4 Using energy efficiently

Energy is essential for meeting basic human needs, for economic growth, and for social development. India is well aware of the challenge of providing access to modern energy services to its population in a sustainable and environmentally-benign manner. The country's development plans also lay emphasis on energy conservation and efficiency improvement. The following path-breaking steps have been taken with respect to the production, distribution, and use of energy.

Cleaner power from fossil fuels

The country recognizes the critical need to minimize environmental problems arising from the production and use of coal, the single most important source of energy in India. More efficient use of coal is being encouraged through legislative, financial, managerial, and technological interventions, thereby contributing to GHG mitigation. Key technological interventions being promoted in the country include the following.

- CBM (coal-bed methane) recovery and commercial utilization
- New methods for coal beneficiation
- Advanced technologies for power generation
- Control of mine fires
- Energy conservation.

The development of CBM recovery started in India almost at the same time as in China and Australia. Methane is a highly potent GHG compared to CO_2, but is a remarkably clean fuel when burnt. Its combustion produces no sulphur dioxide or particulates, and only about half the CO_2 associated with coal combustion. For harnessing CBM, a pilot-scale demonstration project has been undertaken by the Ministry of Coal with funding from the UNDP (United Nations Development Programme) and GEF at two mines in the Jharia coalfield. In addition, seven blocks have been awarded for development through competitive bidding by the Ministry of Petroleum and Natural Gas. It is estimated that exploitation of CBM from the awarded blocks can yield around 20 million cubic metres of methane for 25 years, which is equivalent to approximately 4600 MW of power generation capacity.

Considerable attention has also been given to coal beneficiation for power generation. Indian coal is characterized by high ash content and low sulphur content. An MoEF notification requires the use of beneficiated/blended coal (with ash content not exceeding 34%) in power plants located beyond 1000 km from pitheads, and those located in critically polluted areas, urban areas, and ecologically sensitive areas. The reduction of ash content from 41% to 34% is estimated to result in the following benefits.

- Reduction in diesel fuel demand for rail transport of coal and 15% reduction in CO_2 emissions annually
- Reduction in stack emissions of 131 000 tonnes of CO_2 annually for a 1000-MW thermal power plant.

Use of beneficiated coal leads to various improvements in the performance of thermal power plants, which contribute towards reduced CO_2 emissions per unit of power generated. For every 10% reduction in feed coal ash content, the following benefits can be expected.

- 10% reduction in auxiliary power consumption for every 10% reduction in feed coal ash content
- 50% reduction in support fuel requirement
- 1.5% improvement in thermal efficiency
- 5%–10% increase in plant load factor
- 20% reduction in operation and maintenance costs.

The NTPC (National Thermal Power Corporation) established a Centre for Power Efficiency and Environmental Protection in 1994, to assist utilities in reducing CO_2 emissions. The Technology Information Forecasting and Assessment Council established under the Department of Science and Technology facilitates the transfer of environmentally sound technology. It has conducted a study on clean coal technologies, which are critically important given the large share of coal-based power generation in India, and the high ash content of Indian coal. Advanced fossil fuel technologies like fluidized bed combustion, IGCC (integrated gasification combined cycle), and circulating fluidized bed combustion are being assessed, and a feasibility study for a 100-MW IGCC unit has been undertaken by NTPC.

The Indian government has taken a number of steps for controlling fires and subsidence in coalfields. Environmental Monitoring and Subsidence Control schemes have been taken up in Raniganj and Jharia coalfields for controlling fires (MoEF 2002). Energy conservation measures in mines include the following.

- Introduction of in-pit crusher and conveyor technology in opencast mines to reduce consumption of diesel oil
- Proper design of underground roadways and ventilation circuit to minimize overall resistance
- Re-organization of pumping layout in mines with high-efficiency pumps.

The use of fly ash generated by thermal power plants for bricks, cement, roads, etc. is being encouraged. In addition, preservation and generation of forest cover is also undertaken in mining areas.

The Indian government's Accelerated Power Development and Reform Programme provides assistance to states for R&M (renovation and modernization) of old stations and upgradation of sub-transmission and distribution networks. An extensive R&M programme for 163 thermal-power-generating units has been implemented successfully, resulting in improved fuel efficiencies (MoEF 2002). All these steps are complemented by the introduction of demand-side management measures like time-of-day tariffs and metering.

