India’s Energy Efficiency and Renewable Energy Potential: Policies and Programs

Jayant Sathaye (JASathaye@lbl.gov)
Berkeley India Joint Leadership on Energy and Environment (BIJLEE)
Lawrence Berkeley National Laboratory
Berkeley, CA
The Atlantic Energy Efficiency Policy Briefs

What are the most effective ways to achieve energy efficiency globally? And what forms of collaboration are likely to be most useful? The Atlantic Energy Efficiency Project was funded by the European Union to find out, drawing on experience on both sides of the Atlantic, and also on lessons from China, India and Japan.

It was led by University College Dublin, in partnership with the University of California Berkeley, the Centre for European Policy Studies (CEPS), Brussels, and the Sustainable Energy Authority of Ireland.

A series of papers were commissioned, and in 2010 and 2011, three workshops were held in Brussels, Berkeley and Paris, hosted by CEPS, the University of California and the International Energy Agency respectively.

From these activities and events, a portfolio of insights and information has been forthcoming. A number of these have been converted into Atlantic Energy Efficiency Policy Briefs, organised as follows: those in the ‘general’ category, that synthesise key findings, address action at international level, finance, and green stimulus; those in the ‘insights from the US’, ‘insights from Europe’ and ‘insights from Asia’ categories. Specifically, the following topics are addressed:

**General**


*End-use Energy Efficiency – an overview of performance and governance at international level*, Pedro Guertler

*Public sector funding for energy efficiency measures in emerging economies*, Dominic Marcellino and Christiane Gerstetter

*Linking green stimulus, energy efficiency and technological innovation: the need for complementary policies*, Edward Barbier

**Insights from the US**


*A Vermont Case Study and Roadmap to 2050*, Blair Hamilton

**Insights from Europe**


*The UK Policy Mix to reduce emissions from energy intensive industry*, Pedro Guertler, Louise Sunderland
Insights from Asia

Key Features of China’s Energy Efficiency Strategy, CS Kiang, Du Tingting, Zhao Chunhong

Will China Overwhelm the World with its Greenhouse Gas Emissions? Mark D. Levine

India’s Energy Efficiency and Renewable Energy Potential: Policies and Programs, Jayant A. Sathaye

Energy Roadmap Description and Performance – India, Arijit Sengupta and Saurabh Kumar

Insights from Japan, Patrick Shiel

The Audience

The idea is to provide the busy reader with an overview that can be digested in 30 minutes about a particular topic of interest. We hope that it will be of some use to the following:

- Members of a Minister for Energy’s cabinet or advisory team, advisers to relevant parliamentary committees
- Key stakeholder groups – business, NGO, community leaders, local government
- Members of the general public who have some knowledge, and want to know more
- The media who communicate with these groups.

In June 2011, the European Commission tabled a directive on energy efficiency¹, with the ambition that it be approved by the member states and the European Parliament by the end of 2012. The proposed Directive establishes a common framework for promoting energy efficiency in the Union to ensure the target of 20% primary energy savings by 2020 is met and to pave the way for further energy efficiency afterwards. It lays down rules designed to remove barriers and overcome some of the market failures that impede efficiency in the supply and use of energy. Specifically, if enacted, it would:

- Improve the timeliness and flow of information [individual meters, inventory of installations, assess energy efficiency of existing and new installations, promote the energy services market]
- Impose requirements i.e. regulation [purchase of high energy efficiency products and services by public authorities, retrofit of 3% per annum of total floor area owned by local authorities, obligation scheme (annual savings of 1.5%) for all for energy distribution and sales companies, waste heat recovery, priority dispatch for electricity from high efficiency co-generation].
- Remove regulatory and non regulatory barriers to energy efficiency, including split incentives (e.g. landlord vs. tenant)
- Network tariffs and regulations to provide incentives for grid operators to network users to permit them to implement energy efficiency improvements.
- Require each member state to prepare and implement an energy efficiency plan designed in aggregate to achieve a 20% reduction in final energy consumption in the EU by 2020.

China and many other jurisdictions also have ambitions to give energy efficiency parity of esteem with energy supply. We hope that these policy briefs will help advance the status and effectiveness of the efforts world-wide to advance the agenda in ways that are effective, fair and efficient.

Frank J Convery, Project Director, University College Dublin
Sheila Convery, Project Manager, University College Dublin
Christian Egenhofer, Centre for European Policy Studies, Brussels
Michael Hanemann, University of California, Berkeley
J. Owen Lewis, Sustainable Energy Authority of Ireland

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Dedication

Blair Hamilton

Lee Schipper

In the course of the Atlantic Energy Efficiency Project, two of our most distinguished contributors died. The last words of the famous French grammarian Dominique Bouhours to his family surrounding his deathbed were: “I am about to - or I am going to - die; either expression is correct”. Blair Hamilton and Lee Schipper would empathise; they both understood the value of fighting the good fight to the end.

Blair was a co-founder of Efficiency Vermont, and was director of policy at the Vermont Energy Investment Corporation, a non profit organisation created to drive the energy efficiency agenda in the State; it focussed in particular on utilities. In the US State ranking for 2009 provided by the American Council for an Energy Efficient Economy (ACEEE), Vermont ranked number 1 for Utility and Public Benefits Efficiency Programs and Policies. This achievement is largely a product of his unique combination of idealism, business acumen, persistence and very well honed political skills. He was an institution builder. What works in Vermont can work elsewhere, and latterly he was spreading the word about what they had done, how, why and to what effect so the rest of us could learn from their achievements and mistakes.

Lee’s contribution was different in style and in scope. He held a bachelor’s degree in music and a Ph.D. in astrophysics, both from Berkeley. But he devoted his professional life to marshalling evidence to challenge the conventional wisdom, or at least the political nostrums being proposed to address energy use and greenhouse gas emissions in transport. He contributed to scholarly journals, but he had a particular talent in communicating his insights simply and convincingly to the public. In Matthew Wald’s obituary in the New York Times, he noted that: “In addition to his work in the field of energy, Dr. Schipper mastered the haiku-like prose of letters to the editor, which requires making complicated points in about three sentences, and had 15 of them published in The New York Times over a 36-year period, mostly on energy”. And he brought a nice touch of whimsy to life’s table. His music group – which performed at climate change conferences – was called ‘Lee Schipper and the Mitigators.’

Dante compared death to a ship lowering its sails as it enters harbour. They have both finished the journey. It was a great privilege to have them in our midst; they will be missed.
1. What’s at stake: The critical roles of energy efficiency and renewable energy

The Indian economy has grown rapidly over the past decade. The rapid economic growth has been accompanied by commensurate growth in the demand for energy services that is increasing the country’s vulnerability to energy supply disruptions. This vulnerability is not unlike that observed in the US and China, which too import an increasing share of their oil and gas requirement.

