



Energy Efficiency in India

History and Overview

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Foreword

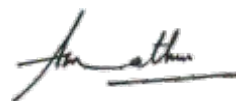
India's substantial and sustained economic growth is placing an enormous demand on its energy resources. The gap between electricity supply and demand in terms of both capacity (i.e. kW) and energy (i.e. kWh) has been steadily growing. Consequently, energy efficiency across all sectors of the economy is essential to enable the decoupling the economic growth from energy supply growth, while ensuring that energy service demands are met.

The Government of India has initiated a comprehensive programme to significantly enhance availability of energy at an affordable price to meet the growing needs of the economy. While capacity addition has been a major focus, energy efficiency along with renewable energy and nuclear energy are the thrust areas to ensure sustainable development. Accordingly, enabling energy efficiency policies have been put in place with an aim to create appropriate conditions for a robust market to function and unlock the estimated potential of around 20%. The enactment of the Energy Conservation Act 2001 has led to the implementation of various Energy Efficiency and Demand Side Management programmes in different sectors of the economy.

These programmes seek to accelerate the diffusion and adoption of energy efficient products, services and best practices, through a combination of regulatory "push" and demand "pull" initiatives, coupled with innovative business models and technical and institutional capacity building.

Documentation of the energy efficiency interventions in India will help provide insight into the lessons learnt, as well as identify the roadmap ahead. The compendium being brought out by Alliance for an Energy Efficient Economy (AEEE) under the aegis of Shakti Sustainable Energy Foundation will be a reflection of the Indian industry's experience in the sustainable transition towards energy efficiency.

I compliment AEEE on bringing out this document. I am sure that this compilation, through the sharing of experience and lessons, will provide further impetus for the rapid adoption of energy efficient technologies and practices.



Ajay Mathur, Ph.D

Director General,

BUREAU OF ENERGY EFFICIENCY

(Ministry of Power, Government of India)

About AEEE

Alliance for an Energy Efficient Economy (AEEE) is an industry association that provides a common platform for energy efficiency stakeholders.

Over a short period, since its formation in 2008, AEEE has carved out a niche as an advocate and think tank in energy efficiency and clean energy debates. AEEE addresses barriers to EE implementation through policy research; facilitating market transformation; fostering technology innovations; capacity building of energy professionals; and stimulating financial investments.

AEEE has supported government policy formulation in Measurement & Verification, Demand Side Management, and in developing performance and quality assurance systems and approaches. AEEE programmes and initiatives have complemented the efforts of peer associations on focused themes and activities by engaging them as partners and collaborators.

About Shakti Sustainable Energy Foundation

Shakti Sustainable Energy Foundation aids design and implementation of policies that support the efficient use of existing energy resources as well as the development of cleaner energy alternatives. Shakti is part of the ClimateWorks Network, an association of technical and policy experts that operates through a network of regional foundations in the areas with the greatest potential for reducing greenhouse gas emissions. Shakti is ClimateWorks' regional foundation for India.

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List of Acronyms

AEEE	Alliance for an Energy Efficient Economy
Ag DSM	Agriculture DSM
ASE	Alliance to Save Energy
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
CDM	Clean Development Mechanism
CEA	Central Electricity Authority
CII	Confederation of Indian Industries
CO ₂ e	Carbon Dioxide equivalent
DC	Designated Consumer
DisCom	Distribution Companies
DSM	Demand Side Management
EC Act	Energy Conservation Act 2001
ECBC	Energy Conservation Building Codes
ECO-III	Energy Conservation and Commercialisation Programme-III
EE	Energy Efficiency
EIA	Environmental Impact Assessment
EPC	Energy Performance Contract
EPI	Energy Performance Index
ESCert	Energy Saving Certificates
ESCO	Energy Services Company
GHG	Greenhouse Gas
GRIHA	Green Rating for Integrated Habitat Assessment
HVAC	Heating, Ventillation and Air Conditioning
IEP	Integrated Energy Policy
IGBC	Indian Green Building Council
IGEA	Investment Grade Energy Audit
IREDA	Indian Renewable Energy Development Agency
LEED	Leadership in Energy and Environmental Design
MNRE	Ministry of New and Renewable Energy
MoCF	Ministry of Chemicals and Fertilizers
MoP	Ministry of Power
MoUD	Ministry of Urban Development
MoMSME	Ministry of Micro, Small and Medium Enterprises
MSMEs	Micro, Small and Medium Enterprises
MTOE	Million Tonne of Oil Equivalent
MuDSM	Municipal DSM
NAPCC	National Action Plan for Climate Change
NBC	National Building Code
NMEEE	National Mission for Enhanced Energy Efficiency
NMSH	National Mission on Sustainable Habitat
PAT	Perform, Achieve & Trade
PCRA	Petroleum Conservation Research Association
REEC	Regional Energy Efficiency Centre
SDA	State Designated Agency
SEC	Specific Energy Consumption
SIDBI	Small Industries Development Bank of India
ULB	Urban Local Bodies
UNFCCC	United Nations Framework Convention on Climate Change

History of Energy Efficiency in India

Overview

The chapter

- Traces the origins of the Energy Efficiency movement in India and tracks the Fuel Efficiency initiatives and institutions involved
- Recognises and acknowledges the role of and contributions by individuals, organisations, policies and institutions towards EE developments in India over the years¹

A national interest in energy conservation in India began in the 1970s as an outcome of the global oil crisis triggered in 1973 with the onset of the Yom Kippur war. Conservation efforts initially directed towards reducing the consumption of petroleum fuels were broadened over the years to include electricity. As energy fuelled the rising aspirations of a growing industrial economy in India, it was evident that drastic reductions in consumption would be difficult. Every sector, be it industry, infrastructure, agriculture or housing depended on energy inputs. Reduction in wastage and higher efficiency in use was the key. The potential for conservation and increasing efficiency was huge – from exploration, refining, pipelines and transportation to retailing (in the case of liquid fuels); and in the case of electricity – from power plants to transmission and distribution, and

end-use in appliances. However, there was still a long way to go before energy conservation and efficiency was incorporated into various policies and legislation as we see today.

Figure 1 shows that yet India has traversed a long path in its energy conservation initiatives. The earliest approach to efficiency was primarily awareness creation through print and electronic media (radio in those days). At the time, the primary effort came from the ministries dealing with petroleum fuels and (to a smaller extent) electricity, which aimed at creating awareness about energy efficiency and conservation issues. The government's emphasis was mainly on identifying supply sources to meet the growing demand.

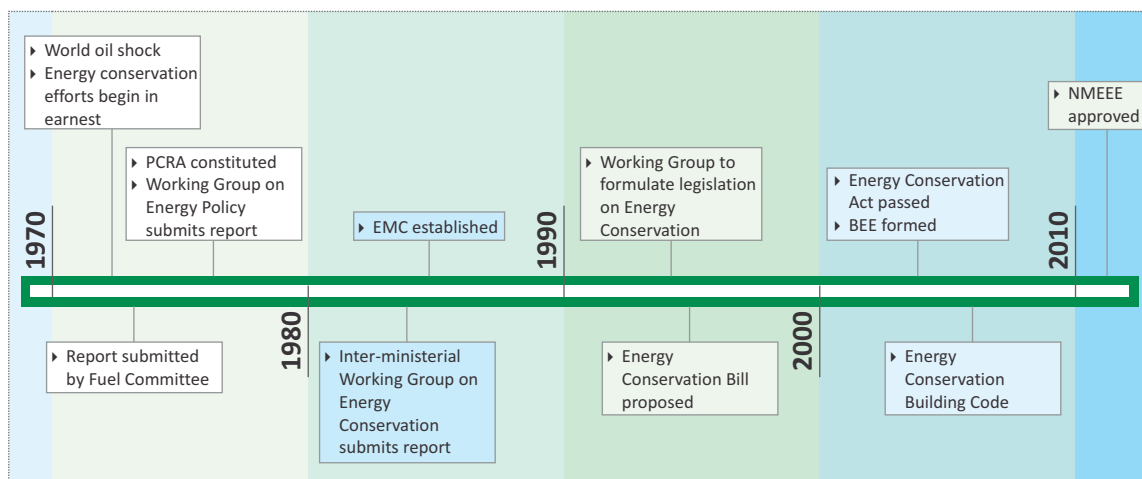


Figure 1: Timeline of important energy conservation initiatives in India

¹ THIS BOOK IS AN EFFORT TO CREATE A SINGLE SOURCE OF INFORMATION ON VARIOUS EE INITIATIVES IN INDIA. ALL EFFORTS HAVE BEEN MADE TO INCLUDE PEOPLE, ORGANISATIONS AND EVENTS THAT HAD AN IMPACT ON EE IN INDIA. ANY EXCLUSION IS UNINTENTIONAL.

1947-1970: Post-Independence Surge in Energy Demand

The Indian Electricity Act, 1910 provided the basic framework for electricity supply in India. The period immediately after independence saw the introduction of many new policies, legislation and programmes aimed at progress and development in India. Electricity was one of the sectors which received attention during this period. The primary concern was the supply of electricity, and also oil and coal, to support growth; conservation of energy was not a matter of priority during the first 15-20 years after independence.

