privatization	Separation from government allows independent regulation of environmental performance ⇑ Generating capacity increased by private power development ⇓ Which reduces diesel self-generation ⇑ Off-grid renewable generation boosted by removing subsidies for grid extension ⇑ Generation, transmission, and distribution assets upgraded by private capital ⇑	Customer efficiency incentives improved by stronger attention to cost recovery and subsidy removal ⇑ Reduced cost-effectiveness of utility end use efficiency investments due to higher discount rate ⇓
Unbundling	Deployment of distributed generation depends on ability to capture system-wide benefits Equal access to transmission system by renewable power projects depends on contract terms Profit motive of transmission and distribution providers reduces energy losses ⇑ Non-renewable generation favoured by power purchase terms ⇓	Customer incentives to invest in efficiency improvements depend on how upstream costs are reflected in bills Retail supplier investment in efficiency improvement depends on treatment of capacity, fuel, transmission and distribution costs
Wholesale competition	Low capital cost, dispatchable generation rather than renewable generation favoured by short-term markets ⇓ Highly-efficient fossil fuel generation technologies favoured by short-term markets ⇑	Customer efficiency incentives weakened when competition lowers prices and makes future economic benefits less certain ⇓
Retail competition	Low capital cost generation favoured by retail competition ⇓ Reduced incentives to invest in R&D on environmentally – superior technologies ⇓	Rate cap regulation creates incentives to maximize kWh sales ⇓ Customer efficiency incentives weakened by ability to switch to lower cost supplier ⇓ DSM services may be

offered to stand out from competitors ⇑