ICSD Newsletter

India Council for Sustainable Development

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Editor
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About the ICSD

As India surges ahead on a path of high economic growth, it is vital for the country's policy to factor in sustainability issues in its development strategy. With this in mind, TERI (The Energy and Resources Institute) initiated the ICSD (India Council for Sustainable Development), which was launched by Mr Montek Singh Ahluwalia, Hon'ble Deputy Chairman of the Planning Commission, Government of India, in January 2007. The Council has a strong and an active advisory role as a non-government initiative. Its purpose is to provide guidance and relevant analysis on integrating environmental concerns with development, with specific emphasis on the reduction of poverty, ensuring an equitable growth of income and wealth in India. It seeks to further fortify cooperation and exchange between India and the international community in the field of environment and development, with the broad objectives of

- assessing the challenge of integrating environmental issues with development strategies, in order to establish a pattern of sustainable development in India,
- formulating strategies and directions, which would be provided as recommendations and advise to various levels and agencies of the Government of India, and,
- disseminating and publishing information on issues linking the environment and development in India and practices to promote sustainable development.

At present, the Council is working with and seeks to build further collaboration with the CCICED (China Council for International Cooperation on Environment and Development) in order to play a key role in bringing together experts and the policy community from India and China to help forge an understanding and appreciation of the sustainable development construct in the two countries.

The ICSD operates under the able guidance of its distinguished members, comprising leaders in the government, industry, and academia from all over. The members meet annually to discuss the progress and propose a way forward for the Council's activities. TERI provides the Secretariat support to the Council on an ongoing basis.

With an objective of creating awareness and disseminating information on issues of environment and development pertinent for India, the Council Secretariat publishes a biannual newsletter, which, along with raising issues of concern also puts forth the viewpoints of various experts and informs readers of the current activities of the Council.

Energy transformations for India – responding to energy security and climate challenges

Foreword

India's energy sector faces some critical challenges on account of several factors that need to be carefully considered and built into strategies for the future. First, with the increase in global oil prices and India's mounting dependence on oil imports, a socio-economic dilemma faces the government in formulating pricing policies. Unfortunately, even though the administered pricing regime, which required the government to carry out the pricing of petroleum products, was to be dismantled in 2002, the old system has continued without any perceptible change. Hence, the Government of India still retains responsibility for pricing petroleum products, which inevitably involves several pulls and pressures from those sections of the society, which have benefited from subsidies in the past. Unfortunately, even with the higher prices of oil, the government has not been able to roll back these subsidies, and this has placed a major burden on the public sector oil companies.

India also has a serious problem with the lack of access to modern forms of energy. The rural population of over 700 million people is largely dependent on biomass, including fuelwood (often in the form of twigs and green parts of trees) and animal dung. This continues to pose a major problem, and, as yet, suitable alternatives have not been found for this large part of the population, although in some limited areas, marketing of LPG (liquefied petroleum gas) at subsidized prices has helped to a great extent. Almost 400 million people in the country have no access to electricity, and therefore, they are left with no choice but to use candles, small oil lamps based on kerosene, and other oils. These devices not only provide inadequate lighting but also affect human health through the emissions of harmful gases. Kerosene is subsidized largely because it is regarded as the poor man's modern fuel, but it is well known that a large quantity of the subsidized kerosene does not reach those that it is meant for, and is diverted for other purposes.

The rapid growth of the Indian economy has led to an increasing demand for energy, but capacity, particularly in the power sector, has not kept pace with this growth in demand. Additionally, whatever capacity exists is often utilized at very low levels of efficiency, resulting in substantial losses in the transmission and distribution system and generation of very low plant load factor in several cases. Overall, therefore, the energy challenge for India requires substantial improvements in efficiency and creation of options for rural areas as well as for the urban poor, whereby proper access can be provided to people in the form of affordable and clean sources of energy for basic end-uses such as cooking, lighting, and heating.

All these growing demands would also need to be met in a manner that is environmentally sustainable. With growing concerns on climate change and the pressure to limit emissions of greenhouse gases, this would be another consideration in devising energy solutions for the country. Overall, therefore, India has a set of complex issues to deal with in its future energy decisions. It is clear that repeating what other countries have achieved or attempted will not help India very much, but there would be great merit in looking carefully at solutions that have worked in other parts of the world, although conditions there may be different historically as well as in terms of the underlying drivers determining policies. In this newsletter, several issues have been covered but the effort of the India Council for Sustainable Development in its current programme of work is basically to look at a whole range of options related to the production and use of energy, which would also define the extent to which India can arrive at a low carbon pattern of growth and development.

R K Pachauri
Director-General, TERI, and
Chairman, IPCC

Energy transformations: opportunities, needs, and challenges for India in responding to energy security and climate change concerns

Ritu Mathur[a], Amrita Goldar[b], and Prima Madan[c]

Introduction

In per capita terms, India's energy consumption is still a fraction of that existing in the developed world; however, the fact remains that the country ranks fifth in the world in terms of primary energy consumption. Also, in view of the large population base of the country and the need to provide the population with acceptable levels of human development, a considerable increase in the country's energy demand is inevitable in the coming decades.

In the wake of the above facts, achieving energy security poses a daunting challenge for the country. Though debates and concerns on energy security issues in the past centred around global oil prices, it is now increasingly being recognized that energy security for many countries is much more than just oil security. This is particularly true in case of a country like India, where energy security has two interlinked, but distinct, aspects. The first aspect relates to the need to achieve better distribution and utilization of energy by people (particularly in rural India) so that a minimal, 'lifeline' amount of commercial energy is available to all. The second aspect relates to the need to find ways of fulfilling the growing demand for energy, which would support at least 8% growth in the country's GDP (gross domestic product), which is necessary to drive industrial growth and improve the standards of living of the populace. Accordingly, the country is faced with a formidable challenge vis-à-vis trying to meet its national development objectives on one hand and addressing national concerns on energy security and global concerns on climate change on the other.