- ▶ The Electricity (Supply) Act of 1948 was created to aid co-ordinated development of electricity which was identified to be of increasingly urgent importance for post-war re-construction and development. It allowed for the creation of the **Central Electricity Authority (CEA)** in 1950, to develop “sound, adequate and uniform” national power policies and co-ordinate development.
- ▶ The **Planning Commission** was set up in March 1950 and charged with the responsibility of assessing of all resources in the country, augmenting deficient resources, formulating plans for the most effective and balanced utilisation of resources and determining priorities. The **first Five Year Plan (1951-56)** allocated 27% of the budget outlay towards irrigation and power; multi-purpose river valley projects were given importance. The **second and third Five Year Plans (1956-61 and 1961-66)** gave impetus to interconnection between regional grids, allowing the grids of different states to be connected together. The third Plan, for the first time, referred to increased efficiencies in large thermal boilers by using high temperatures and pressures. It also acknowledged that the overall efficiency of thermal stations had been very low, around 20% until 1960, but improvements were expected in the future due to the operation of larger units.
- ▶ One of the earliest movements to promote “productivity culture” in India was started by the Government of India when the **National Productivity Council (NPC)** was set up in 1958. Besides providing training and consultancy, the NPC undertook research in the area of productivity. This coincided with the formation, in 1959, of the Tokyo based **Asian Productivity Organisation (APO)**, an inter-governmental body of which the Government of India was a founder member. NPC became the rallying point for efficiency in fuel and energy over the next few years and was the focal point for some of the

Pioneers of EE Practices

Organisations like the South Indian Steam and Fuel Users’ Association (SISFUA, now known as Energy and Fuel Users’ Association of India), National Productivity Council – South India, Industrial Fuel Research Consultants (IFCON), Ahmedabad Textile Industry Research Association (ATIRA) and Bombay Textile Research Association (BTRA) have promoted energy conservation. SISFUA pioneered energy audits targeting small and medium enterprises in the regions.

Source:

Prof. Chandra Mohan, Kongu Engineering College, Erode

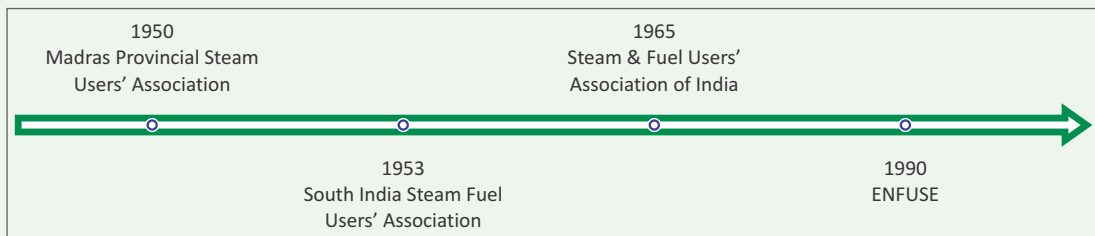
earliest international support and exchange from the UK, Japan and other developed countries.

- ▶ Integrated Energy Planning was recognised as an essential element of development planning in India as early as the sixties, but with very little focus on Demand Side Management (DSM). The **Energy Survey of India Committee (ESIC)** was established in 1963 to study demand and supply of energy on a national, regional and sectoral basis. The study was to provide the government with a framework for energy development planning until 1981, with specific focus on rural energy requirements. The ESIC estimated energy demands for different growth scenarios and made recommendations for investments and pricing of different forms of energy.
- ▶ The **fourth Five Year Plan (1969-1974)** for the first time decoupled power and irrigation and considered power as a separate area for development. Installed capacity increased to 14,290 MW at the end of 1969, from about 1,710 MW in 1950. Although the power sector began with 40% ownership of installed capacity by the public sector, a national push towards increasing public sector dominance in the power sector resulted in **State Electricity Bodies (SEBs)** owning 80% of installed capacity by 1970.

The 1970s: Energy Conservation to Address Energy Access Crisis

Energy & Fuel Users' Association of India (ENFUSE)

ENFUSE can be considered as the first national body with a vision to represent a wide spectrum of Indian organisations who are producers and users of all forms of energy and fuel, including the Building Sector, Chemicals, Textiles and Tyre industries, besides the core sectors like Power, Petroleum and Steel. Its origins can be traced to 1948, when a conference of steam users and boiler inspectors was held in the erstwhile state of Madras, initiated by the government. As a fall-out of this conference, the Madras Provincial Steam Users' Association was formed in 1950, with the objective of assisting boiler owners and users in solving their technical problems. It was a voluntary and non-profit organisation to maximise energy and fuel usage effectiveness, particularly in the industrial sector by playing the role of catalyst and advisor. Awareness programmes that included conferences, seminars, workshops and training programmes were held in different regions of the country. In 1990, the Association was finally renamed as the "Energy and Fuel Users' Association of India" to reflect its role and scope of interests pertaining to several forms of energy besides steam fuel like electricity, compressed air, renewable sources etc.



Evolution of ENFUSE (1950-90)

As industrial production grew, energy became ever more vital for the country. Industry accounted for nearly two-thirds of consumption in the form of furnace oil; power was a growing and major consumer. Dependence on petroleum, particularly fuels used in household and transport sectors, had risen to technologically unmanageable levels.

- ▶ 1973 was a turning point for India, and indeed, the world. In response to a US decision to support Israel in the Yom Kippur war between Israel and a coalition of Arab states, the **Organisation of Petroleum Exporting Countries (OPEC)** announced an oil embargo. The consequent increase in the price of petroleum products led to a world-wide rise in the price of oil, introduced rationing for the first time, and triggered efforts towards energy conservation. The increased oil prices were particularly difficult for oil-importing developing countries since they did not have the financial wherewithal of developed countries to respond to the increased prices. The 1979 Iranian revolution

affected Iran's oil production and Saudi Arabia announced cuts in production which drove oil prices further up.

- ▶ By the end of the 1960s, the government realised the need for understanding the supply-demand balances over the next two decades in order to plan for the energy requirements of the country. The **Fuel Policy Committee (FPC)** was set up in 1970 to develop the country's national fuel policy for the next 15 years. **T L Sankar**, who headed the FPC, introduced the concept of efficient use of fuel. He was involved in working with energy-related issues in a number of capacities². The FPC adopted techniques like the econometric forecasting and end-use analysis in arriving at sectoral energy



T L Sankar

²Interviews with Prof. Chandra Mohan, Kongu Engineering College, Erode, March 2005.

demand estimates. The focus of the Committee was on the necessity of substitution of oil by coal and higher efficiency in electricity generation and transmission with special attention to hydel power developments. It also provided an outline for the energy policy of the country and suggested the integration of the energy plan with the national plan.

The era's national strategy for enforcing a culture of Energy Conservation

- Categorisation of petroleum products based on end-use necessity
 - Maximisation of efficiency of utilisation in areas necessarily dependent on the use of petroleum products
 - Weaning of consumption from petroleum products to coal and other feasible forms
 - Promotion of specialised training in energy conservation with respect to petroleum, coal and power
- The 1973 world oil crisis made the FPC consider the implications of the crisis on the Indian economy. As a result, the recommendations made by the Committee in its final report in 1974 included substitution of oil by coal and electricity, and promoted energy conservation in general. The study highlighted the supply side of energy. With continued economic growth being of primary interest, the government aimed at promoting and enforcing a culture of energy conservation at all levels so that it became a permanent discipline at consumption points as well.
- An inter-ministerial body called the **Standing Committee on Furnace Oil** consisting of members from the petroleum, coal, power and railway ministries was set up by the government as the main implementing mechanism, chaired by the **Directorate General of Technical Development (DGTD)**. To provide the necessary technical support, the Energy Conservation Division in the DGTD was also created. During 1974-75 an overall saving of some 15% in the consumption of fuel oil was achieved. This was a factor in determining the level of assistance in

fuel oil supply to industrial and power projects expected to be commissioned in future years.

- With a fuel crisis looming on the horizon, the NPC took up fuel efficiency issues in the industrial and transport sectors. Under the leadership of **P R Srinivasan**, fuel efficiency services were launched by the NPC in 1974 during an era when conserving fossil and commercial forms of energy was confined to a few practitioners on the shop floor, textile research groups and academia. NPC was at the forefront of energy conservation and efficiency initiatives. It was involved in training and seminars, consulting for and implementing changes in energy conservation and efficiency. **Indian Oil Corporation (IOC)** and **DGTD** were also involved in energy efficiency and conservation activities. IOC was the first company in the world to ask its customers to cut down on consumption. DGTD served as the main medium of communication between the government and industry, both recognising it and treating it as their spokesperson. The industry's cooperation and acceptance of the various energy related programmes by the government would not have been possible without the DGTD's drive, or without the extensive experience and expertise of IOC and NPC.

P R Srinivasan – Sowing the seeds of EE in India

PRS, as he was known, had a significant influence on the success of NPC's efforts. A proponent of energy audits and modern technology, PRS was constantly trying to bring international experience to Indian energy efficiency efforts. He attempted to promote various EE techniques like flameless combustion and submerged combustion for the ceramics and steel industries, fluidised bed combustion boilers, low- and zero-excess air burners and cogeneration in sugar mills. But low energy costs of the era and high investments for these equipment discouraged takers for these interventions.

Source: Interviews with Dr. G C Datta Roy (CEO, Dalkia Energy Services Ltd), Prof. Chandra Mohan (Kongu Engineering College, Erode), K P Nyati, Head, Environment Management Division, CII.