Greening coal mines and power stations

The NLC (Neyveli Lignite Corporation) is making remarkable efforts to utilize mine spoils for cultivation of crops. In a project funded by the Ministry of Coal, and implemented with the Annamalai University, trials were carried out for cultivation of paddy, sugarcane, maize, and finger millet. Nearly 165 ha of mine spoil were taken up for reclamation till July 2002. To improve soil fertility, a bio-fertilizer plant (with a capacity of 100 tonnes per annum) and a humic acid plant (with a capacity of 20 tonnes per annum) have been installed. The NLC also utilizes dry fly ash from its thermal power stations for cement and brick manufacture, and is developing green covers in abandoned ash ponds.

Over the last three decades, the share of natural-gas-based power in the thermal mix has increased from 2% to 14.5%. The country has also been actively exploring the possibilities of strengthening international and regional cooperation for cleaner energy. It is providing technical and financial assistance for hydropower projects to Nepal and Bhutan.

Energy conservation and efficiency improvement

Improvements in energy efficiency have been targeted through a mix of market instruments and traditional command-and-control measures.

Under the Energy Conservation Act, 2001, the BEE (Bureau of Energy Efficiency) has been set up to facilitate and enforce efficient use of energy. The mission of the BEE is to institutionalize energy efficiency services, enable delivery mechanisms in the country, and provide leadership to energy efficiency in all sectors of the economy. The primary objective is to reduce energy intensity by the following means (BEE 2002).

- Providing leadership and a policy framework to national energy conservation and efficiency efforts
- Taking energy efficiency and conservation policies and programmes to stakeholders in a coordinated manner
- Establishing systems and procedures to measure, monitor, and verify energy efficiency results in individual sectors as well as at the macro level
- Leveraging multilateral, bilateral, and private sector support in implementing the Energy Conservation Act and energy efficiency and conservation programmes

- Demonstrating delivery of energy-efficient services through private–public partnerships
- Interpreting, planning, and managing energy conservation programmes as envisaged in the Energy Conservation Act.

The functions of the BEE are as follows.

- Recommend energy consumption norms and standards
- Make energy audits mandatory
- Impose penalties for non-compliance
- Create awareness and disseminate information for efficient use of energy and its conservation
- Promote R&D in the field of energy conservation
- Provide financial assistance to institutions to promote energy efficiency
- Implement international cooperation programmes relating to energy efficiency.

In the Indian refining industry, the following energy conservation measures have been adopted to reduce fuel consumption and GHG emissions.

- Increasing efficiency of furnaces and boilers
- Increasing recovery of heat
- Using cogenerative captive power plants, IGCC technology, and energy-efficient equipment

Success stories in Indian industry

India's cement industry is the second largest in the world in terms of installed capacity, accounting for nearly 6% of the world's cement production. Cement manufacture technology in India has undergone a sea change over the last few decades. Today, more than 90% of the installed capacity is based on energy-efficient and environment-friendly dry process technology. With thermal energy consumption in the range of 680–700 Kcal/kg clinker and electrical energy consumption of 70–75 kWh/tonne cement (for ordinary Portland cement), some of India's modern plants can be compared with the best operating plants in the world.

India's fertilizer industry has also witnessed many changes in technology and feedstock over the last four decades, resulting in substantial improvements in overall efficiency of energy use. Most new plants set up during the last decade incorporate state-of-the-art technologies, while old plants have improved their performance significantly. Ammonia production accounts for more than 80% of the total energy consumed in manufacturing the finished fertilizer product. During 1979/80 to 1996/97, overall specific energy consumption of ammonia plants declined from 14.8 Gcal/MT to 10.9 Gcal/MT, while capacity utilization improved from 63% to 90%.

Source TERI (2001)

Sustainable mobility

Transport sector policy in India is guided by the goals of increasing the share of public transport in meeting urban travel demand, introducing modern and energy-efficient technologies, checking the decline in the modal share of railways, and augmenting the capacity of other modes, such as inland waterways and coastal shipping.

To encourage an increase in the share of public transport, greater private participation is being allowed in the sector and the operations of public transit providers are being restructured. The liberalization of the licensing regime in the early 1990s resulted in the introduction of a number of fuel-efficient vehicles in the car and two-wheeler segments. The use of electricity- and battery-operated vehicles is also being explored.

