Chapter 8

Summary and Conclusion

To summarize the study conducted on Energy Infrastructure in India from 1973-2005, it has been observed that with 15 per cent of the world’s population and an economic growth rate that increases the aspirations of its people to better quality of life, India has a voracious appetite for energy. But the country lacks sufficient domestic energy resources, particularly of petroleum and natural gas, and the gap between production and consumption about 38 per cent is being met through imports.

Summary

The trend and pattern of resources, production and consumption of energy resources in the country, recapitulate that India’s energy-mix comprises both non-renewable (coal, lignite, petroleum and natural gas) and renewable energy sources (wind, solar, small hydro, biomass, cogeneration bagasse etc.). Coal, by far, is the largest source of energy which is available in abundance. The changes in the reserves over time indicate the research and development going into the discovery of new reserves and the pace of their exploitation, thus facilitating in devising effective conservation and management strategies for optimal utilization of these resources. However, the distribution of both non-renewable and renewable energy resources in the country was found to be skewed.

To evaluate the trends and patterns of growth of different energy resources, the latter were converted into Million Tonnes of Oil Equivalent (MTOE), a commonly used measurement of energy. Considering the trend in production and consumption of energy sources from 1973-74 to 2005-06, it has been observed that on the one hand, coal production in India increased from 78 MTs to 406.81 MTs during the period 1973-74 to 2005-06.
2005-06, with a CAGR of 5.13 per cent, while consumption went up from 77.66 MTs to 432.27 MTs in the same period, with a CAGR of 5.3 per cent. The consumption of crude oil registered a higher compound growth rate of 5.69 per cent (20.96 MTs in 1973-74 to 130.11 MTs in 2005-06) as compared to a CAGR of 4.65 per cent in the case of domestic production. While production CAGRs for natural gas and electricity were 9.30 per cent and 7.79 per cent, respectively, consumption has outgrown production with a CAGR of 11.87 per cent and 7 per cent respectively. Natural gas has emerged as one of the most significant conventional sources of energy, recording the highest CAGR.

Accordingly, gaps existed between production and consumption of commercial energy sources, the former growing at a CAGR of 4.72 per cent and the latter at a CAGR of 5.80 per cent. The resource augmentation and growth in energy supply have failed to meet the ever increasing demand exerted by the multiplying population, rapid urbanization and progressing economy. Hence, serious energy shortages continue to plague India, forcing it to rely heavily on imports.

The resource-wise commercial energy analyses revealed that Coal is the most abundant conventional source of energy in the country having a share of 54 per cent in the total commercial energy consumption. However, the average quality of the Indian coal is poor due to high ash content and low calorific value compared to those available in Australia or Canada. Further, the coal washing capacity in the country has not increased sufficiently to generate the required quantity of washed coal for consumption, particularly in steel plants, necessitating the requisite import of high quality coal. This is evident from the fact that the gross import of coal steadily increased from 20.93 MTs during 2000-01 to 24.19 MT in 2006-07 and further to 73.26 MTs during 2009-10.
In the context of crude oil, the country is highly dependent on the import of crude oil. There is negligible export of crude oil from India. The net imports of crude oil increased from 11.68 MTs during 1970-71 to 163.59 MTs during 2010-11. In 2004, India imported 68 percent of its oil and this dependence has increased to more than 70 per cent in the recent years. According to the Approach Paper for the Twelfth Five Year Plan, released by the Government of India, nearly 78 per cent of the demand for crude oil would be met through imports by 2016-17. With only 0.4 percent of the world’s proven reserves and production, available for consumption in 2030, as estimated by the International Energy Agency (IEA), the dependence on foreign oil in case of India is projected to grow to 91 percent by then. The country has also started importing liquefied natural gas since 2004.