► Fuel and energy issues became the focus for policy in the mid-1970s. The Working Group on Energy Policy was constituted under the fifth Five Year Plan in 1977 to outline the national energy policy over the next 5-, 10-, and 15-year periods. The Group submitted its report in 1979. After a detailed analysis of the existing and future energy scenarios of the country, the Group suggested a number of measures to optimise the level and pattern of energy use. The major thrust of these policy prescriptions was towards:

- ✦ curbing oil consumption to the minimum possible level
- ✦ increasing the efficiency of utilisation of energy
- ✦ reducing overall energy demand by reducing intensity of energy consumption
- ✦ increased reliance on renewable energy sources, mostly hydro power

In the wake of the oil crisis and in recognition of the importance of energy conservation, the Petroleum Conservation Action Group (PCAG) was established in 1976 with initiative from NPC, IOC and DGT, which then evolved into the **Petroleum Conservation Research Association (PCRA)** in 1978, under the aegis of the Ministry of Petroleum and Natural Gas, to make oil conservation a national movement. They aimed to do this by creating awareness about the importance, methods and benefits of conserving

petroleum products; by promoting research and development in industry, transport, agriculture and domestic consumers, especially in fuel-efficient technologies; by providing training and technical assistance for better economy and increased efficiency in the use of energy; and also by promoting the substitution of petroleum products by alternative sources of energy. IOC was the primary supporter of PCRA among the oil companies, being its spirit and providing manpower until the 1980s. PCRA developed a number of national petroleum conservation programmes and was involved in awareness and training programmes. PCRA continues to promote measures for accelerating conservation of petroleum products and proposes policies and strategies for petroleum conservation to the Government of India.

The Tata Energy Research Institute (TERI)

TERI was established in 1974 with the vision of tackling and dealing with the earth's finite energy resources. Over the years, the Institute developed a wider interpretation of its core purpose and its application with national and international linkages. Today, TERI activities contribute to demonstrative projects, training and policy research with linkages to the government. The Institute established the TERI University in 1998. Since 2006 TERI has been known as 'The Energy and Resources Institute'.

The 1980s: Energy Productivity and Energy Management

An **Inter-Ministerial Working Group on Energy Conservation (IMWG)** was constituted in 1981 to develop policies to achieve energy savings targets, which submitted its report in 1984 under **D V Kapur**, Secretary to Heavy Industry. IMWG asked the NPC to conduct 200 energy audits covering 12 industrial sectors, which established the fact that an energy saving of INR 19.25 billion could be achieved by investing INR 36 billion. The report stated, "Energy conservation requires lesser energy inputs for the same level of economic growth. In other words, an increase in energy productivity is the hallmark of energy conservation. Energy conservation also implies the substitution of costly imported energy by cheap energy; the harnessing of non-conventional energy resources to supplement conventional resources etc. In the hierarchy of importance, substitution of oil by coal occupies the major importance and challenge." The Group proposed the creation of an apex body to initiate, co-ordinate and monitor the progress and implementation of various energy conservation measures in India.



D V Kapur

- ▶ It was acknowledged in the **sixth Plan (1980-85)** that it was necessary to reduce dependence on energy imports. However, the Plan noted that a country cannot be said to be dependent on other countries as long as it is able to pay for these imports and called for an all-out effort to accelerate growth of exports. About 28% of petroleum products consumption in 1984-85 was being met through imports.
- ▶ **Advisory Board on Energy (ABE)** was set up in 1983. In addition to several important recommendations on the technical, financial and institutional aspects of energy, ABE also made detailed projections of energy demand in different regions till 2004 under assumptions of different macro-economic scenarios. These estimates were made based on both end-use and regression methods. Unlike the predecessor working group that provided policy guidelines for energy sector planning, owing to the complexity of the investment choices available in energy and energy-related sectors, ABE was set up to evaluate various options together with reference to the costs of energy resources involved. This was to provide a more precise indication of the optimum energy strategy to be adopted by the government. The seventh Planning Commission took up long-term energy

modelling to analyse the supply options available in coal, oil, natural gas and electricity with reference to the economic resource costs involved.

The Government of India introduced various fiscal incentives to prioritise energy conservation in industries

- Effective from April 1983, a 100% depreciation allowance on import duties of specific energy-saving devices and systems was allowed (since 2004, they are limited to 80%).
- Energy audit subsidy schemes through various agencies were made available.
- Financial Institutions and banks – SBI, IDBI, ICICI, IREDA, SIDBI and a few other FIs – provided schemes to support energy conservation, energy audit and installation of energy conservation measures.

ABE commissioned the formation of Energy Conservation Bill

- The Bill recommended amendments in the existing law, including the Motor Vehicles Act of 1939, the Bureau of Indian Standards Act of 1986 and the Essential Commodities Act of 1955
- The draft of the Bill completed in 1988 proposed a Nodal Energy Conservation Organisation (NECO) whose observations and recommendations would be binding on all Central and State government agencies as well as on the prescribed authorities.

A 1988 legislation made by the Indian Law Institute reportedly forced the government to abandon the Bill.

- ▶ From 1985, the erstwhile Department of Power (now the Ministry of Power) functioned as the nodal point for the government to facilitate the implementation of a co-ordinated strategy on energy conservation. The Department focused on Energy Conservation (EC) strategies and funding support for strengthening EC programmes, including outreach programmes. An important post of Advisor, reporting to the Cabinet Secretariat, was created to provide a boost to the national effort for energy conservation.
- ▶ In 1989, an **Energy Management Centre (EMC)** was also set up as an autonomous organisation, with the assistance of the **World Bank** and **United Nations Development Programme (UNDP)**, to promote energy conservation. The centre co-ordinated energy auditing of consumers, energy management systems, education and training, and energy generation and conservation based employment and poverty alleviation programmes. In 1986, PCRA started focusing on energy auditing and took up a major initiative for the empanelment of energy auditors.

The 1990s: Energy Demands of an Unregulated Economy

Up until the beginning of the 90s, the Indian economy was protectionist in nature and largely closed to the outside world. A large public sector, a host of nationalised institutions, centrally designed policies and state intervention in markets characterised the economy. The economic crisis of 1991 forced the then government to adopt a policy of reforms including deregulation, privatisation and opening up the country to foreign investment. These reforms included the Energy sector.

- ▶ Despite all the activities described earlier, there was no legislation on the conservation of energy, because of which there were no legal powers to enforce energy conservation and efficiency activities. In 1994, the Ministry of Power constituted a working group of representatives from various ministries to formulate legislation on energy conservation. In 1997, it was decided to propose an enactment for energy conservation, which, in turn, would result in the setting up of a **Bureau of Energy Efficiency (BEE)**. A cabinet note for this proposal was approved in 1997, and a one-man committee was set up to review the proposed **Energy Conservation Bill**.
- ▶ The **ninth Plan (1997-2002)** recognised the need to conserve natural resources and the need to encourage use of renewable sources of energy like the sun and wind. It states, “It is important that conservation of natural resources receives adequate priority, especially from the environmental angle. The danger of further deterioration in the quality of air and water is not unreal... Therefore, it is essential that these resources are used with utmost care so that growth is sustainable.” The Plan also gave cognisance to the need for an appropriate technology base to tackle the issue of natural resource conservation.

The 1990s also saw the beginning of some innovative initiatives targeting energy conservation.

The first Oil Conservation Week (OCW) was organised in 1991, and its continued success led to its extension to the Oil Conservation Fortnight (OCF) from 1997; during this period, awareness and educational programmes and various sectoral activities are undertaken. The government declared 14 December, as the **National Energy Conservation Day** and the **National Energy Conservation Awards** were instituted to recognise organisations contributing to energy conservation in various sectors (In 2010,

1990s – Oil companies promoted major measures to conserve energy and the environment

Energy conservation projects such as revamping and replacing low efficiency furnaces and boilers and various methods for improved energy efficiency, such as enhanced heat transfer system, were deployed.

PCRA undertook various sectoral programmes for oil conservation:

- Adoption of efficient engines and fuel efficient driving habits with training programmes in the transport sector
- Carried out energy audits and fuel oil diagnostic studies in industries
- Promoted fuel-efficient practices like standardisation of fuel-efficient irrigation pump sets in the agricultural sector and development of fuel-efficient domestic appliances

awards were given away in 32 sectors.)

- ▶ In 1991, the government introduced the voluntary **Ecomark Scheme**, licensed under the Bureau of Indian Standards (BIS) for a small fee. The criteria for labelling are based on the entire product manufacturing cycle, from raw material extraction to disposal. Broad environmental aspects are covered in the evaluation including the energy used. The scheme is applicable to a wide variety of products, from food additives to cosmetics to textiles. However, this scheme has not found many takers in the country due to lack of awareness among both manufacturers and consumers.
- ▶ Since the early 1990s, various bilateral bodies have actively worked with the Ministry of Power and its nodal organisations for energy conservation in India – USAID, GTZ, SIDA, DFID, JICA, ADEME, DANIDA, ADB, World Bank and

UNDP, and have put in massive efforts in bringing in their expertise and technical support to intensify national level energy conservation efforts³.



Sreenivasan Padmanaban

Sreenivasan Padmanaban – Witnessing and participating in the evolution of India's energy efficiency pathways

Padu joined the National Productivity Council in 1976, as a fuel efficiency specialist. He led industrial studies across various sectors including Paper, Sugar, Textiles, Cement, Steel and Pharmaceuticals. Padu was part of the core team at NPC that was carved out to set up the PCRA in 1978. PCRA's extensive educational campaign was spearheaded by the team under Padu. A range of information leaflets and booklets were developed that covered fuel efficiency in sectors from cooking stoves to efficient use of steam and fuel oil, as well as efficient combustion of boilers and furnaces in industries.