Several options for transiting to more sustainable energy conversion and use have been discussed in recent studies, and the potential for energy saving from these options seems fairly large in terms of magnitude, especially when compared with current levels of commercial energy consumption. However, it needs to be emphasized that energy-saving potential likely to be achieved by adopting these conventional options would probably do little to bring about a level of comfort, either with regard to energy security or in the context of reducing emissions significantly. This concern assumes even greater significance in the context of oil price shocks and the growing global consensus on the need to tackle climate change. In the Indian context, there is a need to urgently move away from conventional thinking and bring about some major energy sector transformations to address the dual concerns of energy security and climate change.

India's future energy demand

Given the country's developmental goals and plans to maintain a high economic growth rate, various estimates indicate that by 2031, India's primary energy supply would need to increase significantly from the current levels. The *Integrated Energy Policy Report* estimates that under an 8% GDP growth scenario, assuming alternative scenarios of fuel and technological diffusion, India's total energy requirement would be in the range of 1536–1887 MTOE (million tonnes of oil equivalent) by 2031 (Planning Commission 2006). The analysis by TERI (The Energy and Resources Institute), which is based on the MARKAL[1] (MARKet ALlocation) model, indicates that under an 8% GDP growth scenario, with current plans and policies of the Government of India, commercial energy needs would increase to 2149 MTOE by 2031/32 and CO_2 (carbon dioxide) emissions would increase to about 7 Gt (gigatonnes) in the same year (Figure 1) (TERI 2008). Moreover, both these estimates indicate that coal and oil would continue to account for most of India's energy requirement, even by 2031.

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[1] The MARKAL model is a representation of the entire energy system for a geographic entity. The database (version 2008) for the India MARKAL model has been developed by Ritu Mathur, Pradeep Kumar Dadhich, Atul Kumar, Nishant Mehra, Amrita Goldar, Ila Gupta, and Leena Srivastava.

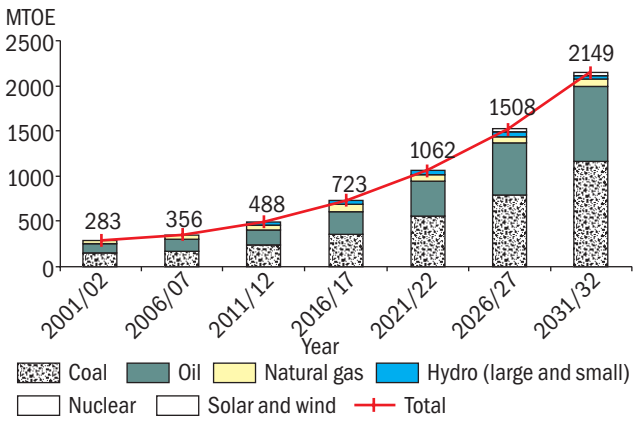

Figure 1 Commercial energy supply in India (business-as-usual scenario)

Increasing imports dependency: key concerns

As mentioned before, coal and oil will continue to be the mainstay of India's energy requirements. But at current production levels, the domestic reserves of coal (till now assumed to be large) are likely to last for only 40 years and would deplete even faster if mined more rapidly to meet the increasing demand. The production of domestic crude oil has remained nearly stagnant for the last 15 years. The reserve to production ratio for oil and gas is 22 and 34 years, respectively (MoPNG 2008). With current levels of technology and E&P (exploration and production) efforts, indigenous supply of conventional energy forms is expected to reach the maximum production limits rather soon, restricting the domestic availability of conventional energy resources. Accordingly, while estimates regarding the level and timing of saturation of indigenous production of conventional energy forms vary, all the studies are equivocal about the fact that the energy demand and supply gap would widen considerably in the next two to three decades, necessitating much higher levels of coal, oil, and gas imports in the future, if past trends were to continue.

In 2005/06, the country imported about 124.0 MTOE of coal, oil, and gas (an import dependency of about 36%) (TERI 2007). The latest statistics published by the Department of Commerce of the Government of India indicate that during the financial year 2007/08, spending on fuel imports accounted for about 8% of the GDP. Although India has relied on oil imports for several decades, it is only during the last decade that it has started importing thermal coal and gas. TERI's analysis indicates that import dependency of all the fossil fuels is expected to increase significantly in the future, reaching 78% for coal, 91% for oil, and 34% for gas in 2031, as per the current estimates of future availability of indigenous energy (TERI 2008). Other reports also corroborate the expectation of higher energy import dependency in the future. This is clearly an unsustainable trend, with implications not only in terms of large monetary outflows but also in terms of infrastructural requirements for port development, handling, and transportation of this energy, apart from concerns about the source of these fuels and the geopolitical issues related with such transitions.

Options and scope for reducing commercial energy requirements

The rapidly increasing energy requirements and the rising import bill necessitate the need to explore options and examine the scope for reducing commercial energy requirements of India. While the energy and emission intensity trends for the economy under the BAU (business-as-usual) scenario reflect progress in the correct direction, recent studies have indicated an energy saving potential of about 25%–35% by 2031. While this would mean a significant level of reduction in absolute terms (nearly double the level of current commercial energy consumption), much of the saving is expected to be on account of energy efficiency—be it on the part of end-users or in terms of efficient energy conversion technologies.

With the help of the MARKAL model, TERI analysed the scope for reducing commercial energy requirements of India under specific interventions. The results indicate that there is a considerable scope for reducing commercial energy requirements from a BAU level of about 2150 MTOE to approximately 1400 MTOE (about twice the total commercial energy requirement in 2001) by using a number of successive energy saving options on the energy demand and supply sides. The specific interventions considered for the above analysis include the following.

- *Intervention I-1* This intervention corresponds to energy efficiency measures in the transport sector in the form of policy interventions by the Government of India, such as increased share of rail-based passenger and freight movement, increased use of public transport, efficiency improvements in motorized road transport vehicles, introduction of hybrid vehicles, and so on.
- *Intervention I-2* This intervention includes efficiency improvement across various end-use sectors, for example, increased use of efficient electrical appliances for space conditioning, lighting, and refrigeration in residential and commercial sectors, efficiency improvements in industrial processes, and so on.