India relies on indigenous coal, and to a lesser extent oil, to meet its energy demand. While the country has had large reserves of coal, it now imports over 15% of its coal supply, relies on imported oil for more than 75% of its oil needs, possesses limited natural gas reserves while importing 30% of total supply, and faces chronic electricity shortages. The gap between electricity supply and demand in terms of both capacity (i.e. kW) and energy (i.e. kWh) has been shifting annually in India. The extent of shortage reported by India’s Ministry of Power (MOP) in its Annual Report for 2007-08, has increased from 7% to 10% (energy) and from 11% to 17% (capacity) in the last five years. The inability of the electricity grid to supply reliable power, particularly to business consumers, has prompted increased use of captive power generation that often uses diesel fuel. The rising demand for petroleum products is expected to be met through imports. India has discovered new natural gas resources in offshore areas, which will reduce its projected dependence on the imports of this fuel. Coupled with deteriorating coal quality, India’s energy situation is likely to worsen its vulnerability to volatile fuel prices in a tightening world oil and gas market.

These vulnerabilities are being addressed through diversification of energy imports, the development of indigenous fossil and renewable energy sources, and, last but not least, reduction of the intensity of energy use of the Indian economy. In this report, we focus on ways to stretch India’s existing energy supply capacity by making energy use more efficient. The increased efficiency will permit energy companies to meet their demand obligations, and energy-short businesses to increase production that will result in higher tax payments to governments at all levels. Similar to the energy efficiency potential, India’s wind energy potential has been reassessed during the past year and the new estimates yield generation capacity that is several times the overall existing generation capacity in the country. More efficient use of energy and renewable electricity generation thus has the potential to reduce the nation’s vulnerability in both the imported fuels and electricity markets.

**Energy efficiency, renewable energy and sustainable development**

Efficiency improvement also has the potential to boost economic growth that can result in higher tax revenue for the government. An analysis of the electricity efficiency potential for India shows that efficiency improvement in combination with new supply can eliminate electricity shortages at the same investment level as for a business-as-usual electricity supply scenario. The higher penetration of energy efficiency technologies reduces the construction of power plants thereby reducing fuel imports and India’s CO₂ emissions by 300 Mt CO₂/year by

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2 http://www.powermin.nic.in/indian_electricity_scenario/policy_initiatives.htm
2017, the end of the 12th Five Year Plan. A recent report by the Ministry of Environment and Forests illustrates findings from five independent carbon emissions models. Four of these models show that India’s emissions in 2030 would range under 4 t CO₂/capita or below the worldwide average level today. A wind energy report shows a total potential capacity upwards of 748 GW. This wind generation capacity may be compared with the 160 GW current total capacity in India’s power generation. Combining wind and other renewables with electricity efficiency improvement options provides an approach for significantly reducing emissions and electricity supply costs while also increasing the GDP growth in India. A recent analysis that included both EE and RE options illustrates these benefits for 2022, which will be the end of India’s 13th Five Year Plan (Figure 1a). The total capacity in the reference scenario adds up to 426 MW with 337 MW from thermal, hydro and nuclear units. In Scenario 3, which includes higher penetration of EE and RE options, the need for thermal units declines from 228 MW to 132 MW, which results in 30% reduction in carbon emissions. The available capacity is large enough to eliminate the electricity shortages in in the reference case. Increased availability of electricity also leads to an increase in business output and GDP growth.

More importantly, provision of adequate electricity supply to business consumers adds substantially to economic growth and increases tax revenue to state and national governments. A similar analysis of macroeconomic benefits for India’s state of Maharashtra illustrates that redirecting electricity saved through efficiency improvements to electricity-short businesses has the potential to increase economic output and tax revenue, which could reduce the state government’s fiscal deficit by 15-30% depending on the size of backup power generation.

Economic analyses of energy efficiency, including demand response (DR), technologies often portray these as being cost-effective when compared with supply alternatives (Figure 1b). Since they reduce energy use and/or shift peak energy use to off-peak hours they also eliminate deleterious environmental consequences and vulnerability to supply disruptions. A key question often posed in earlier studies of energy efficiency is if the technologies are cost effective should their market penetration be higher than commonly observed in developed and developing countries. If the market penetration should be higher then what is the role for government programs and policies?

4 A recent report by McKinsey has observed that GHG emissions would increase from roughly 1.6 billion tonnes carbon dioxide equivalent in 2005 to 5.0–6.5 billion tonnes in 2030 (reference case). The report concludes that India could make a step change in its efforts to lower emissions by 30-50% to approx 2.8 billion – 3.6 billion by 2030 through an aggressive GHG abatement program. (See Section 4.1 for more information.)
5 http://moef.nic.in/downloads/home/GHG-report.pdf
9 There are two ways of reducing the peak electricity demand (Demand Response) - 1) using energy-efficient technologies to permanently reduce peak demand; and 2) creating mechanisms that allow electricity customers to occasionally reduce electricity usage for short time periods in response to signals from system operators either for economic purposes or grid safety purposes.
**Goal of the Report:**

This report accepts the premise that most energy efficiency technologies are cost effective and wind generation technology are lowest cost renewable energy sources, and that their implementation is hampered by institutional, procedural, and process barriers. This is not unique to India. There are lessons to be learnt from other developed and developing countries, such as the US and China, in understanding ways that energy efficiency and renewable energy could be promoted in the Indian market environment. The main goal of this report is to document approaches that ensure that public policy and programs work with market forces and businesses for implementation of energy efficiency and renewable energy (EERE). The paper does not attempt to provide a comprehensive review, but it highlights selected ongoing policies and programs that are overcoming barriers in the buildings, industrial and power sectors, and notes key issues that need to be addressed for their replication in India.

**What the Report Covers:**

The next section #2 focuses on the role of the utility sector in India and the progress India has made in improving its energy productivity in comparison to that in China and the United States and the barriers that continue to exist to market penetration. Section 3 of this report illustrates the Indian government’s vision and the institutions the country has established to design and implement its energy efficiency and renewable energy mandates. The final section #4 concludes by noting the lessons learned and the key activities that India could pursue in moving forward in implementing energy efficiency and renewable energy programs in the country.

1. **Improving energy productivity**

India currently ranks fourth in the world in terms of primary energy demand and fifth when biomass is excluded. If it perseveres with sustained economic growth, achieving 8-10% of GDP growth per annum through 2030, its primary energy supply, at a conservative estimate, will need to grow by 3 to 4 times and electricity supply by 5 to 7 times of today’s consumption. Its power generation would increase to 780,000 MW from a 2011 level of 176,000 MW and annual coal demand would be in excess of 2000 million tons from current 2010 level that is about 700 million tons\(^\text{10}\). At this rate, its demand for energy will continue to soar and by 2030 it could be expected to emerge as the third largest consumer of energy after the US and China. This extraordinary growth in demand will place great stress on the financial, managerial and physical resources of the country, creating capital and energy shortages as well as environmental problems.