Padu's engagement with the World Bank in the 1990s was integral in shaping the early efforts towards power sector reforms in India, especially the unbundling of the Utilities in Orissa into generation, transmission and distribution companies. He set the tone for energy efficiency market transformation in India through bilateral and multilateral support. Over the last decade, as a senior Energy and Environment Advisor to USAID, Padu was instrumental in putting the mooring of the new BEE in 2002.

For his contributions during the last 30 years, to energy conservation in India and globally, Padu received the Council of Power Utilities Award in 2010. He also received the Energy Professional Development Award in 2008 (from the Association of Energy Engineers, USA) in recognition of his efforts in advancing capacity development programmes in energy efficiency and power distribution management in India, and the World Clean Energy Award in 2007 by an international jury constituted by the Swiss-based Transatlantic 21, in global recognition of his achievements in advancing energy efficiency and renewable energy.



³ United States Agency for International Development (USAID), the German agency 'Gesellschaft für Technische Zusammenarbeit' (GTZ) now known as GIZ, UK Department for International Development (DFID), the French Agency for the Environment and Energy Management (ADEME), Danish International Development Agency (DANIDA), Swedish Development Cooperation Agency (SIDA), Japanese International Cooperation Agency (JICA), Asian Development Bank (ADB), United Nations Development Programme (UNDP)

EE Policy Initiatives for Sustaining Economic Growth

Overview

This chapter provides

- ▶ An overview of the latest policies and institutions in place that promote EE in India

India, at present, is the fourth largest consumer of energy in the world⁴. With the present production rate in the country, it is estimated that the current recoverable reserves in oil, natural gas and coal will serve the country for 21 years, 36 years and 114 years respectively. Currently, over 70% of India's energy needs are being met by imports. The energy requirement is expected to grow in the coming years and it is projected that India will become the 3rd largest energy consumer by 2020, after the US and China.

The Energy Conservation Act 2001

In February 2000, the Energy Conservation Bill was introduced in the 13th Lok Sabha. Both Houses of Parliament passed the EC Bill, which received the President's consent in September 2001. The Energy Conservation Act (EC Act) was published in the Gazette of India in October 2001 (and effective from 1 March, 2002) and is known as the Energy Conservation Act 2001⁵.

- ▶ In 2002, the Energy Management Centre was re-instituted as the **Bureau of Energy Efficiency (BEE)**. The EC Act identifies BEE as the statutory body under the Ministry of Power, entrusted with regulatory powers for enforcement of various recommendation of the Act and has penalty provisions for non-compliance

With the passing of the Energy Conservation Act and the constitution of the BEE, the energy efficiency movement is gathering steam in the country. This is particularly important since the expected rapid economic growth will lead to an acceleration of power demand and of the installation of electricity-based appliance stock, often with fairly long lifetimes, especially for some household goods and industrial equipment. Each kW saved at the end-use side is equivalent to almost 1.8 kW saved on the generation side (once auxiliary consumption at the power plant and T&D losses are taken into account). Further, there is also great potential for end-use

Key directives of EC Act 2001

- Minimum energy consumption standards for appliances and labelling of energy use
- Prohibit manufacture, sale and import of equipment and appliances not conforming to standards
- Identification of energy intensive industries and other establishments to be notified as Designated Consumers (DC)
- EE improvement in unorganised sectors such as domestic and agriculture sectors
- Energy audits by accredited energy auditors and implementing techno-economic viable recommendations
- Amending of energy conservation building codes to suit local conditions
- Establishment of Central and State Energy Conservation Fund
- Energy-use inspection of DCs
- Enforcement of energy consumption norms

energy efficiency gains in the country. For example, it is estimated that the deployment of energy efficient lighting, more efficient refrigerators in households, and more efficient motors in industry

⁴Challenge of Availability: Continuity of supply quality & reliability of service, Background Paper, Indian Energy Congress, 2010, New Delhi.

⁵Legal Frame Work for Energy Conservation, MSDA, <http://www.msda.nic.in/downloads.html> Accessed on 21-Jan-2011

could save as much as 10% of the power generation. The industrial and domestic sectors are the two largest consumers of utility-generated power in the country. Consumption in the domestic sector has been growing rapidly, mainly as a result of increasing

penetration of energy-consuming appliances such as refrigerators and air conditioners. Demand Side Management (DSM) measures by utilities, including load shaping, were identified as important.

The Electricity Act 2003

The Electricity Act 2003 was enacted to harmonise and rationalise provisions of existing laws and to reform legislation by “promotion of efficient and environmentally benign policies”; the Act mandates efficiency in various forms in generation, transmission and distribution. Under the provisions of Section 3(1) of the Act, the Central Government brought out the National Electricity Policy for the development of the country’s power system based on optimal utilisation of resources.

- ▶ The policy emphasises higher efficiency levels of generating plants, stringent measures against electricity theft, energy conservation measures and boosting renewable and non-conventional energy sources.



Kirit Parikh

The Kirit Parikh Committee’s Integrated Energy Policy report (2006)

The report stresses the need for energy independence and suggests a number of alternative policy options including:

- Acquisition of oil reserves in other countries
- Resort to increased energy efficiency in the economy itself

The Committee highlighted the need for policy incentives to encourage manufacturers to improve EE. Central to the report is the message that EE investments are as significant as those investments in generating energy. Energy saved is equivalent to or more advantageous than fresh energy generated.

- ▶ DSM was accorded high priority, periodic energy audits were made compulsory for power intensive industries, emphasis was placed on labelling of appliances and high efficiency pumps in agriculture, load management and differential tariff was suggested, and Energy Service Companies (ESCOs) were to be encouraged (the last three have been initiated by BEE).

Reliance on imported oil: Along with the electricity demand, India’s oil requirement is also growing rapidly. Today, India consumes about 3 million barrels of oil per day⁶. The nation’s crude oil imports are projected to reach 5 million barrels per day in 2020, which is more than 60% of Saudi Arabian oil production currently. Power generation, industrial fuel, transport, fertilisers and petro-chemicals form some of the major consumers of petroleum products. The government has initiated various steps to promote conservation of petroleum products in the transport, industrial, agricultural and domestic sectors:

- ▶ Adoption of measures and practices which are conducive to increase fuel efficiency and training programmes in the transport sector
- ▶ Modernisation of boilers, furnaces and other oil-operated equipment with efficient ones and promotion of fuel-efficient practices and equipment in the industrial sector
- ▶ Standardisation of fuel-efficient irrigation pump sets and rectification of existing pump sets to make them more energy efficient in the agricultural sector
- ▶ Development and promotion of the use of fuel-efficient equipment and appliances like kerosene and LPG stoves in the household sector

⁶ India’s Downstream Petroleum Sector, IEA 2010, www.iea.org/papers/2010/Indian_Petroleum.pdf Accessed on 13-Feb-2011

These activities are promoted and co-ordinated by the PCRA and oil marketing companies under the guidance and supervision of Ministry of Petroleum & Natural Gas. R&D projects that have been taken up, including the recovery of kerosene in textile printing, trials of Battery Operated Vehicles (BOV) and synchronisation of traffic lights.

National Mission for Enhanced Energy Efficiency (NMEEE)

The Working Group for the **eleventh Plan (2007-12)** suggested an outlay of about USD 1.4 billion for energy conservation measures, but this is minuscule in relation to the budget for other elements of the power sector. One of the objectives of the Eleventh Plan is to reduce the energy intensity per unit of Greenhouse Gas (GHG) by 20% from the period 2007–08 to 2016–17. India's objectives for GHG emission reduction was formally addressed when the Government of India launched the **National Action Plan for Climate Change (NAPCC)** in mid-2010.

The NAPCC relies on eight missions where the **National Mission for Enhanced Energy Efficiency (NMEEE)** is a critical one. NMEEE aims to boost the programmes under the EC Act through four major initiatives:

- ▶ Perform, Achieve and Trade (PAT) scheme, designed as a market-based mechanism to enhance efficiency in DCs (energy intensive industries and facilities as specified by BEE) by setting goals, reducing energy intensity and allowing those who exceed goals to receive energy permits that can be traded with other DCs
- ▶ Market Transformation on Energy Efficiency (MTEE), which envisages an active shift to energy efficient appliances and machinery in designated sectors through innovative measures
- ▶ Financing mechanisms to help finance Demand Side Management (DSM) programmes
- ▶ Enhancing of EE in power plants

The Bureau of Energy Efficiency (BEE)

Since the enactment of the Energy Conservation Act 2001, the decade saw various policy initiatives for mobilising public and private enterprises towards EE. The BEE was formed, under the Ministry of Power, as a vehicle for deploying the recommendations of the EC Act. The BEE is also the legal entity for executing the initiatives under NMEEE and engages in public-private partnership in implementing various EE programmes under it. The EE policy endorsements through the Electricity Act 2003 and NMEEE, reinforces BEE's role as the central agency for developing and establishing systems and procedures necessary for achieving India's overarching energy efficiency goals (see Figure 2).

BEE programmes aim to achieve macro-level conservation by promoting EE in individual sectors.

Those sectors that have received multi-lateral, bi-lateral and private sector support for implementing energy conservation measures are now empowered by BEE initiatives. State nodal agencies are empowered to initiate and drive energy conservation measures. State Energy Regulatory Commissions, Distributing Companies (DisComs) and Utilities are entrusted with implementing regulatory conservation measures and promoting various EE programmes. The following chapters examine these verticals with an effort to compile various EE developments, supplemented by interviews with experts, and case studies and examples.