- *Intervention I-3* This intervention considers adoption of advanced coal-based power generation technologies, such as ultra-supercritical and IGCC (integrated gasification combined cycle) at commercial scale.
- *Intervention I-4* This intervention includes aggressive deployment of nuclear energy for power generation, driven by the assumption that the country is able to import nuclear fuel.
- *Intervention I-5* This intervention includes enhanced exploitation of renewable energy sources.

The analysis reveals that the maximum scope for reduction in commercial energy requirements is from end-use efficiencies in the demand sectors, as represented by the area between BAU and I-3 in Figure 2. It is estimated that efficiency improvement interventions in the transport sector could lead to a reduction of about 11% (about 236 MTOE), while options in the other end-use sectors could reduce about 16% (about 352 MTOE) of total commercial energy requirement in 2031.

While there is a significant scope for energy saving in the transport sector, with limited technological options for fuel switching, the options are largely focused on increasing the share of public transport, enhancing the share of rail-based movement, and so on. Accordingly, fiscal and policy interventions are important in inducing efficiency in this sector. While recognizing the relevance of alternative fuel options such as CNG (compressed natural gas), ethanol, bio-diesel, and electricity for the future, studies have thus far indicated that these alternatives can play a rather limited role in the next couple of decades.

In the industry sector, while several large industries are already doing well, and the country has some of the BATs (best available technologies) to demonstrate, there is a need for upscaling the efforts and improving energy efficiency across the board. Particularly difficult is the task of bringing about efficiency improvements in the numerous small industries engaged in various industrial activities. In the residential and commercial sectors, opportunities in terms of efficiency improvement of appliances for lighting, space conditioning, and so on, have been explored, but substantial efforts are required to bring about major transformation. Although efficiency improvement (that is, conservation measures) generally indicates substantial scope for reductions, there are several barriers (financial, socio-economic, and technical) to the adoption of these options. Moreover, these savings are spread across diverse sectors and end-users, such that the nature of barriers differs widely for various options, making it impractical to adopt any single policy or undertake a particular technological approach across the board to make a significant impact.

Increased use of renewable energy is estimated to reduce about 109 MTOE of commercial energy demand in 2031, and the possibility of commercial energy saving due to advanced coal-based technologies is about 35 MTOE in the same year. Aggressive penetration of nuclear energy for power generation, as indicated by area between I-3 and I-4 in Figure 2, is estimated to further reduce the total commercial energy requirement by 18 MTOE in 2031, based on assumptions of likely progress of advanced and clean power generation technologies. Although renewables have been recognized to play a role in decentralized applications, these have thus far been examined in a rather limited context, both on account of the relatively slow technological progress and diffusion worldwide and the relatively high development costs associated with most of these technologies. Accordingly, renewables thus far have been estimated across all the studies to displace only up to 5%–6% of the total energy requirement by 2031. However, given the large potential of renewables in India, this is one area that needs to be re-evaluated in terms of its possible contribution to decreasing the use of fossil fuels and making a major difference to energy security and environmental well-being.

There are several barriers to the success of these theoretical energy reduction possibilities. Even if one were to consider that all these options could be exploited so as to achieve this fairly significant reduction in energy by 2031, the level of overall energy

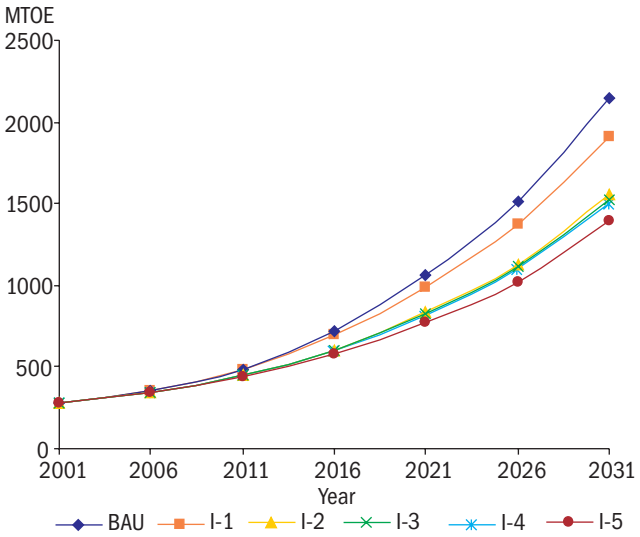

Figure 2 Scope for reducing commercial energy requirements

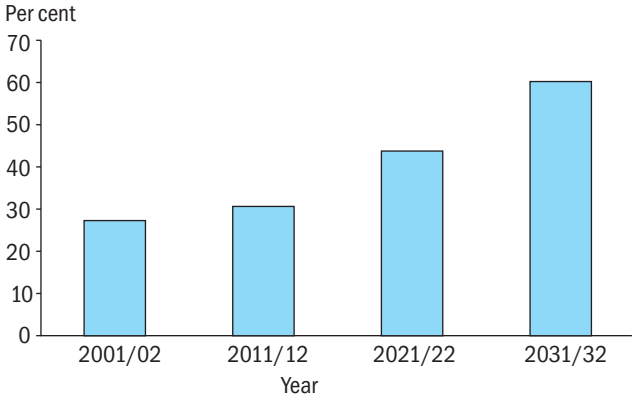

Figure 3 Import dependency in the alternative/ hybrid scenario

import dependency for the country is likely to remain fairly high, as indicated in Figure 3, making the adequacy of these options in terms of addressing energy security questionable.

Reconciling development, energy security, and sustainability – key opportunities

While there is a need to adopt a multi-pronged strategy to prepare for and respond to various dimensions of energy sector problems, keeping energy security and development needs as central, there is an element of urgency with which the country needs to look at the role of renewable energy options and consider ways of providing clean and affordable energy to all. The need of the hour is to re-evaluate the options available, re-assess the scale of change that may be required to achieve sustainable development, and mobilize efforts in a targeted and planned manner to exploit the relatively easier options in the short term, without losing sight of the longer time frame.