India’s primary energy supply, excluding the supply of about 6.8 exajoules (EJ) of traditional biomass, was about 18.1 EJ in 2007 (Figure 2). This value was 19% that of the US and 25% that of China. The smaller size of the Indian economy is a factor in its lower energy use, but higher space heating demand is a significant factor in the larger energy use in the other two countries. India’s energy use per capita (excluding traditional biomass) increased at a lower rate as that of China since 1971 but India’s population increased at a much faster rate (Figure 3). The Indian population increased from 560 million in 1971 to about 1,210 million in 2010 while China’s increased from 841 million to 1,350 million over the same period.

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While the share of natural gas has increased over the past three decades, coal and oil supply have continued to dominate India’s energy sector. Coal is used extensively for power generation and in heavy industry and to a minor extent for rail transportation and cooking. Gasoline and diesel is used predominantly for transportation, and kerosene is used for lighting and along with LPG for cooking in the residential sector. Natural gas is used mostly for electricity generation and as raw material for the chemicals and fertilizer industry.

The intensity of energy and electricity use is a measure of the energy required to produce a unit of economic activity, i.e., it is a measure of the energy productivity of an economy. This energy measure has declined steadily in the US and other industrialized countries since the late 1970s, and more steeply in China since 1980 (Figure 4). Chinese energy supply increased at half the rate of economic growth until 2001 when it began to increase rather sharply raising concerns about the country’s ability to maintain a high level of energy productivity in an era of increasing market liberalization. Electricity generation intensity in both China and the US has hovered around the same level as it was in 1971 but has shown an upward trend in China since 2001 (Figure 5). Electrification of the economy is evident here as it has increasingly substituted for other energy carriers and expanded its reach into newer end uses.

In contrast to the trends observed for the US and China, India’s intensity of primary energy supply increased from 1971 to the early 1990s, and then declined steadily. India’s electricity generation intensity too increased until the 1990s, and decreased after that.

Installed electricity generation capacity in India was 177 GW in 2011 (Table 1), including 23 GW or 15% in the private sector. Over half of the capacity was coal fired and hydro, natural gas and renewables constituted much of the remaining share. Renewable sources constitute the largest increase in share of capacity since 2004-05 from 6.1 GW (Sathaye et al. 2006). Due to continued shortages of electricity supply, captive power generation continues to play an important role in providing electricity, albeit expensive, for industrial and commercial, and increasingly for urban residential consumers.

Electricity deficit increased from 7.8% of energy demand in 1990-91 to 11.1% in 2009-10. On the other hand, peak power deficit declined from 18.0% to 11.9% over this period. Figure 3 shows the average shortage of electricity in the state of Maharashtra, which has worsened since then and reached a peak of 4800 MW or 29% of capacity in 2008.

A growing amount of diesel fuel is used for captive and/or backup electricity generation. The total installed capacity of diesel based captive power plants with a capacity less than 1 MW was 23,000 MW in 2004-2005, while that greater than 1MW was reported to be 24,986 MW by 2008-09. Information on the average plant load factor (PLF) of diesel-based back-up generation plants is not available. Shukla et al. (2004) indicate the PLF of diesel-based back-up generation plants in Gujarat ranged from 15 to 40%. Since the price of diesel has increased substantially since the time of this study, and the shortage percentage has remained the same, the PLF of diesel based generators may be lower than indicated in this study. The average cost

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12 CEA (2009).
of supply from diesel based back up generators ranges from Rs. 8 to 12 per unit (CII, 2005,) compared to between Rs. 3 to 4.5 for grid based electricity.\textsuperscript{14} Depending on the PLF, diesel consumption for captive electricity generation is estimated to be between 3-8% of the country’s total diesel consumption of 39.7 million tonnes in 2004-05.

Table 1: Electricity Generation Capacity, India

<table>
<thead>
<tr>
<th>Generation Capacity (2004-05)</th>
<th>Generation Capacity (June 2011)</th>
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<tbody>
<tr>
<td>(MW)</td>
<td>(%)</td>
</tr>
<tr>
<td>Coal</td>
<td>68,434</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>12,430</td>
</tr>
<tr>
<td>Oil</td>
<td>1,201</td>
</tr>
<tr>
<td>Hydro</td>
<td>32,135</td>
</tr>
<tr>
<td>Nuclear</td>
<td>3,310</td>
</tr>
<tr>
<td>Other (Renewables)</td>
<td>6,158</td>
</tr>
<tr>
<td>Total</td>
<td>123,668</td>
</tr>
<tr>
<td>Captive (&gt;1 MW)</td>
<td>19,103</td>
</tr>
<tr>
<td>Captive (&lt; 1 MW)</td>
<td>23,000</td>
</tr>
<tr>
<td>Total Captive</td>
<td>30,195</td>
</tr>
</tbody>
</table>

Source: Economic Survey, Govt. of India (2006), CEA (2005)\textsuperscript{15}, CEA (2009)\textsuperscript{16}

Note: Captive power estimates for <1 MW are for 31 March 2004, and >1 MW are for 31 March 2005 and 2008

The trend in industrial energy intensity (industrial energy use per unit of value added) parallels the overall trend in energy intensity in India. It increased until the mid-1980s and continually declined after that (Figure 4). The trend is also similar to that in the US and China although the decline in India was not as steep as that in China where concerted policies and programs in the industrial sector led to a dramatic decline in energy intensity beginning in the 1980s. Much of the decline is attributed to gains in firm-level energy productivity; shifts in sectoral composition were less important at the 2 digit level.

Residential energy consumption (excluding traditional biomass) per capita rose the fastest in India, compared to China and the US (Figure 5). Both switching from traditional biomass to modern fuels, and the increasing use of modern fuels by an expanding urban population are driving factors behind this increase.

In a nationwide survey, the National Productivity Council has collected information from distribution companies to estimate the size of the commercial building sector. According to preliminary findings, there are 3,319 buildings with over 500kW connected load in India, the


\textsuperscript{15} Central Electricity Authority (2005) Report on Tapping of Surplus Power from Captive Power Plants. New Delhi: Ministry of Power, Govt. of India.

\textsuperscript{16} http://www.cea.nic.in/power_sec_reports/Executive_Summary/2009_04/27-33.pdf
total connected load from all these buildings is approx. 3,600 MW with an annual electricity consumption of 9,260 GWh.

Changes in population, GDP, energy intensity, and carbon intensity of energy supply (excl. traditional biomass) may be considered as key factors that contribute to changes in carbon dioxide emissions (Figure 6). The Kaya identity forms the basis for the approach used in such models. Using the identity, carbon emissions at an aggregate economy-wide level may be expressed as:

$$CO_2 = \frac{P \times GDP}{P \times E/GDP} \times \frac{CO_2}{E}$$

Where:
- $P$ = Population,
- GDP = Gross domestic product,
- E = Primary energy use
- $CO_2$ = Carbon dioxide emissions

India’s carbon emissions from fossil fuel combustion amounted to 1,250 Gt CO$_2$ in 2006, or about 22% of comparable US and Chinese emissions. Both population and GDP increases contributed to the increasing trend observed since 1971 despite the improvement in carbon dioxide-GDP intensity over this period. The carbon content of India’s fuel mix remained relatively unchanged, and hence the carbon dioxide-GDP intensity declined due to the decline in energy intensity after 1991.