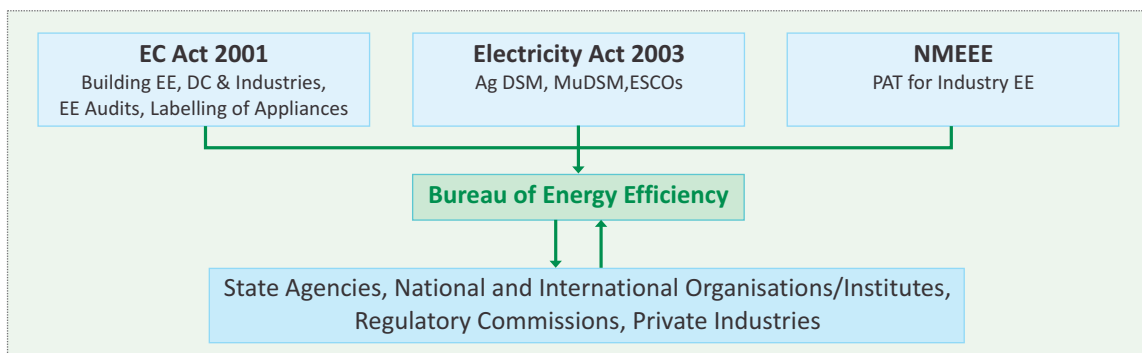


Figure 2: Policy stimuli for EE initiatives in India

Barriers to Energy Efficiency

Despite various efforts, the pace of change for energy efficiency appears to be painfully slow. Some historic barriers continue to hinder the achievement of faster market transformation in energy efficiency in India. Some of these barriers are:

- ▶ Distortions in the price including subsidised pricing of energy (including that of electricity), particularly for agriculture. Low prices provide fewer incentives for people to regulate and/or reduce consumption. This also adds to the financial burden on the country's exchequer. The recent decontrol of petrol is, therefore, a step in the right direction.
- ▶ While lack of information was a barrier in the early years, the government's effective use of mass media, including the print and electronic media, has somewhat widened the reach of the energy efficiency message. However, these changes have benefitted urban and semi-urban regions much more than others.
- ▶ Rural areas struggle with energy conservation issues in the agrarian sectors because of inefficient practices partially driven by an unreliable power supply. Non-technical losses

like energy theft has continued to be a concern.

- ▶ While small conservation projects in homes require little or no financial investment, such initiatives in the industrial, building and other sectors usually require some investment due to the scale and nature of the related activities. There is a range of financial programmes available at the central and state levels. While it is premature to comment on their effectiveness, there is a concern that information on these are not easily available to those who can benefit from it.

Thus, there is an urgent need for greater awareness about the correlation of climate change issues and its impact on the national economy and society with an emphasis on energy efficiency. For a larger impact, it requires major consumer-pull in scaling up the demand for energy efficient products and services. This book aims to compile various initiatives taken to address these gaps, the success stories, the lapses, and discusses the way forward for India's energy conservation objectives.

Energy Efficiency in the Building Sector

Overview

This chapter discusses

- ▶ The residential and commercial building sectors in India and their impact on India's energy future
- ▶ Policies affecting EE in buildings
- ▶ Building Rating Systems, Benchmarking, Appliance Standards and Labelling
- ▶ Methods to improve EE in buildings

“Energy Efficiency is indisputably the cheapest and the most sustainable option that we can easily access today. It is time energy efficiency became ‘the primary fuel’ for India.

For all things in its favour, it is sometimes difficult to fathom why the energy efficiency sector has failed to realise its full potential. India's energy commitments are huge and growing rapidly. I am convinced that the sector needs re-doubling of efforts to bring together policy makers, business and technology providers to overcome major barriers and convince the public of their critical role by initiating and sustaining behavioural change.

Society's inability to catalyse behaviour change often turns out to be the biggest barrier of all. Making energy performance visible and measurable can be a powerful way to bring about permanent behavioural change. Otherwise, advancements and progress made by policy makers and technology providers tend to get nullified by our innate desire to consume more.

Making a case for quantifying something that is invisible and intangible; struggling to come up with a compelling visual that captures the essence of the industry; grappling with the industry's fascination for widgets and features rather than giving customers what they want; doing simple things right and rewarding them handsomely – the EE industry needs to overcome these fundamental issues to start realising its full potential and truly be considered as the first fuel of the 21st century.”

Dr. Satish Kumar

*Energy Efficiency Ambassador, Schneider Electric
Past Chief of Party, IRG/USAID ECO-III Project*



Since the enactment of the Energy Conservation Act 2001, various policy initiatives and market solutions have emerged in the building sector. This chapter gives an overview of such initiatives.

Globally, buildings account for 40% of total national energy consumption. In 2009, the building sector in India accounted for a third of the total electricity consumed in the nation (BEE, 2009). The fast-growing economy is creating a huge increase in demand for building space and more than 500 million people are expected to live in cities by 2030:

- ▶ 70-80% of the building stock required by 2030 is yet to be built
- ▶ 22 billion sq. m to be added by 2020 and is expected to double by the end of the following decade

By 2030, annual steel and cement consumption will grow by six to seven times, primarily driven by construction and infrastructure development (McKinsey 2009).

If these growth rates are any indication as **International Energy Agency (IEA)** estimates, energy demand from construction activities in India

and China will influence about half of global energy investments till 2030. USD 1.2 trillion capital investments will be necessary to meet the demands of urban India in the next 20 years (McKinsey 2010).

Without energy efficient buildings, the growth in energy demand will fast outpace power generation capacity addition and add to the country's chronic electricity shortages. It is estimated that about 20-40% energy savings potential exists across both residential and commercial buildings. **United Nations Environmental Programme (UNEP)** projects that if EE of buildings in India is not prioritised, the total electricity related emissions from buildings could be more than 390% higher than current levels by 2050 (UNEP 2010). As most of the building stock required in the future decades is yet to be built, opportunities for energy conservation in buildings are large. In addition to using less energy, energy efficient buildings result in

- ▶ lower building operating costs
- ▶ increased comfort and
- ▶ better quality of environment

1. Drivers of Growth of Energy Demand in Buildings

Rapid urbanisation and better access to disposable incomes have driven the demand for better habitats. The demand from the hospitality sector, organised retail and commercial spaces and Special Economic Zones is driving the surge in India's building market. On the other hand, the housing deficit in the nation at 27-28% indicates the urgent demand for residential spaces.

Policy initiatives that opened up retail and construction sectors to Foreign Direct Investment (FDI) in 2005 and the availability of domestic finance (institutional and retail) have spurred this growth. According to Cushman & Wakefield⁷, a large portion of FDI received in the country went into the real estate and housing sectors. Between 2008 and 2012, the largest growth in demand is expected to be from the residential sector, followed by the commercial sector (see Figure 3). This is reflected in McKinsey (2009) projections where **India is expected to have 41 billion sq. m of built area by 2030.**

Increased penetration of electrical appliances in all types of buildings and wider electrification of rural

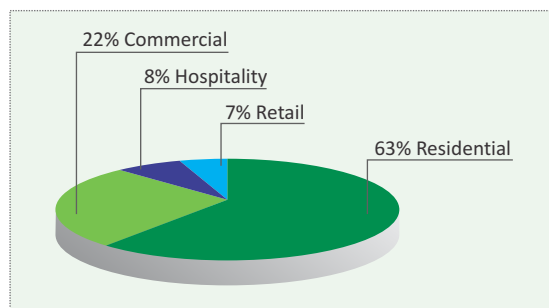


Figure 3: Floor-space demand in India (LBNL 2011)

homes influence the nation's building energy demand. Out of the total electricity consumed in 2009, the residential sector accounted for 25% while the commercial sector used about 8% (BEE 2009).

⁷ Cushman & Wakefield. 2008. *The Metamorphosis: Changing Dynamics of Indian Realty Sector*

A building's energy use is primarily defined by the electricity consumption used for lights, fans, air conditioning, and office/household appliances or machines. Water pumps also add to the energy use.

- ▶ **More than 80% of the electrical energy consumed in buildings is for lighting and cooling**
- ▶ In naturally ventilated buildings, lighting accounts for maximum energy consumption
- ▶ Air conditioning consumes about 40-50% of the total electricity in buildings, while lighting systems and other appliances contribute to 20-30% of the total⁸

Figure 4 shows the rapid increase in air conditioner sales in India that doubled in just over four years.

This growth is expected to continue its pace so that

1.1. Energy Use in Commercial Building Sector

In 2010, the commercial floor space in India was estimated to be about 1 billion sq. m⁹:

- ▶ About 30-70 million sq. m is projected to be added annually to the existing stock
- ▶ This will be about 4 billion sq. m of commercial floor space by 2030

With the increase of commercial building stock, electricity consumption of this sector has been growing rapidly at 11-12% annually. **Between 1990 and 2005, commercial building energy consumption increased by 60%.**

The floor space distribution (see Figure 5) is projected to witness a concentrated expansion in sectors like retail establishments and large private office occupancy. Amplified demand from office and hospitality sectors besides the growth in the organised retail sector will drive the commercial floor space expansion in the coming decades (BEE 2009). This demand is reflected on the electricity consumption of the sector which grew by 14% in 2009 alone. Since 2005, around 580 **Special Economic Zones (SEZs)**¹⁰ have been approved to be built on 0.11 million hectares (1.1 billion sq. m)

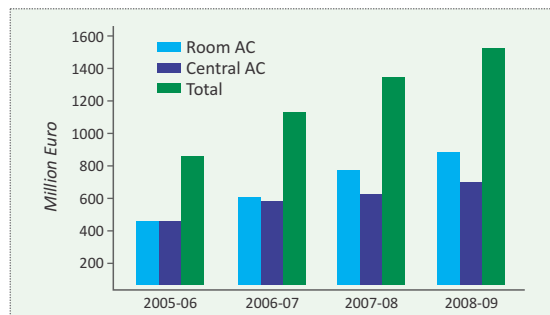


Figure 4: Growth of air conditioner markets in India (GTZ 2010)

by 2030 more than 60% of the commercial space in India will be air-conditioned, while four out of every 10 urban homes will have at least one air conditioning system installed (McKinsey 2009).