The recently released *National Action Plan on Climate Change* by the Government of India has proposed eight missions, which represent multi-pronged, long-term, and integrated strategies for achieving key goals in the context of climate change. The document also indicates that while several of the proposed programmes are already part of the country's current actions, they may need a change in direction, enhancement of scope, and effectiveness and acceleration of the implementation of time-bound plans (Ministry of Information and Broardcasting 2008).

One of the key areas in which there is a strong need to re-evaluate the road map is the renewable sector, more specifically, the use of solar energy. India receives about 5000 trillion kWh/year equivalent energy through solar radiation. In most parts of India, clear sunny weather is experienced for 250–300 days a year. The average solar insolation incident over India is about 5.5 kWh/m^2 per day. Just 1% of India's land area can meet its entire electricity demand till 2030. The *National Action Plan on Climate Change* has also placed a great deal of importance on the National Solar Mission and proposes the use of solar energy for power generation and other applications, along with the integration of other renewable energy technologies, such as biomass and wind, with solar.

With the country enhancing its refinery capacity to reduce the pressure on imports of petroleum products, it is equally important to focus on enhancing the transport sector efficiency by bringing about policy changes that enhance the use of public transportation, increase the share of rail-based movement, and encourage efficiency improvements in motorized road transportation. Moreover, it is imperative to focus on the move towards low carbon fuel options in the transport sector. In this regard, the scope for using biofuels and moving towards battery-operated and hybrid vehicles must also be re-evaluated so as to reduce dependency on petroleum products in the transport sector in due course of time.

Thereby, given the massive potential it is extremely crucial for renewables to occupy a dominant share in India's energy mix. Accordingly, efforts need to be made by all concerned stakeholders in order to encourage appropriate technology development, as well as to create an enabling environment by suitable policy interventions to promote the use of efficient technological options and low carbon fuels by providing adequate incentives to encourage investments in the sector.

Apart from transforming the energy mix, it is crucial and urgent for the country to address 'energy access' issues and ensure that adequate and affordable energy is provided in a sustainable manner to all. While the government has made considerable headway in this regard, the challenge is still rather daunting in terms of making available adequate infrastructure and energy to support this in a timely manner. In this context, while renewables can play a key role in the long term, it is important to find solutions that can help improve the human development index in the interim period.

As per the 2001 Census, approximately 83 million people in India were using kerosene as the primary source of lighting, of which around 92% (76.9 million) people were from rural areas. Recognizing the need to change the existing scenario, TERI, with its vision to work for global sustainable

development and its commitment towards creating innovative solutions for a better tomorrow, undertook the campaign 'Lighting a Billion Lives', or LaBL. The LaBL campaign aims to bring light into the lives of one billion people by replacing kerosene and paraffin lanterns with solar lighting devices, thereby facilitating education of children, providing better illumination and pollution-free indoor environment for women to do household chores, and providing livelihood opportunities at individual and community levels. While the rural households are being electrified under the RGGVY (Rajiv Gandhi Grameen Vidyutikaran Yojana), the LaBL lamps could provide a better lighting alternative in the interim period as compared to kerosene lamps. The cost of Rs 2–5 per day would be same as that spent on purchasing kerosene (Chaurey 2008). It is estimated that even if all rural households are electrified by 2016, a large number would still be dependent on kerosene-based lighting in the interim period. It is estimated that in 2006, approximately 54 million households were using kerosene-based lighting, and this figure would decrease to a still sizeable 23 million by 2011, based on current plans of the government. The transition to LaBL lamps would also lead to a reduction in CO_2 emissions, apart from accruing savings in terms of avoided kerosene subsidy, which, in turn, could be shifted to funding solar lighting, thus encouraging campaigns such as LaBL.

In addition to efforts needed to encourage the use of alternative sources of energy through technological interventions, right pricing of fuels is also needed. There is a need to undertake appropriate interventions within the domestic energy supply sectors in terms of moving towards market-based/full cost pricing of energy products such that the scarcity value of the fuels is adequately represented, and there is no wasteful utilization of energy resources. For instance, currently, kerosene is available at a highly subsidized price. There has been no revision of price for kerosene since 2004, whereas the price of crude oil (Indian basket) has increased by nearly 180% during the same time frame. While kerosene is subsidized with a view to promote its access to poor households as a clean cooking fuel, the low price has led to nearly 40% of the kerosene supply being siphoned off to adulterate diesel (NCAER 2005). Consequently, the less than market price of the fuel has led to suboptimal utilization of the product. A similar situation has been faced in the electricity market. In select states of India, electricity is provided to agriculture at very low prices or for free, leading to wasteful use of energy as well as excessive use of water, which negatively impacts the yields as well as water tables in the region.

The way forward

To summarize, the government, through policy documents such as the *National Action Plan on Climate Change*, which focuses on eight missions, has brought out the priority areas for the country in responding to climate change. Similarly, with regard to energy sector planning, other studies such as the *Integrated Energy Policy Report* and the *National Energy Map: Technology Vision 2030* have been vocal on several dimensions that require action. Therefore, it is noteworthy that while progress is already being made across several of the priority areas, it is desirable to re-evaluate the nature and scale of energy transformation efforts required in the context of energy security concerns and consider a targeted approach so as to achieve the required transitions.

In addition, while it is important to have a long-term perspective to achieve the required energy transformations, taking into account both climate change and energy security concerns, interventions such as LaBL campaign in the intermediate period can go a long way in altering the long-term energy portfolio in favour of clean source of energy as well solving the energy access issues in the interim period.