Despite a manifold increase in the installed generation capacity of electricity, the country has failed to meet power sector targets by a significant margin. The achievement in generating capacity has fallen short of the targets in the entire planning process of 60 years except during the Seventh Five Year Plan when the achievement has been noted at 97 per cent. The slippages in the power generation are due to a host of factors ranging from shortage of fuel or fuel availability (especially thermal projects), shortage of equipment to the delay in financial closure, land acquisition problems, environmental clearances, financial risk, manpower shortages and inadequate preparedness of projects. Moreover, the Hydro projects also facade issues like rehabilitation and resettlement, security clearances, financing, availability of hydrological data and power evacuation. The distribution segment is facing impediments in terms of operational efficiency as well as financial performance. The slow pace of

\[\text{81 Before the release of the Twelfth Five Year Plan, the Government of India has released the Approach Paper to the Twelfth Five Year Plan in the year 2011 providing the strategy of the Government for achieving a faster, inclusive and sustainable economic growth.}\]

investment generation in the distribution infrastructure can be attributed to the severe cash flow problem associated with the under-recovery of costs and poor collection efficiency. The distribution utilities have poor operational efficiency which further aggravates the situation imposing a heavy burden on the economic resources of the respective state governments. On an average, the country loses about 26.15 per cent of electricity in terms of Aggregate Technical and Commercial losses in the year 2010-11 as compared to a level of 32.54 per cent in the year 2002-03. The total losses incurred by the distribution companies, taken together were estimated at about Rs 40,000 crore in 2009-10 as compared to Rs. 24,063 crore during 2001-02. These are likely to rise to even higher levels because of the increasing share of short-term purchase of power at high prices. According to the Thirteenth Finance Commission Report, the losses of the distribution companies are expected to increase to Rs. 1,16,000 crore in 2014-15. The rate of return of the distribution utilities has deteriorated from a level of 32.8 per cent in 2001-02 to 14.3 per cent in the 2008-09.

Although there has been a gradually increasing dependency on commercial fuels, a sizeable amount of the national energy requirement, especially in the rural household sector, continues to be met by non-commercial energy sources (30 per cent share in the total energy consumption of the country). These include fuel wood, crop residue, and animal waste, as well as human and draught animal power. Future economic growth will lead to a rapid increase in demand for commercial energy due to rapid urbanization, and adoption of modern lifestyles.

Due to the increasing demand-supply gap, especially as population increases; large untapped potential of renewable sources of energy; environmental issues regarding burning of fossil fuels; the need to strengthen India’s energy security; and the need for a viable solution for rural electrification, the Government of India has taken numerous steps
to develop renewable sources of energy. In April 2002, renewable energy based power generation installed capacity was 3475 MW which was 2 per cent of the total installed capacity in the country. As on 31.12.2010, it has reached 18,655 MW, which is about 11 per cent of the total installed capacity of 1,68,945 MW and corresponds to a contribution of about 4.13 per cent in the electricity mix.

An attempt was also made to study the relationship between economic growth and energy consumption to see the impact of energy consumption on GDP of the country. Our assessment through the Johansen’s Co-integration Technique and Vector Error Correction model demarcated that energy consumption (in totality and resources-wise) does have a long-run relationship with the economic growth of the country exerting a significant impact on its GDP, as it has a unidirectional relationship with the economic growth. The energy consumption is also influenced by the accelerating population growth rate as it adversely affects the long-run energy demand. The increasing import dependency of energy resources imposes a high financial burden on the country and makes the economy vulnerable to global oil price shocks, raising increasing concern about India’s energy security.

The assessment of energy policies have shown that India’s energy sector has consistently adopted relevant new policy legislations, technologies, structural shifts to support the increasing demand for energy resources due to higher economic growth.

The policy landscape in India has progressively evolved since Independence, and has led to radical changes in the energy sector, especially in terms of competition, private sector involvement and focus on green energy over the last decade. During the pre-reform period, the commercial energy sector was totally regulated by the government. The economic reform and liberalization, in the post 90s, has gradually
welcomed private sector participation in the coal, oil, gas and electricity sectors in India. The Government of India has allowed greater individual initiatives and, importantly, foreign direct investment. Federal and state-owned companies still dominate the energy industry, but the private sector is actively capturing market share and even investing in the state-owned companies. Energy prices in India are administered with subsidies provided to meet certain socio-economic needs of the public resulting in distortion and inefficiency in energy utilisation. The government has taken serious steps to deregulate the energy price from an Administered Price Mechanism (APM) regime to market driven mechanism. The prices of all grades of coal and petroleum products have already been deregulated. In the electricity sector, most of the State Electricity Boards (SEBs) have started adopting reform measures and regulatory commissions have been set up to determine tariffs based on economic rationale.