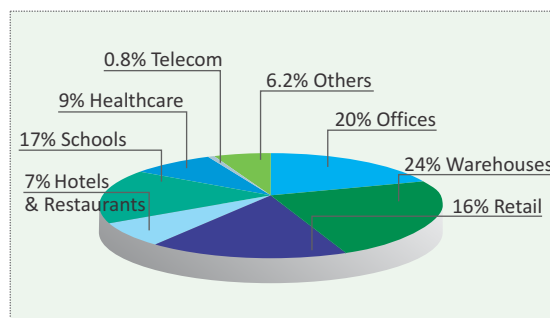


Figure 5: Commercial floor space distribution 2005 (LNBL 2011)

across the country, out of which 286 proposals are for IT and ITES companies alone. These sectors generally deploy large number of office spaces.

Figure 6 shows that air conditioning across various public and private commercial buildings attributes to 23-55% of total energy use, while lighting in the retail sector consumes about 40% of the total energy demand.

If the growth in commercial buildings continues at the current rapid rate, with no energy conservation intervention, energy use of the buildings is projected

⁸ TERI. 2000. *Energy efficiency in green buildings-An integrated approach to building design*.

⁹ LBNL (2011) & ECO-III (2010b) estimates indicate 659 million sq. m while McKinsey (2009) project 1022 million sq. m. Estimation disparity is attributed to "non-uniformity in space utilisation across regions and building types".

¹⁰ SEZs are primarily commercial regions that enjoy more free-market liberties than what is practised by the nation, thereby meant to drive FDI into the nation.

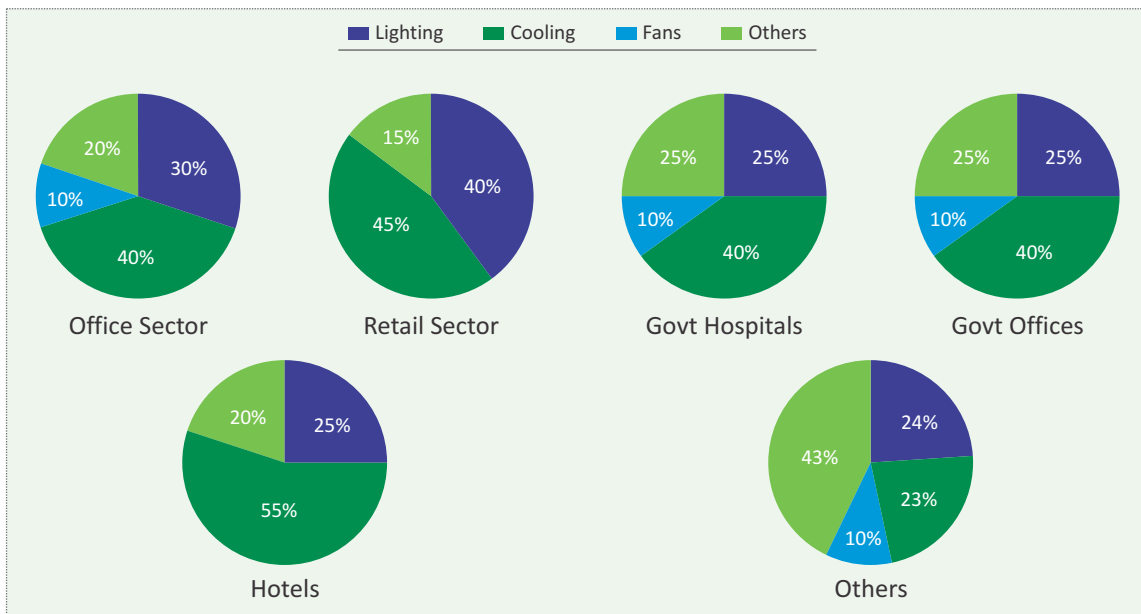


Figure 6: Energy use of buildings (LBNL 2011)

to quadruple in the next two decades. High Energy Performance Indices (EPI) of India's commercial buildings influence their energy usage, about 200-400 kWh/sq. m/year¹¹. EPI of a building indicates the annual energy required for heating, lighting, cooling etc. of unit floor space. Developed nations have much

lower EPI averages at 140 kWh/sq. m/year (Mathur 2007). As Table 1 shows, energy performance of lighting and cooling systems in conventional buildings is almost 50% higher than that of buildings with energy efficient systems.

	Conventional Buildings	Low Energy Buildings
Lighting	37-60 kWh/sq. m/year	21-28 kWh/sq. m/year
Cooling (in warm-humid regions)	263 kWh/sq. m/year	195 kWh/sq. m/year

Table 1: Energy performance comparison (TERI 2010)

1.2. Energy Use in Residential Sector

Energy demand for cooking and lighting defines the fundamental needs for household energy. The majority of rural India relies on biomass energy for cooking, kerosene is extensively used in semi-rural and suburban areas and LPG is used widely in urban India. The sheer number of households and increased appliance ownership in households drive electricity consumption in the residential sector at a compounded annual growth rate of 9.76%.

- ▶ Electrical appliances are a major source of household energy consumption, particularly in higher-income urban households.
- ▶ Appliance penetration of refrigerators and air conditioning units is expected to be the main driver of growth for residential energy demand.

Figure 7 shows that tube lights, incandescent lights and fans together account for more than 50% of the total electricity usage of households. It is projected that rapid appliance sales driven by thermal comfort demands will alone attribute to more than 40% of the total energy consumed in 2030 (World

¹¹ ECO-III arrived at this EPI based on selected samples.

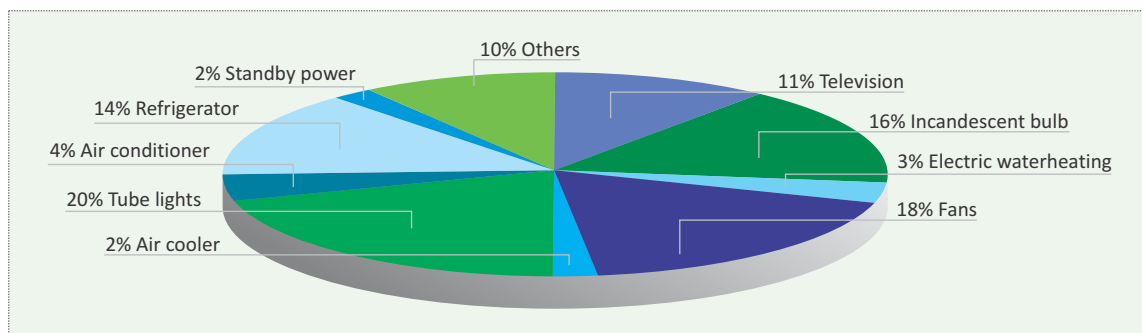


Figure 7: Appliance electricity usage share in 2008

Bank 2008). This indicates the opportunity for markets to cater to energy efficient appliances. Aided by regulatory and market drivers, buildings can reduce 30% of the additional energy demand

required in 2013. The opportunity lies in acting now so that just by using EE appliances in all households in 2008-13, capacity addition of 4,000 MW per year can be avoided (Sant 2010).

Taking the Green Way for Future Buildings

Construction growth is set to spike the energy demand by 2030 in India.

Energy demand from cement manufacturing alone will need 16% of the total coal used in the country.

Appliance efficiency will play a critical role in building energy demand.

(McKinsey 2009)

Increase in HVAC efficiency, lighting replacement with LEDs and use of high efficient appliances can **negate power demand by 390 TWh in 2030**.

This requires an **incremental capital expenditure of EUR 170 billion across 2010-30⁸** (i.e., about 2% of the GDP in 2030; currently India spends 6% of GDP on infrastructure development).

What will it cost India to not negate 390 TWh of power?

For instance, setting up India's first coal-fired advanced ultra-super critical 800 MW plant costs EUR 1.2 billion.

Assuming 60% of the actual cost, to generate 390 TWh, India will need investments worth EUR 346.1 billion.

⁸ EUR valued at 2009 (McKinsey 2009)

2. Policy Drivers

The regulatory framework for EE in buildings began with the Energy Conservation Act of 2001 and the subsequent formation of the BEE. Over the past decade, the Ministry for New and Renewable Energy (MNRE), the Ministry of Environment and Forests (MoEF), the Ministry of Power (MoP) and the Ministry of Urban Development (MoUD) have introduced sustainability components with overarching policy objectives to promote energy conservation in buildings. Table 2 lists key national policies and guidelines that recommend energy efficiency in buildings under various ministries.