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The downstream Indian oil industry and energy security

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In 2002, when the APM (administered pricing mechanism) was dismantled, refineries in India were allowed to import crude and sell products at import parity prices. As the customs duty of many products were higher than that of crude and the price of imported products contained elements such as ocean freight, which was not incurred by the refineries, they operated in a high effective tariff protection regime. This resulted in high gross margins for the refineries, which facilitated the setting up of new grassroot refineries and upgrading the existing ones. Later on, the Rangarajan Committee recommended a trade parity pricing system where the price of petroleum products were based 80% on import parity and 20% on export parity (ocean freight and others were excluded). This was accepted by the government and implemented. Also, over a period of time, customs duties on both crude and products were reduced, and the differential kept slightly lower. In the case of kerosene and LPG (liquefied petroleum gas), customs duty was made zero resulting in negative tariff protection for these two products. In August 2008, another committee headed by the former Cabinet Secretary and former Petroleum Secretary, Mr B K Chaturvedi, recommended, inter alia, that the pricing of products should be entirely based on export parity, thereby further paring refinery margins. The recommendations of the Committee have largely not been accepted by the Ministry of

Petroleum, including the one on export parity pricing.

Tariff protection is normally given to start up industries, in order to enable them to withstand competition in their formulative years. These are later reduced or eliminated once the industries are able to stand on their own feet. In principle, therefore, the Chaturvedi Committee had a sound rationale for their recommendations. However, it appears that it did not take into account the wider picture and issues, such as energy security and oil companies' profitability.

First, the growth of the refinery sector in India has considerably enhanced its energy security. India is one of the few countries, which has a total refining capacity, to not only meet its domestic demand but also export surplus high value products. It has developed the capacity to process sour crudes, which are cheaper than sweet crudes and yet make quality products. Excluding the two export-oriented refineries of Reliance and Essar, the total refining capacity is currently 135 MTPA (million tonne per annum) (2.7 million b/d [barrels per day]) against a domestic demand of 129 MTPA (2.6 million b/d). This capacity ensures that India is not dependent on the large-scale import of products, which could be in short supply at times of crisis. It must also be noted that environmental clearance for a new refinery is not as big an issue as the US and Europe, allowing the number of Indian refineries to grow in line with demand.

Second, refineries are owned and their products are marketed by integrated companies, whose profits streams from both refining and marketing combine to give corporate profitability. With the cap on the prices of petrol, diesel, LPG, and kerosene, the very high marketing losses being sustained by these companies was being somewhat compensated by high refinery margins. Export parity pricing could have been considered if these companies were simultaneously allowed free pricing of these products. But this is not going to happen.

The export-oriented refineries of Reliance and Essar are on a different footing to refineries in the domestic tariff area, as they export most of their production at international prices. Though their imports of crude oil adds to the country's overall import bill, the export of value added product results in a significant gain of foreign exchange. Also, the energy security of India is strengthened as export of finished products from India creates a more inter-dependent oil trade scenario for India, where the country is seen not just as the consumer of crude oil, but also as a significant contributor to global product availability. This will further improve when Reliance's second refinery comes on stream, resulting in a total export-refining capacity of 70 MTPA (1.4 million b/d).

The Chaturvedi Committee had recommended monthly steep increases in the prices of petrol and diesel. Since then the situation has changed dramatically, with crude prices dropping steeply from around $140/bbl to $50/bbl. While this has given some relief to marketing under-recoveries, the hit is now being taken by the refineries. Their gross margins have plummeted due to the reduced differential between crude and product prices, the depreciation of rupee against the dollar, and the high priced crude oil inventories that they had built up earlier. The oil companies will, therefore, continue to be supplicants to banks for increasing their borrowing limit and continue to petition the Ministry of Finance through the Ministry of Petroleum for the oil bonds, which are their due but which they are yet to receive. These oil bonds will, with difficulty, be traded in the market at discounts ranging from 10%–15% as the Reserve Bank of India scheme to buy these bonds at par and give the oil companies equivalent foreign exchange to import crude oil was short lived. Over the long-term, the oil companies will not be able to provide the marketing infrastructure to cater to the growing demand, which is a necessary component for ensuring internal energy security.

Soon, the government will need to come to grips with the very distorted pricing regime in the oil industry in India. For example: by 2010, Indian refineries are required to produce high quality petrol and diesel confirming to Euro IV standards for marketing in select metros in India. The issue that arises is when and how the oil companies will be compensated for the investment of about Rs 50 000 crores ($12 billion) that they have spent in upgrading these products to meet market requirements. Also, if the large differential between diesel and kerosene prices remains, the adulteration of high quality diesel with kerosene will continue (despite stringent checking, marker system, and so on), thereby undermining the whole purpose and investment incurred for the clean fuels project.

Energy security in the power sector: need for a holistic approach

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As per the Integrated Energy Policy of the Government of India, 'we are energy secure when we can supply lifeline energy to all our citizens irrespective of their ability to pay for it as well as meet their effective demand for safe and convenient energy to satisfy their various needs at competitive prices, at all times, and with a prescribed confidence level considering shocks and disruptions that can be reasonably expected.' A number of serious concerns unfold if we look at the power sector in the context of this definition and Vision 2012 of the Ministry of Power, which aims at reliable and quality power for all, the per-capita consumption of 1000 units, and an assured minimum lifeline consumption of one unit per household as a merit good.

The demand for power is increasing at a rapid pace as is expected in a scenario of accelerated economic growth, low consumption base, and a relatively high population growth. Although availability of power has also been increasing at a steady rate, it has not been able to keep pace with the demand. As a result, the country has been witnessing power shortages of varying degrees in different parts of the country. In the first four months of the current financial year, the peaking shortage across India was of 18.4%, with the western power region recording a shortage of as high as 25.7%. The per-capita consumption is still very low, about one-fourth of the world average, and nearly 44% of the population has no access to electricity. Even where access exists, the quality of power supply is often a concern. Looking into the future, it is expected that the demand for power would increase at a sustained rate of 6%–7% in the next two decades. It is obvious that it would be an extremely challenging task to provide adequate generating capacity to meet this demand in a reliable manner, especially if one were to go by the past track record of meeting capacity addition targets in the country. Energy security issues are, therefore, likely to be more intense and complex in the coming years. Any strategy to address this situation should look at the entire supply-demand chain.