Till the early 1990s', the power sector was shielded from any private sector involvement; however, the mounting pressure on Government resources to support capacity additions, repeated delays encountered by state utilities and the growing demand-supply gap urged the Government of India to open the power generation sector to private participation in line with country’s globalization policy. The New Exploration and Licensing Policy for increasing the production of oil and gas, and the nuclear sector’s recent embrace of international companies to provide equipment and related services are a step in this direction.

Despite the efforts made by the government to enhance and conserve energy supplies, India still faces a grave energy crisis. The factors detrimental to economic growth in the context of energy are summed up in Box 8.1.
Box 8.1
India’s Energy Concerns

- High import dependence on fossil fuels.
- A quadrupling of energy demand by 2030.
- Increasing energy shortages and peak deficit in power sector.
- 400 hundred million people without access to energy.
- Few indigenous energy resource endowment.

Sector-wise energy policy issues revealed that although India has abundant supplies of coal as a natural resource, there is a dearth of coal to meet the growing demand due to its inferior quality (high ash content and infrastructural constraints, mining and environmental issues). Moreover, the production of coal being confined to the state-monopolists have aggravated the existing coal crisis due to inefficient production techniques. This in turn affects the power sector as 70 per cent of coal is utilized for thermal power generation. Distribution of power is the liability of the publicly-owned distribution companies that are often bankrupt, their tariffs kept too low by local politicians. The firms which run their own power stations use imported coal, and as a result, the distribution companies cannot afford their higher-priced power. Because of inadequate availability of high quality of coal and uncertain demand conditions, the private firms that have built new power stations are in financial trouble.

The Indian subcontinent has plenty of sun and wind, and other forms of renewable energy. However, the renewable energy projects are held up due to problems relating to land acquisition and cost escalations. Wind energy which has a net potential of 45,000 MW, is mainly confined to the wind resource rich States of Tamil Nadu, Maharashtra, Gujarat, Karnataka, Rajasthan, Andhra Pradesh and Madhya Pradesh. The states
of Gujarat and Rajasthan have excellent solar radiation and the other suitable states for solar power are Andhra Pradesh, Tamil Nadu, Karnataka, Madhya Pradesh, Maharashtra, Orissa etc. Similarly, small hydro power potential is mainly available with the Himalayan States and north eastern region states. The intermittent nature of Solar and Wind Power in the absence of an adequate balancing mechanism limits the flexibility of the state grid to absorb this power.

As for nuclear power, India’s attitude has long been hyperbolic on paper and ambivalent in practice, despite striking a civilian nuclear deal with America in 2005. Foreign companies are put off by the prospect of unlimited liability in the event of an accident. Nuclear plants face opposition from hostile state governments and protesters.

If we continue to depend so heavily on our coal reserves, the power sector in India faces a bleak future as coal supplies are estimated to last just for another 40 years. Besides, burning of coal raises environmental issues and the twin challenges of power and clean environment have to be met squarely.

India imports (to varying degrees) its three major sources of energy, and its dependence on imported oil is expected to increase even further. The situation is complicated by a number of factors:

(i) major oil suppliers are in unstable regions in the Middle East and Africa;

(ii) oil prices are high, spurring higher gas prices;

(iii) geopolitical uncertainty stokes fears of a possible supply disruption and volatility in oil prices;

(iv) slow market reform has limited investment; and

(v) few or no viable energy alternatives currently exist.
It is against this backdrop that the Government of India has given due significance to the development of renewable sources of energy. Creation of a separate Ministry of New and Renewable Energy is a testimony to this effort. However, the use of the renewable energy resources is limited at present.