**Barriers to market penetration:**

The market penetration of energy-efficient technologies is often hampered by barriers$^{17}$ that are influenced by prices, financing, international trade, market structure, institutions, the provision of information and social, cultural and behavioral factors. Many papers and reports have documented the pervasiveness of barriers to energy efficiency improvements.$^{18}$

India is moving toward the adoption of policies and regulations that promote competition and more open markets, and is thus positively influencing the adoption of energy efficiency technologies. Nonetheless, the adoption of energy efficient technologies faces numerous market impediments and failures that both must work together to overcome. Some of the most significant market barriers and steps to address them include:

- Consumer discount rates are many times higher than societal discounts rates. In industrialized countries, this has meant that incentives have been required to get consumers to adopt new technologies, even when they are clearly already in their own financial interest to do so. Similar or possibly even stronger incentives will be required in developing countries like India.
- Absence of financial intermediation by banks and other lending institutions to promote and develop energy efficiency lending; the relative lack of private sector energy efficiency service delivery mechanisms such as ESCOs. There is insufficient

$^{17}$ A barrier is any obstacle to reaching a potential that can be overcome by a policy, program, or measure.
understanding and assessment of the risks and benefits that accrue to the parties in an energy efficiency transaction.

- No incentive to build efficient new buildings. Most new commercial buildings are not occupied by the owner—they are rented. The builder's objective is to construct the building for the lowest initial cost; the renters also have no incentive to invest in efficiency improvements in a property they do not own.

- Failure by the power sector to treat energy efficiency on the same economic basis as new capacity. This market barrier is being addressed in industrialized countries by adopting integrated resources planning techniques, and by designing and implementing demand-side management (DSM) programs.

Economists recognize two categories of market failures that are relevant for implementation of energy efficiency—principal agent (PA) and lack of information problems. There are few if any papers, however, that quantify the extent to which such barriers reduce penetration of energy efficient technologies. A recent paper shows the effect of one barrier, the split-incentives or principal agent problem, on residential energy consumption in the US. The PA problem affects about 26% of refrigerator energy consumption, 42% and 48% of the electricity consumption in water heating and space heating respectively, and 2% of lighting electricity consumption. A general conclusion from this analysis is that the energy use percentage affected by the PA problem is lower in end uses where the stock turnover is rapid such as lighting, and vice versa. The affected energy use is thus masked from energy prices, implying that non-pricing programs would be more effective in reaching these customers. On the other hand, efficient lighting, CFLs for instance, while not as affected by the PA problem is still plagued by lack of information about its quality and its inappropriateness for particular applications.

Economic Gains – Who benefits? At least two and often many more stakeholders benefit from the supply and use of energy and energy efficiency services and DR policies. Identifying beneficiaries in such transactions is an important step to determining the stakeholders who would have an interest in paying for energy efficiency. Low or no agricultural electricity tariffs benefit the farmer but the utility loses net revenue in this transaction. While it is not in the farmer’s financial interest to buy efficient pumps, it may still be in the utility company’s interest to promote their use. An analysis for Maharashtra, for example, shows that the cost of installing efficient pumps would have been lower than MSEB’s short-run cost of electricity generation. It would thus be to MSEB’s benefit to promote a program on agricultural efficiency.

The same analysis illustrated that reselling electricity saved by subsidized customers to electricity-short business customers would result in additional sales tax revenue for the state. The state loses sales tax worth Rs. 9 per kWh ($0.20/kWh) for each kWh of electricity not supplied to businesses. The increased tax revenue would amount to 15%-30% of state revenue deficit depending on the level of backup generation. The state would thus be a net beneficiary and hence it would be in the state’s interest to develop programs for the promotion of energy efficiency.

21 Phadke, Sathaye, and Padmanabhan, 2005 (op. cit.)
A recent study of the macro-economic benefits of demand-side electricity efficiency improvements in India illustrates that energy efficiency costs are only a fraction of those for supply, and offer a way to eliminate the electricity deficit without increasing direct investment in capacity addition (Sathaye and Gupta, 2009)\(^2\). This study shows that energy efficiency offers a way to alleviate the deficit while potentially increasing India’s economic output by US $165 to $500 billion and employment opportunities by over 11-33 million person-years over the next eight years by the end of the Twelfth Five Year Plan (2012-2017). However, these impacts vary by the exact nature of the deficit, the rate of energy efficiency technology penetration and other variables. In addition to output and employment, removing the deficit also reduces the fiscal deficit by reducing subsidies and government capital outlay. An important conclusion from this study is that the low-voltage (LV) industrial sector and the commercial sector, which along-with the domestic sector usually experience electricity cuts during times of shortage, are actually more productive per unit of electricity consumption than the high-voltage industrial sector, which rarely experiences electricity cuts. Thus, the Indian economy would greatly benefit if the removal of electricity shortages in the more productive LV industrial and commercial sectors were given the highest priority. These results are robust even under conservative assumptions.

### 2. India’s Climate Change and Energy Vision

In July 2008, India released its first National Action Plan on Climate Change (NAPCC) outlining existing and future policies and programs addressing climate mitigation and adaptation (Table 2).\(^2\) The plan identified eight core “national missions” running through 2017. NAPCC’s goal is to focus on measures that promote India’s development objectives while also yielding co-benefits for addressing climate change. It notes that plan would be more successful with assistance from developing countries. The Plan includes eight missions, one of which is on energy efficiency, National Mission on Enhanced Energy Efficiency (NMEEE), and another one on solar energy, National Solar Mission (NSM).


Table 2: India National Action Plan on Climate Change

<table>
<thead>
<tr>
<th>Mission</th>
<th>Objective</th>
<th>Responsible Entity</th>
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<tbody>
<tr>
<td>National Solar Mission</td>
<td>20,000 MW of solar power by 2020</td>
<td>Ministry of New &amp; Renewable Energy</td>
</tr>
<tr>
<td>National Mission for Enhanced Energy Efficiency</td>
<td>10,000 MW of EE savings by 2020</td>
<td>Ministry of Power</td>
</tr>
<tr>
<td>National Mission for Sustainable Habitat</td>
<td>EE in residential and commercial buildings, public transport, Solid waste management</td>
<td>Ministry of Urban Development</td>
</tr>
<tr>
<td>National Water Mission</td>
<td>Water conservation, river basin management</td>
<td>Ministry of Water Resources</td>
</tr>
<tr>
<td>National Mission for Sustaining the Himalayan Ecosystem</td>
<td>Conservation and adaptation practices, glacial monitoring</td>
<td>Ministry of Science &amp; Technology</td>
</tr>
<tr>
<td>National Mission for a Green India</td>
<td>6 mn hectares of afforestation over degraded forest lands by the end of 12th Plan</td>
<td>Ministry of Environment &amp; Forests</td>
</tr>
<tr>
<td>National Mission for Sustainable Agriculture</td>
<td>Drought proofing, risk management, agricultural research</td>
<td>Ministry of Agriculture</td>
</tr>
<tr>
<td>National Mission on Strategic Knowledge for Climate Change</td>
<td>Vulnerability assessment, Research &amp; observation, data management</td>
<td>Ministry of Science &amp; Technology</td>
</tr>
</tbody>
</table>

The Plan’s broad goals are consistent with the three pillars of sustainable development – economic, social and environmental, which all need to be addressed in the provision of adequate energy supplies. Articulating such a vision and making it implementable in the field of energy efficiency is a challenge faced not only by India but also by other major countries. The NMEE2 builds on over 30 years of experience with energy efficiency programs in India that are summarized below.