Starting from the resource end, over 53% of the power generation in the country at present is coal based. Coal is likely to retain its dominant position in future—at least for the next three decades. How secure is the supply chain of this primary energy resource? There are some alarming signals. In recent years, a number of coal-based power plants have been facing coal shortages and a number of power majors are scrambling for securing coal supplies from abroad. In fact, it is reported that even some of the pit-head power plants had to import and transport coal over long distances. The steep rise in coal price in the international market and inland transportation bottlenecks further accentuate the complexity of these concerns. There are also conflicting versions about the estimates of reserves. The estimates of proven reserves vary from 52 BT (billion tonnes) to 98 BT. The question that arises in this context is how far we are right in pursuing a coal-centric growth for the power sector. The options seem limited and, hence, the efforts should be directed towards improving domestic production of coal, obtaining more realistic estimates of economically extractable reserves, strategizing import, acquiring of coal equity abroad after assessing the geo-political aspects, and so on. Opening up the coal sector for private participation and establishing an independent regulatory framework merits special mention in this context. On the power generation front, a plan for progressive retirement/renovation and modernization of inefficient plants, along with an aggressive policy for adoption of new technologies such as critical and supercritical boilers, and IGCC (integrated gasification combined cycle) are needed. Reduction of GHG (greenhouse gases) should be an integral part of these efforts.

The 1990s witnessed considerable interest in developing gas-based generation, especially in the private sector. However, limited availability of gas and competing demands from other consuming sectors such as fertilizer sector, have severely impacted the operation and growth of gas-based power plants. In fact, in recent years a number of plants had to remain idle or operate at very low plant load factors due to non-availability of adequate gas. It is also a matter of concern that production of gas has remained almost stagnant for over five years now. The rising trend, including the high volatility in international gas price, also discourages consumers in relying too much on the gas route. Nevertheless, gas is still preferred as fuel for power generation from environmental and operational considerations. Therefore, efforts are needed to get

over the difficulties being experienced now. An aggressive exploration policy, development of a gas grid and a preferential allocation and pricing policy for the power sector can help in this regard.

As a resource, water or hydropower merits special emphasis. It is renewable and non-polluting, offers high flexibility in system operation, and the price is almost insulated from inflationary pressures. As per the CEA (Central Electricity Authority) estimates of late 1980s, India has a fairly rich hydropower potential—84 GW at 60% load factor. Only about 22% of this has been developed and, hence, accelerated development of the unexploited resources has a very high relevance from an energy security point-of-view. However, past experience shows that a host of factors like long gestation periods, higher levels of construction risks, inter-state water disputes, environmental and social concerns at times over hyped, user right demands of resource bearing states are proving to be barriers to the accelerated development of hydropower. It is heartening to note these have been addressed, to a large extent, in the 2008 hydropower policy of the Government of India. The added focus on hydropower is also evident in the prime minster's 50-GW initiative and the constitution of the high level task force on hydro project development. The developers need to play a proactive role in understanding and acting on the needs of the local people, and this merits special emphasis in this context. This can go a long way in winning over the local people and sympathetically addressing their genuine needs, which, at present, is one of the major issues in project sustainability. At present, many private developers are finding difficulty in getting access to past records of hydrological data of some of the river basins (on confidentiality grounds). This is especially true in case of the Brahmaputra Basin. At the same time, developers need this data for the proper planning of the project. The government should resolve this tangle expeditiously if we want to encourage private participation. In the mean time, the global warming phenomena and threats of receding glaciers in the Himalayan region have also added to some new dimension to the concerns of hydropower development in the long run. The likely impact of these, need to be carefully studied. A reappraisal of the country's hydropower potential using state-of-art investigation tools also appears necessary. This might even indicate higher resource availability, similar to what had occurred in other countries. With regard to hydro, it should also be expedient on the part of the government to develop the country's good sites for multipurpose storage projects. This would be essential, not only from the energy security point-of-view, but also from the considerations of drinking water supply, flood control, surface water for irrigation, and so on.

Nuclear power is getting increasing acceptance in many parts of the world as a green resource. In India too nuclear power is likely to be one of the major components in the fuel basket. According to certain estimates, nuclear share may go up to 7% by 2032 from the present level of approximately 3%. Access to uranium and a fast-track approach to the thorium route are important in this context. The rich R&D base in the country, built up over the years, should prove to be a distinct advantage in this context. Pursuit of public–private participation in uranium mining and power generation is also required.

Renewable energy sources are also expected to play a key role in diversifying the fuel basket. Increasing access and, above all, in greening the sector. India has already made significant progress in harnessing wind power. In recent years, increasing attention is being given to policy and regulatory fronts, and to development of renewable-energy-based generation. In this regard, the concerns relate primarily the relative high cost of generation, intermittent nature of power availability, and lack of reliable estimates. If these issues could be addressed effectively, along with the grid connectivity issues, significant progress in greening the sector and increasing access could be realized. Aggressive R&D and mass production of renewable energy products can help bring down the cost of power from these resources, which is today a main barrier to development. According to industry experts, the prospects are bright in this regard. Solar power would need special attention in view of its abundance in availability in the country.

Along with increasing the generating capacity with a fuel basket, there is an urgent need for targeted action on energy efficiency and conservation front. There is a growing realization on the part of governments that 'Negawatts', without compromizing on the aspirations of people, has to be most effective 'mantra' for ensuring energy security. The Energy Conservation Act, 2001, and Electricity Act, 2003, provide legal and regulatory framework for promoting energy efficiency. The regulatory commissions are focusing on transmission and distribution loss reduction and on benchmarking efficiency levels. The BEE (Bureau of Energy Efficiency) has, in recent years, made some tangible impacts by way of labelling of electrical appliances, ensuring mandatory audits of energy intensive industries, notification of Energy Conservation Billing Code, and so on. The National

DSM (demand side management) Action Plan is also expected to give an accelerated push to the efforts.