**Policy Options**

The grim existing and perspective Indian energy scenario has raised energy security concerns for the country. More than 38 per cent of the commercial energy demand is being met through imports making the country vulnerable, frequent geo-political tensions between the nations and natural physical supply constraints in the oil extracting regions. From early 2007 to mid-2008, the price per barrel of crude oil skyrocketed from about $60 to a record high of $147, particularly straining the oil import bill of the developing countries of the world. Further, the imports of coal and natural gas have aggravated the existing energy deficits. To minimise the energy demand and supply gaps and to provide access to environment friendly energy resources, the following policy measures may be looked into:

1. **Integrated Approach**

   The Report of the Expert Committee on Integrated Energy Policy was adopted by the Government in 2009. However, the implementation and adoption of the recommendations lays in the hands of the respective energy sector Ministries. The output of one Ministry becomes the input for the other Ministry. Therefore, the need to have a holistic and coordinated approach to develop a grand strategy in achieving energy security is imperative. Further, technological improvements resulting in the development of new forms of energy like shale gas, hydrogen etc., also need to be incorporated in the strategic energy policies.
In view of the above dynamics, the need for a separate Ministry for Energy comprising all segments of various energy resources viz., commercial, non-commercial and renewable, cannot be overemphasized. The Ministry of Energy should look at the entire energy space as an integrated whole. The policy uncertainty existing today is largely due to managing this most vital critical infrastructural space by desegregating it into independent silos and sectors.

2. Resource Base

In order to have a wider resources base, it is essential to expand energy resources both, conventional and non-conventional, through exploration, R&D and through an efficient demand and supply management. The environmental impact of various fossil fuels is of growing concern owing to widespread use of energy. Hence, it is necessary that the demand for energy in the country be met in an environment-friendly and sustainable manner. This calls for an optimal exploitation of fossil energy resources using enhanced recovery techniques. Additional sources of energy such as Coal-bed Methane (CBM)\(^3\) may be fully exploited and fossil fuel reserves advanced through intensive exploration. Moreover, the contribution of renewable forms of energy like wind and solar, specifically in the case of India, being a tropical country, need be increased.

3. Energy Mix

Energy security can be enhanced by adopting an optimal energy mix in the country and thereby reducing the dependence on coal and oil, which have a share of 70 per cent in commercial energy consumption.

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\(^3\) Coal bed gas, or coal mine methane (CMM) is a form of natural gas extracted from coal beds. In recent decades it has become an important source of energy in United States, Canada, and other countries. Australia has rich deposits where it is known as coal seam gas.
Therefore, there is an urgent need to intensively explore hydrocarbons and other fossil fuels. Also, Natural gas could be the preferred choice. Moreover, to minimize the infrastructural constraints and to achieve the desired energy production targets, the Government of India should encourage private investment, acquire overseas assets, conduct oil diplomacy, and participate in projects like transnational pipelines to gain access. Accordingly, an energy sourcing plan must take into account the geographical, technical, economic, and ecological factors, for example, the significance of coal in eastern India and natural gas in the western and northwestern parts of the country cannot be overlooked. An optimal energy mix should be such as to reduce the dependence on fossil fuels and emphasizes an intensive use of nuclear, hydro, solar and wind energy in the times to come.

4. **Comprehensive Policy Framework**

A comprehensive sectoral policy framework should link all aspects pertaining to energy resources, production, consumption, pricing, transportation, distribution, extraction and mining issues, efficiency concerns, R&D geographical dynamics, acquisition of assets, role of private sector and alternative sources of energy. The government should monitor the progress and implementation of such a policy at regular intervals.

5. **Energy Efficiency**

Energy efficiency measures, awareness in terms of energy education for use of energy resources to reduce wastages and prevention of energy losses are important policy initiatives in demand and delivery management. Awareness of the importance of energy in human life and the need to increase efficiency in production and consumption and its linkages with water and environment should be highlighted. It also involves a review and upgradation of energy-efficient standards implying
the need of acquiring global infrastructural conditions amidst financial constraints. The role of the Bureau of Energy Efficiency (BEE) should be enhanced and strengthened further for energy conservation. BEE should be given regulatory powers to implement energy efficiency measures.