Policy/ Code	Year	Ministry	Status	Energy Conservation Guidance
National Building Code (NBC)	1970 revised 2005 (under revision for 2011)	MoUD BIS	Model Code (Building Bye-Law)	▶ no mandatory energy performance standards ▶ building material ▶ construction technologies ▶ building and plumbing services
Energy Conservation Building Code (ECBC)	2007 Amendment 2010	MoP BEE	Currently voluntary, will be made mandatory by 2012	▶ minimum performance standards for building envelope ▶ roofs and windows ▶ lighting system ▶ air conditioning system ▶ electrical distribution system ▶ water heating and pumping systems
Integrated Energy Policy (IEP)	2008	Planning Commission	Policy Guidance	▶ design and construction ▶ HVAC ▶ lighting ▶ household appliances
Environment Clearance Notification – Environmental Impact Assessment (EIA)	Manual on Norms & Standards for Environmental Clearance of Large Construction Projects, 2007	MoEF	Environmental Clearance is mandatory for large construction projects with built-up area of 20,000 - 150,000 sq.m. The manual provides recommendations for energy conservation	▶ low energy design concepts ▶ energy efficient techniques and technologies ▶ solar passive techniques – landscaping, optimum building orientation, arrangement and shape of buildings, effective surface to volume ratio, proper location and size of opening, glazing type, shading of windows and selection of building materials
National Mission on Sustainable Habitat (NMSH)	Approved in 2010	MoUD	Policy guidance document	▶ sustainable habitat standards ▶ energy performance of buildings ▶ structural safety ▶ energy efficient construction

Table 2: Chronological listing of key policies and codes

2.1. The National Building Code (NBC)

NBC is India's model Building Code meant for adoption by local bodies, Public Works Departments, other government construction departments and private construction agencies. The NBC, revised in 2005, recommends that municipalities and development authorities should incorporate energy efficiency elements like daylight integration, electrical standards and heating, ventilation and air conditioning standards in their design norms.

2.2. Energy Conservation Building Code (ECBC)

The BEE introduced the Energy Conservation Building Code (ECBC) in India in 2007¹². This was the first real effort in the country to set a minimum performance standard that enables energy efficient design and construction of buildings/ major renovations if the connected load exceeds 110 kVA or if peak demand is greater than 100 kW. ECBC draws from standards set by the BIS, NBC, ISO 15099, and ASHRAE¹³.

Compliance: ECBC focuses on minimum performance of building envelope, mechanical systems and heating, ventilating, and air conditioning (HVAC) systems, interior and exterior lighting systems, hot water systems, electrical power and motors, while taking into account the five climates zones present in India. Compliance with the code is expected to have the highest impact on EE of buildings either by:

- ▶ Prescriptive Approach strictly requires all building materials, construction and equipment to meet a minimum performance standard

OR

- ▶ Whole Building Performance that allows flexibility in design but requires specialised energy simulation to demonstrate compliance, where the actual building is compared to a notional building (by simulating the modelling of compliance)

Energy Performance Index (EPI) in kWh/sq. m/year is used for measuring compliance. BEE introduced ECBC as a voluntary code and now the code is being adopted by state governments. The BEE is now proposing mandatory implementation of ECBC for 8 states: Delhi, Maharashtra, Uttar Pradesh, Haryana, Tamil Nadu, Andhra Pradesh, Karnataka and West Bengal will have to make ECBC mandatory for any new construction of commercial buildings in the states from April 2011 onwards¹⁴.

Voluntary Implementation: The mandatory deployment of the code is supported by the experience of voluntary adoption of the code and

ECBC compliant buildings could be up to 40% more efficient than non-compliant ones

- Average energy use to reduce from 200 kWh/sq. m/year to 120-160 kWh/sq. m/year

the results of the capacity building efforts to create sufficient numbers of ECBC experts in the country by:

- ▶ Publishing the ECBC User Guide, Tip Sheets, and Design Guides to assist users understand the application of the ECBC
- ▶ Awareness programmes in key cities like Delhi, Mumbai, Bangalore, Hyderabad, Pune, Chennai and Kolkata where the stock of new buildings is expected to be among the highest
- ▶ Awareness and capacity building of building designers and the concerned state level authorities through nationwide awareness workshops and training programmes
- ▶ In 2010, BEE introduced an ECBC conformance check tool, ECONirman¹⁵, to assess overall ECBC conformance of major buildings systems - envelope, HVAC, lighting, service water heating and pumping, and electrical power systems for commercial buildings. The tool is customised to check the compliance in five climatic zones in India
- ▶ ECBC capacity building programmes for architects, designers and other building professionals across the country¹⁶

¹² United States Agency for International Development (USAID) programme Energy Conservation and Commercialisation (ECO-III) has partnered with BEE in various EE initiatives for buildings.

¹³ Bureau of Indian Standards (BIS), National Building Code (NBC), International Standard for Organisation (ISO), and American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).

¹⁴ ECBC for commercial buildings mandatory for eight states from FY 12, Deccan Herald, <http://www.deccanherald.com/content/148204/ecbc-commercial-buildings-mandatory-eight.html> Accessed 1-Apr-11

¹⁵ ECONirman is designed and developed by USAID ECO-III Project in collaboration with BEE. ECONirman (beta version), launched on 10 December, 2010, is a software tool.

¹⁶ BEE has been partnering with USAID/ECO-III, CEPT University, Glazing Society of India and Shakti Sustainable Energy Foundation among others for ECBC capacity building.

2.3. National Mission on Sustainable Habitat (NMSH)

NMSH was launched by the MoUD to promote energy efficiency as a core component of Urban Planning. The NMSH stresses the need for awareness, incentives for wide-spread adoption of energy efficiency programmes, promoting a mix of voluntary guidelines and mandatory rules for energy efficiency in buildings, and capacity building of state and city-level bodies for implementing and enforcing these rules.

- ▶ Financial incentives like tax rebates and soft loans for increased adoption of efficiency measures are mooted
- ▶ MoUD aims to integrate ECBC, NBC and EIA norms for spatial and urban planning and to integrate these standards in the Building Bye-laws¹⁷

2.4. Environmental Impact Assessment (EIA) and Clearance

EIA mandated by MoEF for large development projects reinforces the objectives of NBC and ECBC.

- ▶ EIA rates projects on various environmental criteria like energy management, use of renewable energy, water harvesting, location and land use impact among others
- ▶ Both the NMSH and the MoEF acknowledge the need to integrate energy conservation recommendations of the NBC, ECBC and EIA norms
- ▶ The NMSH proposes to address this need

through the development of Sustainable Habitat Standards by integrating and harmonising various provisions of ECBC, NBC, EIA, etc. that will unify norms and standards for energy conservation in buildings (including the green building standards discussed later in this chapter)

- ▶ Effective implementation and seamless integration of the above mentioned regulatory and mandatory codes and policies will be pivotal in future building policies

2.5. Solar Passive Buildings

India has been promoting Solar Passive Buildings since the early 1980s and the initial efforts led to the construction of solar passive buildings in three climatic zones of the country – houses at IIT Delhi (Composite), hostel at Jodhpur (Hot and Dry) and extension of a dispensary at Srinagar (Cold and Cloudy). Since then, numerous residential and commercial buildings were constructed across the country. Solar Passive Buildings are now promoted by MNRE. Passive designs take advantage of local climates and reduce energy consumption for heating or cooling the building by optimising insulation, ventilation, orientation and shade of a building.

Wipro Limited, Kolkata – A recent solar passive office building with 11,079 sq. m

- The building built in a climate responsive manner incorporates ECBC recommendations
- A warm-humid zone, only a third of the building is air conditioned
- Operational 24x7
- The EPI of the Wipro building is about 35% lower than conventional buildings

¹⁷Strategic Plan of Ministry of Urban Development for 2011-2016
www.urbanindia.nic.in/what%27snew/Strategic_Plan_draft_new.pdf Accessed on 13-Feb-2011

3. Building Energy Rating

About 30% of the total commercial space estimated in India is owned by the public sector (see Figure 8). In 2003-04, a series of **Investment Grade Energy Audits (IGEA)** by BEE to assess the EE potentials in public buildings. It was estimated that public buildings and hospitals in the national capital alone consumed electricity worth more than INR 60 billion per year. From the audits across 36 cities in the country, it was identified that public buildings alone have an energy saving potential of 760 GWh per annum. IGEAs showed that air conditioning facility improvements required 80% of the total investments while only 10% of the total investments were necessary for lighting retrofit projects (Singh & Michaelowa 2004).

Following the IGEAs, retrofit projects completed in 9 public buildings including the Rashtrapati Bhavan in Delhi showed that 25-30% energy conservation can be achieved in existing buildings with a payback period of 2-3 years. The results of the retrofit programmes at Rashtrapati Bhavan (with a floor space of 18,580 sq. m):

- ▶ 27% reduction of energy demand (0.98 MWh was saved), with annual savings of INR 5.9 million while an investment of INR 5.12 million was recovered over a year
- ▶ In the second phase of the programme, 17 more public buildings were taken up through Energy Service Company (ESCO) services

3.1. Energy Services Companies (ESCOs) in India

Energy Service Companies (ESCOs) are widely promoted by BEE for accomplishing various EE initiatives. The IGEAs discussed above were to attract potential ESCOs to take up the projects, primarily in existing buildings. ESCOs not only provide technical expertise but can also financially invest in the project. The client and the ESCO enter into an energy performance contract and the investment is recovered by the ESCO from the project's savings¹⁸. The concept of EE project implementation through Energy Performance Contracting (EPC) by ESCOs has been around for more than twenty years internationally and is now emerging in India.