A few other issues will also need immediate attention. Often, the regulators of the power sector have little control on pricing and quality of fuel, which are under different regulatory regimes. There have been some discussions about having a common energy regulator; but there is a strong view that this would be rather premature considering the prevailing scenario of fuel availability, efficiency levels, and the pricing and subsidy schemes in the different energy-related sectors. The bureaucratic acceptability of this issue is also doubtful. Hence, emphasis should be for ensuring coordination between the regulatory institutions in the different energy-related sectors. In this regard some initiatives have been taken in recent years; the efficacy of these need to be observed. The transportation of fuel would also need simultaneous attention. Last but not the least, concerted efforts are required to remove the distortions in energy pricing and provide for mechanisms that would ensure targeted delivery of subsidies to those in need. Political support assumes importance in this context.

Renewable energy development in India

Ajit Kumar Gupta
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Energy security and climate concerns are driving a global transition towards a low carbon and sustainable energy path. Energy security has assumed vital importance in order to achieve a sustained 8%–9% growth rate in India as well. However, a new paradigm of energy security is needed to address the development goals, as removal of poverty remains an immediate imperative. This would imply not only an assured supply of energy to the vast population but energy at affordable prices, which is environment friendly and can lead to sustainable development. Though fossil fuels will continue to be the mainstay in near future, they are, however, finite. The growing import bill for oil on account of steep increase and volatility of prices is placing a heavy burden on the economy. Along with coal, oil, and gas, other energy sources such as hydro, nuclear, and renewables will, therefore, need to be developed, apart from implementation of effective demand side measures.

India is blessed with diverse natural resources like solar, wind, water, and biomass, which can be harnessed in abundant measure to meet the growing energy requirements in years to come. What is more, this can be achieved in a sustainable manner through the use of indigenous resources and people's participation, while creating employment and new economic opportunities. As far back as 1982, the Indian government could envision the promise of renewable energy, a foresight that resulted in the creation of a separate Department of Non-conventional Energy Sources. It was later upgraded to a Ministry and re-named. To this day, India remains the only country to have a separate Ministry of New and Renewable Energy.

Today, India has a renewable power capacity of over 13 000 MW, which is about 8% of the total installed capacity in the country and contributes about 3% to the electricity mix. A major contribution of 9000 MW has come from wind power. India ranks fourth in the world in wind power installed capacity. Almost the entire capacity has come through private investment. Wind power is poised to witness a structural shift, away from a captive power and tax driven market to utility-scale development. Small hydro projects, up to 25 MW station capacity, aggregating to 2200 MW have also come up. Biomass power projects of 650-MW capacity, based on combustion of crop residues and agro-industrial wastes, have also been set up by private developers. Apart from this, surplus power of about 900-MW capacity is being exported to the grid from bagasse cogeneration projects, particularly in private sector sugar mills.

India is third after the US and Germany in the Ernst & Young Renewable Energy Country Attractiveness Index. A key driver for renewable power development has been the evolving policy and regulatory framework. A comprehensive Electricity Act was enacted in 2003, which provides for the state regulators to specify a minimum percentage of power to be procured from renewable sources in the respective states. The RPS (renewable portfolio

standards) of up to 10% has already been established in 16 states for overall renewable energy purchase. The National Electricity Policy seeks to encourage private sector participation and the Tariff Policy calls upon state regulators to provide preferential tariff for renewable power.

India has considerable potential for solar power generation. High solar insulation is available on large tracts of land in arid and semi-arid regions of the country. A pilot programme has been launched for grid connected solar power projects for which tariff support will be provided on power fed to the grid. The programme has elicited tremendous response from solar companies, developers, and investors. The experience from this limited programme will pave the way to a full-fledged commercial programme, based on photovoltaic and concentrated solar thermal power, backed by a suitable regulatory regime. Solar parks or farms are likely to come up in high insolation areas, which will provide land, water, and infrastructure for power evacuation and solar manufacturing. Solar power is expected to reach grid parity by around 2015–17, against the backdrop of escalating fossil fuel prices, and reducing costs and efficiency improvements of solar power.

A key challenge in the energy sector is to provide access to India's vast rural population. Decentralized generation and distribution in rural areas has been de-licensed under the Electricity Act. The National Rural Electrification Policy calls for decentralized distributed generation to be based on conventional or non-conventional electricity generation, whichever is more suitable and economical. Renewable energy systems can be deployed even where grid connectivity exists, provided that there is unmet demand and they are found to be cost-effective. Those villages and hamlets that are not likely to receive grid connection are being provided clean energy through installation of biomass gasifiers, mini-hydel units or solar photovoltaic systems. Access has been provided to 6500 villages and hamlets through renewables. Apart from this, over 1.5 million home-lighting systems and solar lanterns have been provided in rural households. Focus is being made to provide solar lights to millions of rural households that still use kerosene, which entails a huge subsidy/under-recovery on its sale.

Biofuels are likely to play a central role in the quest for energy security and GHG (greenhouse gas) emissions reduction in the coming decades. A National Biofuel Policy is on the anvil, which is aimed at the development of indigenous biomass feedstocks and next generation biofuels to increasingly substitute petrol and diesel for transport and stationary applications. The Indian approach to biofuels is based solely on non-food feedstocks, to be raised on degraded or wasteland not suited to agriculture, thus avoiding a possible fuel versus food security conflict, while creating new employment opportunities in rural areas.

There is a vast domain of captive power in the industry, estimated at about 40 000 MW, which falls outside the installed power-generating capacity of the country. Power demand in the industry is met, largely through captive generation based on fossil fuels that entails diversion of diesel, which is heavily subsidized. Apart from the Energy Conservation Act which calls for energy efficiency in various sectors, the Electricity Act places considerable emphasis and mandates open access for captive generating plants. Renewables are increasingly providing alternative solutions for captive power in industry and mitigation of energy shortages in urban areas. There is considerable saving of conventional electricity and fossil fuels through installation of solar water-heating systems, solar air-heating systems, solar photovoltaic systems, biomass gasifiers, waste-to-energy systems, and so on. Over 2.3 million square metres of solar collectors have been installed for water heating, mainly in the domestic sector. New initiatives include promotion of green buildings based on solar passive design, installation of renewable energy systems, and development of solar cities, or green cities, through active participation of urban local bodies.