In recognition of the importance of energy conservation, the Indian government created the Petroleum Conservation Research Association (PCRA) in 1978. PCRA continues to play an active role in the promotion of petroleum fuel saving strategies and functions as a think tank to the government for proposing policies and strategies on petroleum conservation and environmental protection aimed at reducing excessive dependence on oil.

In 2001, the Indian parliament passed the Energy Conservation Act 2001, which established the Bureau of Energy Efficiency (BEE) with effect from 1 March 2002 under the Ministry of Power. BEE’s mission is to develop programs and strategies on self-regulation and market principles with primary objective to reduce the energy intensity of the Indian economy. BEE is developing regulatory and voluntary programs and strategies with primary objective to reduce the energy intensity of the Indian economy. Some key activities that BEE is pursuing include the development of energy performance standards and labels for refrigerators, motors, air conditioners, and other mass produced equipment, certification of energy managers and auditors, assisting industry in the benchmarking of their energy use, and energy audits of prominent government buildings. BEE is also working closely with energy development agencies at the state level in order to deliver energy efficiency services including through public-private partnership.

24 http://www.pcra.org/
25 http://www.bee-india.nic.in/index1.php
The Indian Parliament also passed the Electricity Act in 2003 (referred to as the Act) under which the Government of India is directed to prepare the National Electricity Policy and Tariff Policy, in consultation with the State Governments and the Central Electricity Authority (CEA) for development of the power system based on optimal utilization of resources such as coal, natural gas, nuclear substances or materials, hydro, and renewable sources of energy. The Act consolidated laws related to generation, transmission, distribution, trade and use of electricity. Among other things, it called for rationalization of electricity tariffs, creation of a competitive environment, and open access in transmission and distribution of electricity.

The Indian central government enacted the Electricity Regulatory Commission Act in 1998 that established state electricity regulatory commissions (SERC) (Figure 10). The law mandated that the SERCs will promote competition, efficiency, and economy in the power sector, and regulate tariffs of power generation, transmission and distribution and to protect the interests of the consumers and other stakeholders. The SERCs rule on the tariffs proposed by the electricity distribution company ensuring that the criteria specified in the law are obeyed.

The Central Electricity Regulatory Commission (CERC) regulates the tariff of generating companies owned or controlled by the Central Government and those that have a composite scheme for generation and sale of electricity in more than one state (Figure 11). CERC regulates and determines the tariff of inter-state transmission of electricity, and issues licenses to persons to function as transmission licensee and electricity trader with respect to their inter-state operations. CERC specifies the grid standards and enforces the standards with respect to quality, continuity and reliability of service by licensees. CERC also serves in an advisory capacity to the Central government on the formulation of National electricity policy and tariff policy; promotion of competition, efficiency and economy in the activities of the electricity industry; and promotion of investment in electricity industry.

Central Electricity Regulatory Commission (CERC) does not have direct authority over the decisions of state commissions and utilities unless the issues span more than one state. However CERC convenes the Forum of Indian Regulators (FOR) - a statutory body consisting of the chairperson of all the SERCs - that can provide support and guidance on DSM to the SERCs (Figure 12). The objective of FOR is to evolve a common and coordinated approach to various issues faced by the SERCs.

In June 2008 FOR decided to constitute a Working Group on “DSM and Energy Efficiency” that consisted of commissioners from CERC, 3 SERCs, and the Director of BEE. The Working Group would consider the relevant provisions of the National Electricity Policy, Tariff Policy and various initiatives taken by the SERCs and give its recommendations on the following issues:

- Components in the tariff structure for providing incentives to energy efficiency;
- Institutionalizing energy efficiency in the organizational structure of distribution utilities;
- Load Research, load forecasting and appropriate DSM options;
- Preparation of DSM plans and how to implement them; and
- Special measures for promoting energy efficiency in pumping ground water for agricultural use.

26 http://powermin.nic.in/acts_notification/electricity_act2003/preliminary.htm
Indian industry associations have played an important role in promoting energy efficiency. The Confederation of Indian Industry (CII) and Federation of Indian Chambers of Commerce and Industry (FICCI) are engaged in capacity building through the organization of training programs, workshops, conferences, exhibitions, poster displays, awards, and field visits. The Indian Green Business Centre is an example of an institution created by an industry association; CII jointly with the Andhra Pradesh government and with technical support from USAID set it up as a public-private partnership\(^ {27}\). Its building has acquired the LEED platinum rating, and one of its five working groups is engaged in facilitating energy efficiency improvement across industry through improved capacity utilization, fine tuning, and technology upgradation. Private companies mobilized and set up the Alliance for Energy Efficient Economy (AEEE) in 2008 to network, provide input to policy makers, support business development, and disseminate information on energy efficiency. AEEE\(^ {28}\) was created for the specific purpose of facilitating collaboration among India’s energy efficiency industries and service providers and to help promote an energy-efficient economy through research, policy advocacy, and education.

In addition to the public and private sectors playing a role in promoting energy efficiency several civic organizations too are taking on this challenge. Prayas Energy Group\(^ {29}\) is one of these organizations playing a prominent role in providing technical and analytical support to many institutions in order to ensure that programs are designed and implemented equitably.

The government’s strong push for the use of energy efficient devices is also matched by consumer interest in their purchase, where electricity tariffs or energy prices are not heavily subsidized. For instance, recent data show that the saturation of CFLs in an average urban household has reached 2.3 lamps. This has occurred primarily due to the low price of CFLs and the associated cost advantage to the consumer. The sustainable development vision of the government needs to factor in the growing interest in energy efficient products and promote policies to encourage the private sector to manufacture and implement plans for the sale and use of efficient products. The market for such products is easily of the order of tens of billions of dollars and could eventually match the current IT industry.

### National Mission on Enhanced Energy Efficiency

On 24 August 2009 the Indian Prime Minister’s Council on Climate Change approved “in principle” the National Mission on Enhanced Energy Efficiency (NMEEE). It is said that this Mission will enable several billion dollars worth of transactions in energy efficiency. In doing so, it will, by 2015, help save about 5% of annual energy consumption, and nearly 100 million tonnes of carbon dioxide every year. NMEEE is one out of eight missions, planned under the National Action Plan on Climate Change. Following is a brief overview of the planned actions which are being envisaged by BEE under NMEEE, which takes into the EC Act 2001:

**Perform Achieve and Trade (PAT)**

The Perform Achieve and Trade scheme is a market-based mechanism to enhance energy efficiency in the ‘Designated Consumers’ (large energy-intensive industries and facilities). The scheme includes the setting of a specific energy consumption (SEC) target for each plant, reduction of energy intensity within a three-year period (2009-2012), and trading between

\(^{27}\) [http://greenbusinesscentre.com/energyeffic.asp]

\(^{28}\) [http://www.aeee.in/]

\(^{29}\) [http://www.prayaspune.org/peg/energy_home.php]
consumers who exceed their target and those who fail to meet their target. Not meeting the target may result in penalties. Energy consumption is based on external audit and BEE verification.