Dramatic improvements in emission norms for all types of vehicles have taken place since these were introduced in 1991. Vehicles of a certain vintage, which have high utilization rates, are not permitted to operate in the city of New Delhi unless retrofitted for use with cleaner fuels. Progressively stringent vehicle emissions norms (Bharat Stage I and II) have been introduced alongwith cleaner fuels in major cities. Compressed natural gas has been introduced for use in commercial vehicles in Delhi and a few other states.

- Reducing hydrocarbon losses through emission control equipment to control fugitive emissions and conversion from fixed- to floating-roof tanks
- Reducing steam/utility consumption
- Using natural gas, hydrogen-rich fuel gas, and low sulphur crude oil
- Using low-NO_x burners, hydrocracker, and thermal deNO_x technologies
- Installing sulphur and flare gas recovery units.

The use of such measures has improved the overall energy efficiency in the Indian refining industry, equivalent to annual fuel savings of about 2 million tonnes.

Extensive work on energy efficiency and technology upgradation in the oil and gas industry is carried out by the R&D centres set up by the Indian Oil Corporation Ltd, the Oil and Natural Gas Corporation Ltd, and the Centre for High Technology under the Ministry of Petroleum and Natural Gas. The Petroleum Conservation Research Association, a society funded by the oil companies, undertakes conservation programmes, including adoption of efficient engines and spreading awareness about fuel-efficient driving habits, energy audits and oil diagnostic studies in industries,

standardization of fuel-efficient irrigation pump sets, development of fuel-efficient domestic appliances, etc. (MoEF 2002).

Measures to improve energy efficiency in industry include promotion of fuel-efficient practices and equipment, replacement of old and inefficient boilers and other oil-operated equipment, and fuel switching and technology upgradation. Fuel-efficient equipment/appliances such as kerosene and liquefied petroleum gas stoves, compact fluorescent lamps, and pumps for lifting water in high-rise buildings are also being promoted in the residential sector. Significant measures in the agriculture sector include increase in agricultural tariffs in many states, move towards metering of energy consumption by agricultural consumers, and programmes to support rectification of pump-sets.

Since the introduction of economic reforms in 1991, the administrative pricing system for coal has been dismantled in phases, and prices of all grades of coal have now been deregulated. Similarly for the oil industry, the phased dismantling of the administered pricing mechanism began in 1998, with complete deregulation of the sector in 2002. A number of states in the country have embarked on the process of electricity sector reform with transfer of tariff-fixing powers from the government to an independent regulator, and rationalization of the tariff system. All these policy changes, along with increased private sector participation in the energy sector, provide the right signals for discouraging inefficiencies in the generation and use of power, promoting technological innovations, and encouraging the use of non-conventional energy sources.

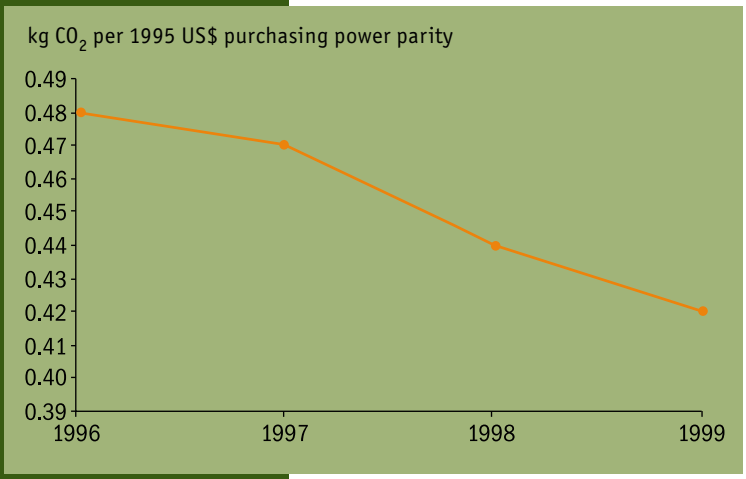

Figure 5 CO_2 intensity (emissions from fossil fuel combustion) of gross domestic product in India
Source IEA (2001)

These efforts to improve energy efficiency in various sectors, along with shifts to cleaner forms of energy, have helped contribute towards a decline in India's CO_2 intensity of GDP (Figure 5) in recent years.