The private sector and industry are playing a major role in the production of renewable energy equipment as also in the development of renewable energy capacities. There has been a major scale-up in manufacturing capability, particularly in the wind and photovoltaic sectors. A few companies from India have attained global leadership in their respective fields. They have commenced multinational operations and renewable energy equipment is increasingly being exported across continents. Investments in the renewable energy sector in India have soared and more than $2.5 billion per annum has been invested in the incremental capacity addition in the last few years. Venture capital and private equity investments in the sector have been growing. Fourteen proposals with a projected investment of about $30 billion have been received for the production of polysilicon, solar cells, and modules.

IREDA (Indian Renewable Energy Development Agency), perhaps the only financial institution in the world solely created to provide financing to the renewable energy sector, has provided loans amounting to approximately $2.2 billion for projects

aggregating to a capacity of 3400 MW. The Indian industry is also seeking out opportunities from the expanding carbon market. About 32% of the CDM (Clean Development Mechanism) projects registered by the UNFCCC (United Nations Framework Climate Change Convention) have come from India. Over 1000 projects have received host-country approval, of which more than half pertain to renewables. If these projects get registered and implemented, they have a potential for generating about 500 million CERs (certified emission reductions) by 2012.

The *Integrated Energy Policy Report* has projected, in different scenarios, an installed capacity of 780 000–960 000 MW in 2031/32 to sustain the high economic growth, with electricity generation projected to increase to 4000–5000 billion units. The momentum generated so far in development and deployment of renewables is not only likely to be maintained but enhanced in the ensuing decades. A renewable power capacity addition of 14 000 MW is planned during the current plan period ending in 2012. Such capacity addition will entail a total investment of about $ 16 billion from the private sector. The renewable power capacity of 24 000 MW in 2012 will correspond to a share of 12% in the then projected total installed capacity of 200 000 MW. By 2032, renewable power capacity is likely to contribute 100 000–120 000 MW, corresponding to about 15% of the then installed capacity, with about 10% contribution to the electricity mix. This could go up further with likely breakthroughs in commercial solar power generation.

Recent developments in India have brought renewable energy into focus in the energy security and climate change space. In the National Action Plan on Climate Change unveiled recently, a National Solar Mission has been announced among eight National Missions. A goal of 20 000 MW of solar power by 2020 is envisaged. In addition, other renewable energy programmes are also to be strengthened to progressively and substantially result in mitigation and assist in adapting to climate change. The regulatory and tariff regime is to be enhanced, which will include introduction of RECs (renewable energy certificates) and setting up of a National Renewables Standard in order to mainstream renewable energy in the national energy system. A separate legislation for the renewable energy sector has also been proposed. A carbon tax on fossil fuel based generation is to be considered to fund the renewables upscaling efforts. With a view to provide renewed thrust to this sector, a comprehensive action plan and roadmap has been prepared, which is aimed at increasing the share of renewables in the energy mix.

India fully recognizes its responsibility, and though its GHG emissions are among the lowest in per capita terms, it has been actively supporting global efforts towards protecting the environment. Considerable progress has already been made solely through voluntary action, but these efforts could get significantly enhanced through greater flow of resources and technology from the developed countries. This will not only bring about transformational change and spur growth but will also help alleviate poverty and realize the development goals, while addressing environmental concerns in a sustainable manner. Access to critical and promising clean, and new and renewable energy technologies to developing countries that have abundant renewable resource endowment should be the key in the global energy and environment agenda.

Current activities under the ICSD

The Green India 2047 study series

In 1997, TERI undertook a major study called the GREEN India 2047 (GREEN – Growth with Resource Enhancement of Environment and Nature), with the objective to determine and quantify the extent of damage to India's natural resource base, which accompanied economic growth during the first 50 years of independence. The results of this study were documented in a publication titled '*GREEN India 2047: looking back to think ahead*'. This study was followed by a 'think ahead' component, documented in the form of a book, *DISHA for sustainable development* (DISHA – Directions, Innovations, and Strategies for Harnessing Action), which envisaged alternative development options for adopting strategies that would lead to a more sustainable future, presented 'base' and 'alternative' scenarios for the period 1997–2047, and projected quantitatively the status of our natural resources and environment.

The sequel to *GREEN India 2047: looking back to think ahead,* GREEN *India 2047 renewed: looking back to change track*, reviewed the status of the environment and natural resources to assess the gains and losses since 1997. Through this study, TERI examined if the country has indeed changed track to a more sustainable path when compared with the first 50 years of development. It also identified areas for further action and suggested ways to gather and sustain a critical momentum for a positive change.

Taking the GREEN India project forward, TERI is presently conducting a study under the aegis of the ICSD, with an aim to

- analyse the damage or enhancement in the state of India's natural capital over the last decade (1997–2007), both in physical and economic terms,
- suggest strategies that will help the country move on a more sustainable path, and
- analyse the energy and climate change challenge, with a view to examine low carbon pathways for India.

The analysis contained under TERI's GREEN India 2047 project will be used over a period of time in various documentations under the Council.

Inputs for the 13th Finance Commission, Government of India

The Finance Commission is set up with a mandate to examine 'the need to improve the quality of public expenditure to obtain better outputs and outcomes'. It is a premiere Commission responsible for identifying the flow of funds between the Centre and states in India. The 13th Finance Commission, under the chairmanship of Dr Vijay Kelkar, lays emphasis on the need to manage ecology, environment, and climate change vis-à-vis sustainable development amongst its terms of reference. In this regard, TERI is about to complete a yearlong study under the aegis of ICSD, which will be documented in the form of a report and provided as inputs to the 13th Finance Commission.

ICSD and CCICED

The Council draws inspiration from and seeks to work in close coordination with the CCICED, in order to help forge a common understanding between India and China with regard to prime sustainability issues. As a step in this direction, the Council launched its first collaborative project with CCICED, *'Environment for development: India and China'* in September 2008. The year-long study would draw commonalities, differences, and lessons, which India and China can learn from each other in the context of environment and development nexus in these countries. It would also highlight the state and trends of the environment in the last decade, thereby suggesting and charting a low carbon pathway for India and China.

Organization of the ICSD

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