The PAT program implementation is currently underway and includes participation of about 500 manufacturing plants from cement, steel, aluminum and other industries. A baseline is being established for each plant, which will be used to set up a percentage reduction relevant to the plant’s characteristics.

**Market Transformation for Energy Efficiency (MTEE)**

Accelerated shift to energy efficient appliances in designated sectors will be enabled through innovative measures. These products would be made more affordable. This target would be achieved by DSM measures, supported with CDM financing wherever possible. The initiative includes the following activities: National CDM Roadmap, Programmatic CDM, Standards and Labeling, Public procurement, Technology program, Energy Conservation Building Code (ECBC), ESCOs Promotion, Capacity building and information, and Policy transparency.

Electricity use in the residential and commercial sector increased to 33% of the total consumption in 2007-08 from 24% in 1994-95. Energy use in the sector clearly deserves much more attention than has been the case thus far. BEE has several programs to set labels and standards for refrigerators, air conditioners, motors and other appliances. It has a three-pronged strategy for this purpose:

- Evolve minimum energy consumption standards for notified equipment and appliances
- Prohibit manufacture, sale and import of equipment and appliances not confirming to standards
- Introduce energy performance labeling to enable consumers to make informed choice

BEE has formulated energy labeling regulations to promote energy efficiency in the design stage for refrigerators, air conditioners, motors, distribution transformers, agricultural pump sets and fluorescent tube lights. It has the mandate to set mandatory performance standards, and to include building design codes. Judging from the potential for efficiency improvement refrigerators and distribution transformers appear to be the ones that provide the largest percentage savings.

Market research conducted for BEE recently as a part of the refrigerator and air-conditioner labeling program shows an exponential growth in the number of consumer electrical/electronic appliances in Indian households. The issue of standby power used by these products is of increasing importance. An effective labeling program has the potential to significantly reduce energy use and GHG emissions. Some of the consumer electronics/electrical products, such as TVs, computers, monitors, and ceiling fans, are included in the list of priority products for labeling in the BEE’s Action Plan.

BEE and the Central Public Works Department (CPWD) are in the process of implementing energy efficiency performance contracting projects in nine government buildings with an

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31 BEE has requested technical assistance from international partners including USEPA and USAID for labeling for consumer electronics (CE) products.
estimated annual savings of approx. 30 GWh (~US 3.5 million) with a simple payback of less than two years. BEE has developed model documents such as Performance contract, Bid evaluation, Request for Proposal, and Payment Security Mechanisms for facilitation of project implementation through ESCOs.³²

BEE with support from USAID ECO-II Project and a Committee of Experts developed Energy Conservation Building Code (ECBC) with an overall purpose to provide minimum requirements for energy efficient design and construction of buildings. In May 2007, Ministry of Power (MoP) launched ECBC for its voluntary adoption in the country. Since then BEE has been promoting and facilitating its adoption through several activities. USAID ECO-III Project has been assisting BEE in these capacity building efforts. As per the EC Act 2001, the State Government has the power to amend the provisions of ECBC to suit regional and local climatic conditions, in consultation with BEE and MoP.

Financing of Energy Efficiency

The initiative focuses on the creation of mechanisms that would help finance demand side management (DSM) programs in all sectors by capturing future energy savings. The initiative includes the following activities:

- Fiscal instruments: Tax exemptions for ESCOs and Venture Capital funds. Reduction of VAT for energy efficient equipment (e.g. CFLs)
- Revolving fund to promote carbon finance
- Partial Risk Guarantee Fund for loans made for energy efficiency projects by commercial banks

BEE has launched a very large Super Efficient Equipment Program (SEEP). SEEP’s goal is to estimate the super-efficient equipment potential which will significantly exceed the 5-Star ratings of the equipment such as ceiling fans. Current estimates indicate a reduction of more than 30% electricity consumption of SE fans compared to 5-Star fans. SE fans refer to products that are already being marketed somewhere in the world but not in India. In order to accelerate the production and consumption of SE fans, BEE will offer tax incentives to manufacturers in order to reduce the production cost and eventually the market price of the fan. BEE intends to set up similar processes for other appliances such as refrigerators and TVs but not for ACs, which may be resisted by policy makers because these are purchased primarily by higher income consumers and will thus not benefit low-income customers.

Several states have also pursued energy efficiency programs in India. India’s Energy Conservation Act 2001 provides for the establishment of state energy conservation agencies to plan and execute programs. An agency of the state of Maharashtra, such as the Maharashtra Energy Development Agency (MEDA), and/or the utility company, Maharashtra State Electricity Board (MSEB), could implement public benefit programs similar to those being implemented in the United States. The Prayas Energy Group (Pune) in its report on the DSM potential in India.

noted that DSM programs were initiated in India by the Ahmedabad Electric Company in 1994 and several subsequent programs were initiated by utility companies in the states of Maharashtra, Delhi, Madhya Pradesh, Uttar Pradesh, and Karnataka. These focused on lighting, agricultural pumping, solar water heating, and reactive power management. The implementation of these schemes was always at the pilot or experimental scale, however, and no replication of the programs was attempted by the utility companies or required by the regulatory commissions until the recent experience in Maharashtra and Karnataka.

The Maharashtra Electricity Regulatory Commission (MERC) instituted a public-benefits type of electricity charge on industry, funds from which can be used to finance renewable energy and energy efficiency programs in the state. MERC ordered utility companies in the state to begin CFL programs in the residential sector in Mumbai and in the Nasik District using these resources in late 2005. In another example, BESCOM in Karnataka initiated a program to promote the use of CFLs. Other State Electricity Regulatory Commissions (SERCs) such as those in Chhattisgarh, Gujarat, Madhya Pradesh, and West Bengal are considering starting similar programs.

**Power Sector Technology Strategy**

This strategy is aimed to enhance energy efficiency in power plants through Adoption of energy efficient generation technologies in new plants, enhancement of energy efficiency in existing plants, roadmap for IGCC demonstration plants, development of know-how for advanced super-critical boilers, and a road map for fuel shift.

**Other initiatives**

In addition to the above mentioned activities, following activities will supplement the overall plan.