6. **Attain Efficient Pricing of Energy Supply**

   High energy prices prompt abuse of resources by the masses who cannot afford it, thus negatively impacting the consumption of the low income class. Also, low administered prices encourage an inefficient use of energy. Therefore, the government may allow market forces to determine pricing and resource allocation under an effective and credible regulatory authority and provide targeted subsidies in a transparent manner.

7. **Increased Funding in the Energy Sector**

   The energy sector being capital-intensive requires huge amounts of investments. Towards this end, public and private sector participation is imperative against the backdrop of long-term stringent funds available in the market. Also, the State Governments need to increase the budgetary allocation to this sector and minimise the delay in the release of funds.

8. **Focus on R&D**

   The role of Research and Development (R&D) in the energy space must be intensified focusing new, energy-efficient and cost-effective technologies in order to enhance energy security of the country. As recommended by the IEP, Planning Commission, a number of technology missions covering areas such as in-situ gasification, Integrated Gasification Combined Cycle (IGCC), solar energy, energy storage, shale gas, hydrogen energy, smart grids, etc. are proposed to be launched. The scope for bio-fuels including extraction of ethanol from agricultural waste using reported advances in technology need to be pursued.
9. **Environmental Clearances**

For sustainable economic development, it is important to resolve the issues of environment and forest clearances due to which a large number of projects in coal mining and power sector are unable to see the light of the day. To ensure a leaner, transparent and an efficient approval process, there is a need to ensure forest and environmental clearances in a time bound manner. To expedite clearances, the single window clearance concept should be adopted by the government at the Central and State levels.

In the case of coal, exploration should be speedened up exponentially to ensure the availability of more explored coal blocks for mining by the private and public sectors. To increase the production of coal from the mining blocks, issues related to land acquisition and R&R should be resolved at the earliest. The enactment of a central legislation to ensure uniform R&R policy and speedy land acquisition is essential. The coal sector regulator should be set up on a priority basis to resolve the issues encompassing coal production in the country.

Natural Gas provides the benefits of a more environmentally friendly and flexible fuel in a country dominated by coal and biomass. Inadequate infrastructure and a flat domestic gas production have constrained gas-use particularly in the power generation and industrial sectors. Therefore, uncertainties related to natural gas pricing which determine the supply and demand balance should be resolved at the earliest. There is a need for infrastructural development, not only in terms of new import infrastructure, but also in terms of transmission pipelines as production centres progressively shift eastwards. In order to further develop the use of gas, it is critical to extend the transmission infrastructure to supply new city distribution networks.

For attaining energy security and reducing the dependence on oil imports, efforts should be made by the government to enhance
exploration and production (E&P) of domestic oil and gas sources in the country. The acquisition of equity oil and gas abroad should be encouraged and incentives and tax holidays should be provided to encourage the same. The possibility of development of Alternative Fuels like CBM, Gas Hydrates, Underground Coal Gasification, and Ethanol for Blending with petrol and bio-diesel should be explored. Reforms are also needed for developing strategic crude oil storage to meet emergency needs, product pipelines infrastructure, pricing and rationalisation of taxes.

Renewable energy technologies are still primitive compared to fossil fuels. While fossil fuel plants deliver hundreds of megawatts from a single site, renewable energy sources are still struggling in the realm of kilowatts. Renewable sources of energy remain a small fraction of installed capacity, yet India is blessed with over 1,50,000 MW of exploitable renewables.

While policy and budgetary support for renewable energy have progressively increased over the years, particularly for large scale grid connected power, there continues to exist several barriers that hinder up-scaling of renewable energy deployment. There still remain some critical gaps, particularly for decentralized distribution in the areas of access to capital, technology development and adaptation, innovation induction, and strategies to up-scale deployment. The Government of India needs to formulate a strategic, integrated energy (conventional and non-conventional) plan in order to achieve a consistent and sustainable economic growth rate of 8 to 10 per cent in 2030 A.D. Hence, efficient project implementation, private and public sector participation, regulatory oversight, energy conservation, R&D, access of energy to the rural sector, and an optimal policy mix are critical to our energy security concerns.