- Set up a public sector implementing company -- Energy Efficiency Services Ltd.
- Strengthening of State Designated Agencies (SDAs):
- Strengthening of BEE funding for infrastructure creation to implement 8 new projects/schemes.
- Awareness Programs

**Power Sector – Smart Grids**

India’s power grid is growing and was not built overnight. From town grids to city grids to state grids to regional and now the national grid has been the journey of the past 100 years. Based on 20th century design requirements, the Indian electricity grid has not sufficiently incorporated energy efficiency, environmental impacts and customer choice. The term Smart Grids covers a wide array of activities focused on optimized (smart) integration of various components of the power system. Figure 13 highlights the various components of what constitutes a smart grid.

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34 MERC (op. cit.)
35 BESCOM (op. cit.)
These include improvements to the transmission and distribution systems, demand-side management including dynamic pricing, demand response to reduce energy use and peak loads, reducing congestion, improving reliability and power quality, energy storage systems, interoperability standards, that can help improve the use of renewables and DR options, and options for ensuring a secure supply of electricity and consumer privacy and ownerships.

The areas are to be targeted for improving the electricity system will depend on the cost and potential opportunities for making improvements within the system. In the US the potential is substantial in the development of “net-zero” energy buildings that include both on-site generation and efficiency improvements while that in India is more spread out through the power sector since the efficiency of electricity generation, T&D, and end-use are all relatively low.

The opportunities are also large in India because its economy is growing at almost three times the US rate of growth and hence integration of new power plants, more efficient operation of T&D systems, distributed generation, and demand response offer a significant long-term benefit unlike that in the US where bulk of the system is already in place. Smart Grid also allows accountability of energy use, by improving power quality, alleviating congestion and energy losses due to transmission, distribution, and theft. The modernization of grid involves solutions that involve both of policy and technology. The Smart Grid emphasizes on integration of control systems and information technology (IT). With strengths from many key IT and control companies, a coordinated collaborative process will enable public-private partnerships to develop Smart Grid solutions as new technologies is rolled out in India.

In India, the birth and rapid growth of the IT industry has led to its rapid expansion and assisted the use of efficient devices through much of the Indian economy in a manner similar to that described above. The aggregated effect maybe observed in a rapid decline in the energy intensity of the Indian economy since 1997 compared to a slower decline from 1991-1997 and an increase prior to 1991. While detailed analysis of the factors driving the trend are not available, it would not be unreasonable to assume that a continued improvement in the IT industry would help lower the energy and emissions growth rate of the Indian economy as well.

In India the aggregate technical and commercial (AT&C) losses are very large, about 35%, and hence the discussion and effort on smart grids in India has focused primarily on how to reduce these losses. From a carbon perspective, it is important to note that the reduction in loss needs to focus on the technical losses, which are in the range of 25 to 30%. Reducing the non-technical (commercial) losses is good for improving the utility finances but has no direct benefit for reducing energy use and emissions since the electricity is being generated and used by someone but not being paid for. In India, the focus needs to be on reduction of technical losses and the other items noted in Figure 12.

The Indian IT industry in particular has a significant potential for participation in the development of Smart Grids. IT industries, such as Infosys, are already active in promoting Smart Grids. An increased focus on the installation of smart electronic meters and their use for managing peak load through utility controlled time of use pricing would enable demand management so as to reduce the peak demand shortages, which are about 12% in 2008-09

studies have shown that demand response through smart meters eventually leads to reduced electricity demand with limited load shifting, which results in reduced electricity generation and decreased carbon emissions.

As noted in Item 1 on electricity shortages, reduction of technical distribution losses by 10% from 27% to 17% would result in annual savings of 69 TWh and CO2 reduction of 55 MtCO2/year. The extent to which these losses can be reduced through the use of Smart Grids, however, needs to be investigated further.

**Renewable Energy:**

As a developing country, India does not have binding emissions reduction targets, but voluntarily declared a reduction of 20-25 percent in missions intensity by 2020 compared to 2005, at the Copenhagen talks. India has been promoting renewable energy through its Ministry of New and Renewable Energy (MNRE) since the 1980s. Under the Electricity Act (2003) and the National Tariff Policy (2006), the Central Electricity Regulatory Commission sets indicative preferential feed-in tariffs (FiTs) for different grid-connected renewable energy technologies including solar, while individual state electricity commissions are free to adopt these tariffs or set their own norms (Table 3).

Table 3: Renewable Energy Feed-in Tariff: CERC Norms

<table>
<thead>
<tr>
<th>Sr No</th>
<th>RE technology</th>
<th>Tariff (Rs/kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wind</td>
<td>3.75 – 5.63 (based on wind zone)</td>
</tr>
<tr>
<td>2</td>
<td>SHP</td>
<td>3.35 – 4.62 (based on plant capacity &amp; location)</td>
</tr>
<tr>
<td>3</td>
<td>Solar PV</td>
<td>18.44</td>
</tr>
<tr>
<td>4</td>
<td>Solar thermal</td>
<td>13.45</td>
</tr>
<tr>
<td>5</td>
<td>Biomass power</td>
<td>3.83 – 5.42 (based on location)</td>
</tr>
<tr>
<td>6</td>
<td>Non fossil fuel based cogeneration</td>
<td>4.16 – 5.62</td>
</tr>
</tbody>
</table>

The big push for solar came in 2010, when the Central Government of India launched the Jawaharlal Nehru National Solar Mission (JNNSM), which set a target of developing 22,000 MW of solar installed capacity by 2022. The mission stated the following deployment objectives – clean energy, energy security, environmental awareness and, most importantly, access to energy, given that a large section of the population is deprived of it. The mission also has


40 The overall JNNSM target includes individual targets of 20,000 MW for grid-connected solar (both PV and CSP) and 2000 MW of off-grid solar by 2022. Phase I of the JNNSM has a target of 1000 MW (half PV and half CSP) of large scale grid-connected solar, 100 MW of rooftop solar PV, and 200 MW of off-grid solar by 2013. The mission also sets targets for solar home lighting systems aimed at providing clean lighting solutions to a large section of the population without access to electricity.
domestic value addition objectives of job creation, economic development (by developing the domestic industry), and strategic support for RD&D.\textsuperscript{41}

Given the high interest in setting up large-scale grid connected solar plants (1000 MW target for Phase I), the Indian government selected projects through the reverse auction mechanism. Auction of the first 150 MW of solar PV and 470 MW of CSP yielded tariffs that were on an average 30 percent lower than the Central Electricity Regulatory Commission’s cost-plus-based tariffs.\textsuperscript{42} The first 1000 MW of solar power from large-scale plants will be ‘bundled’ with 1000 MW of cheap coal power from the government-owned National Thermal Power Corporation, and sold at a bundled rate to the distribution utilities. This cheap coal power is highly valued by state utilities and its bundled price with solar is also expected to be attractive compared to market prices in power-deficit India. However, this arrangement is limited to Phase I of the JNNSM, following which the demand for solar is expected to be driven through solar-specific RPOs. In 2011, the National Tariff Policy was amended to prescribe a solar specific RPO, starting from 0.25 percent in 2012-13 to 3 percent by 2022.\textsuperscript{43} However, given the poor financial health of electric utilities, it remains to be seen whether individual states (where state electricity regulatory commissions are independent and free to set their own RPO targets) will set and enforce solar-specific RPOs that are aligned to national targets.\textsuperscript{44} In addition to expanding deployment, India aspires to develop its domestic solar manufacturing industry. The Indian government is providing a 20-25 percent capital subsidy through the Special Incentive Package Scheme of the Department of Information Technology for different parts of the PV manufacturing supply chain.\textsuperscript{45} To encourage the development of its domestic PV manufacturing industry and avoid potential imports from lower cost suppliers from other countries, the government of India has imposed some mandates for domestic content for its utility-scale solar power projects under the JNNSM.\textsuperscript{46}

Forty percent of India’s households (approximately 70 million) have no access to electricity, and have to rely on subsidized kerosene for lighting. Many more households that are connected to the grid do not get reliable electricity, especially in the rural areas, where power cuts are


\textsuperscript{43} Ministry of Power, Government of India (2011), “Amendment to the Tariff Policy”

\textsuperscript{44} In 2008-09, state owned utilities in India (that form the bulk of utilities) reported aggregate losses (without accounting for state government subsidies) of 53,000 crores (~US$12 billion) (Power Finance Corporation (2010), “Performance of State Power Utilities for the years 2006-07 to 2008-09”).

\textsuperscript{45} Department of Information Technology, Ministry of Communications and Information Technology, Government of India (2007), “Special Incentive Package Scheme to encourage investments for setting up semiconductor fabrication and other micro and nano technology manufacture industries in India”, available at http://mnre.gov.in/noti cation/noti cation-210307.pdf, accessed on 5th July 2011.

frequent. Solar home lighting systems and solar system micro-grids are being looked upon as an option to provide clean lighting to rural households.\textsuperscript{47}

In addition to solar energy, wind energy provides the largest share, about 14,500 MW of renewable energy. It is a sector that has increased very rapidly over the past 5 years from about 6,000 MW. The estimated potential for wind energy is enormous in excess of 750MW. Wind energy has received very strong government tax incentives for many years. The Government of India initially gave incentives to grid quality power generation by wind turbine technology in 1985.

The Ministry of Non-conventional Energy Services (MNES which is now MNRE) formulated a series of policy incentives and fiscal incentives that have been successful in the development of the wind power sector in the late 1980s. On top of this policy, individual state governments have declared their own incentives. These incentives have created an attractive investment environment that has led to a surge of investment in the sector. The fiscal incentives extended by the Indian government to the wind turbine sector are twofold. Direct taxes – 80 per cent depreciation based on the investment in plant capacity in the first year of installation of a project and a tax holiday for 10 years. One result of these incentives has been to encourage industrial companies and businesses to invest in Indian wind power. An important attraction is that owning a wind turbine assures them of a power supply to their factory or business in a country where power cuts are common. Wind farms in India therefore often consist of clusters of individually owned generators. Much of the installed capacity is in the states of Tamil Nadu (46 per cent), Gujarat (16 per cent), Maharashtra (18 per cent), Karnataka (13 percent) and Rajasthan (12 per cent). The private sector has dominated investment (97 per cent) in these regions (GWEC, 2005).

The Indian government has recently issued new tax incentives that focus on the generation of electricity and not on the plant capacity. The wind suppliers, however, have a choice of selecting either the capacity and generation incentives to pursue. Thus far the focus continues to be on capacity incentives noted above that unfortunately does not provide incentives to increase the capacity factor of Indian wind power plants, which historically have been very low.

3. Conclusions:

Future growth in energy demand will place considerable stress on India’s ability to garner domestic and imported energy supplies. Continued energy shortages and environmental pollution, particularly in urban areas, may be exacerbated, and the country may continue to be vulnerable to potential oil and gas supply disruptions, and to the volatility of petroleum crude prices. Exclusive dependence on supply sources would aggravate the energy security risk posed by such disruptions. Energy efficiency offers a cost-effective solution to overcoming this risk that is almost entirely within the control of the Indian government and private sector. Building capacity to plan and implement energy efficiency programs will help advance India’s energy security and mitigate the local environmental and global warming impact of unbridled energy

growth, specifically coal. Improving the country’s energy productivity will require a concerted effort by all sectors.

Renewable energy offers a substantial potential for generating electricity. Due to the rapid expansion of wind power plants over the past five years, renewable energy is the fastest growing component among all the power generation sources. Combined with potential growth of solar power plants renewable energy can also contribute to the elimination of electricity shortages, reduction of local pollution and carbon emissions from conventional power plants. Policies that promote faster growth of wind energy, development of new transmission grids, and ways to integrate renewable sources into the grid are being worked on and hopefully will be set up soon to accelerate wind penetration.
**Figures**

**Figure 1a: Installed Capacity 2022 Example**

![Installed Capacity 2022 Example](image)

**Figure 1b: Energy efficiency is competitive with generation technologies – US example**

![Energy efficiency](image)

Figure 2: Primary Energy Supply (EJ)
(Excl. traditional biomass)


Figure 3: Primary Energy Supply per Capita (Excl. traditional biomass)
(Indexed to 1971=100)

Figure 4: Primary Energy Supply /GDP

(PJ/2000 US $; Excl. traditional biomass Indexed to 1971=100)

Sources: International Energy Agency, Paris, France
Figure 5: Electricity Generation/GDP
(kWh / 2000 US $, 1971=100)


Figure 6: Maharashtra State Electricity Board – Available Capacity and Demand
(Annual average 2002-03)

Figure 7: Primary Industrial Energy Consumption /Value Added
(PJ/2000 US $; Indexed to 1971=100)


Figure 8: Residential Energy Consumption per Capita
(Excl. traditional biomass; 1971=100)

Sources: International Energy Agency, Paris, France
Figure 9: Decomposition of India’s CO2 Emissions
(Indexed to 1971=100) (Primary energy excludes traditional biomass)

Figure 13: Integrated Smart Grid Considerations

Transmission
- Real time system improvements
- Congestion control
- Intelligent Agent integration and application
- Implementing RFS
- Advanced grid communications and control
- Extreme event planning and response
- CAISO market redesign (MRTU)
- Automatic network reconfigurations
- Rapidly deployable systems
- Self healing grid

Distribution
- Distribution automation
- Advanced grid communications and control
- Congestion control
- Self healing grid
- Implementing Microgrids
- Integration of DER
- Reliability, availability, PQ improvements
- Reduce peak demand
- Low carbon network benefits

DER Integration
- Integrating renewables
- Integration of DER
- Implementing Microgrids
- Advanced grid connected power electronics
- Advanced communications and control

Demand Response
- AMI systems and implementation
- CAISO MRTU Implementation of DR
- Advanced communications and control
- Integration of DR automated technologies
- Development of enabling DR technologies

Energy Storage
- Renewable firming and dispatchability
- Reduce peak demand
- Low carbon network benefits
- Advanced grid connected power electronics
- Advanced communications and control

Security
- Wireless Network Field Demo
- Network survivability
- Self healing systems
- Rapidly deployable systems
- Automatic network reconfigurations