In 2008, the Asian Development Bank (ADB) estimated that India has an ESCO market potential of USD 10 billion that can create annual energy savings of 183.5 billion kWh¹⁹. Towards this objective, BEE initiated an accreditation system and there are now 89 BEE accredited ESCOs. Following are a few facts about ESCOs in India:

- ▶ Major presence of vendor ESCOs. Vendor ESCOs are advantageously placed as they are product driven whereas smaller ESCOs have to look for investments and are handicapped by the need for collaterals
- ▶ Banks and other financial institutions are yet to participate actively in the ESCO industry owing to a lack of confidence in ESCOs' capabilities and their unwillingness to take risks

- ▶ Information gaps and the lack of standardised processes are often barriers to ESCO industry developments in India
- ▶ The **Energy Efficiency Services Limited (EESL)**²⁰ was launched in 2010 by the government to serve as a super ESCO for the public sector (including municipalities, government buildings, etc.). It supports capacity development of ESCOs and also facilitates access to project financing. It may also act as a leasing or financing company to provide ESCOs and/or customers EE equipment on lease or on benefit sharing terms

ESCOs and their roles are discussed in this book in different chapters with greater emphasis on financing of EE in various sectors.

¹⁸ The energy savings is achieved based on guaranteed savings or shared savings model. In the shared savings model, the ESCO provides the financing, and the client and the ESCO share the savings based on a pre-determined ratio.

¹⁹ Investment Potential in India for Energy Efficiency Companies, WRI, www.wri.org/press/2009/04/investment-potential-india-energy-efficiency-companies-ripe-wri-report-finds Accessed on 10-Dec-2010

²⁰ EESL is a joint venture of four public sector undertakings – NTPC Limited, PFC, REC and POWERGRID – with a shared capital of INR 1900 million.

3.2. Rating Systems for Commercial Buildings

Energy use rating programmes for existing and new buildings were introduced to recognise the efforts in energy conservation and create a market for such energy conserving buildings. Building rating systems in India have brought energy conservation in commercial buildings to the fore, particularly by providing recognition to early adopters of green building practices. The buildings follow rating criteria to achieve one or more objectives like energy and water conservation, thermal comfort, internal air quality standards, and provision of sufficient amenities and resource conservation with low life-cycle costs of construction, operation, maintenance and demolition of the building.

- ▶ BEE Star Rating Scheme is a performance based rating of existing buildings where energy consumption is measured and rated against scientifically benchmarked building energy use data. Figure 8 shows that large commercial spaces in existing buildings have opportunities for energy conservation
- ▶ IGBC-LEED and GRIHA offer rating through green building design intent (not the actual performance) and rating by design evaluation of the building

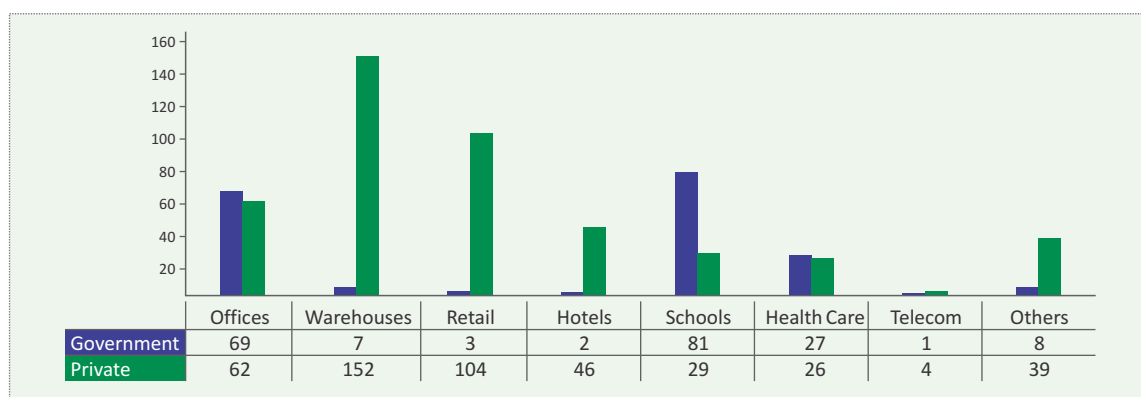


Figure 8: Commercial spaces under government and private ownership in 2005 (in million sq. m)

a) BEE Star Rating Scheme

BEE Star Rating programmes for buildings were introduced in India to create a demand in the market for EE buildings based on the EPI, the actual performance of the building. The programme covers five categories of commercial buildings – office buildings, hotels, hospitals, retail malls, and IT parks – in four climate zones across the country.

- ▶ Rating applies to buildings with a connected load of 500 kW or above
- ▶ 1-5 Star rating is given to buildings (see Figure 9), on actual energy performance of the buildings over a year
- ▶ Buildings in warm-humid, composite, hot-dry and temperate zones are currently rated (where space cooling demands are high)
- ▶ Overall energy use is considered, but the share

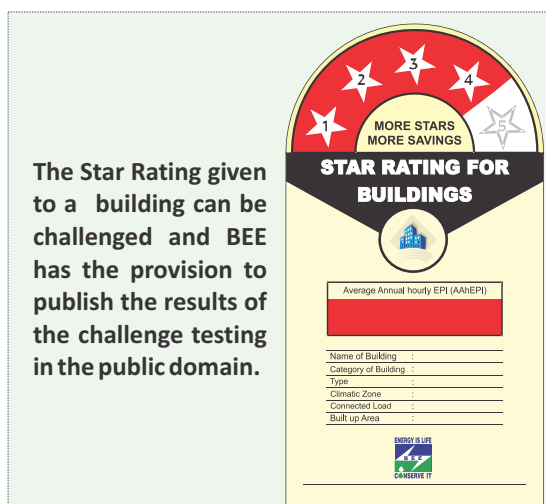


Figure 9: BEE Star-rating for buildings

of electricity generated onsite from renewable sources is not included

- ▶ As BPOs²¹ tend to have varied hours of operation, performance is measured in Average Annual Hourly Performance Index
- ▶ At the end of each year, the building owner or manager has to file the Building Information and Energy Data of that year at BEE

A building gets a premium 5-Star rating if its EPI falls

below 90 kWh/sq. m/year and 1-Star (the minimum) if it is between 165-190 and 90 kWh/sq. m/year. The climatic conditions influence the rating based on the need for air conditioning. A building located in a warm and humid climatic zone might have higher EPI, hence its bandwidth for rating is wider than that of its contemporaries in temperate zones. In 2010, BEE awarded Star labels to 49 office buildings²².

b) Green Buildings Rating Systems

With about 1,000 registered green building projects, India has the third largest green building footprint in the world, spread across 56 million sq. m (IGBC 2011). These projects include IT parks, hospitals, offices, banks, convention centres, hotels, factories and residences, among others.

Rating System	GRIHA	LEED-India	IGBC
Types of Buildings	Homes, Office Buildings, Hotels, Hospitals, Retail Malls, and IT Parks	Office Buildings, Hotels, Hospitals, Retail Malls, and IT Parks	Homes, Factories, Townships, SEZs, Schools, Existing Buildings and Landscape
Registered	108	956	
Certified	3	135	

Table 3: Overview of various Rating Systems followed in India

GRIHA

Green Rating for Integrated Habitat Assessment (GRIHA) is the national rating system in India. GRIHA was conceived by TERI²³ and developed in association with the MNRE as a green building design evaluation system, specifically developed for India. GRIHA primarily caters to naturally ventilated or partially air conditioned buildings.

- ▶ For fully air conditioned buildings, ECBC compliance is mandatory
- ▶ GRIHA emphasises the use of passive architectural practices for visual and thermal comfort
- ▶ As a point-based rating system, passive design application and energy efficiency measures fetch most credits

MNRE launched GRIHA as a voluntary scheme primarily for commercial and institutional buildings

(built area 2500 sq. m and above). By 2010, 3.95 million sq. m have already been registered²⁴ for GRIHA rating, and the eleventh Five Year Plan targets 5 million sq. m of GRIHA-compliant built-up area by 2012. It is also now mandated for all upcoming buildings under the Central Public Works Department. The **Association for Development and Research of Sustainable Habitats (ADaRSH)** promotes and maintains GRIHA.

GRIHA has a 1-5 stars rating system, based on 43

²¹ Business Process Outsourcing (BPOs) facilities often function 24x7

²² BEE Report on Verified Energy Savings with the activities of 'Bureau of Energy Efficiency' for the year 2009-10, NPC, Sept 2010

²³ The Energy and Resources Institute (TERI)

²⁴ TERI. 2011. National Conference on 'Green Design: Buildings and Habitats',

http://www.teriin.org/index.php?option=com_pressrelease&task=details&sid=216 Accessed on 1-Feb-2011

criteria, and under four categories, such as site selection and site planning, conservation and efficient utilisation of resources, building operation and maintenance and innovation points. MNRE has introduced various incentives to promote GRIHA²⁵:

- ▶ Reimbursable registration-rating fees up to 90% for 3-star rated buildings up to 5000 sq. m and for 4-star rated projects with built area of more

than 5000 sq. m

- ▶ Offers INR 5 million to municipal corporations and INR 2.5 million to other **Urban Local Bodies (ULB)** for compliance in new public buildings and providing rebate in property tax for Green Buildings and up to INR 200,000 to institutions for organising capacity building and awareness programmes

Paharpur Business Centre and Software Technology Incubator Park (PBC-STIP), New Delhi

PBC-STIP is BEE 5-Star rated, and is the first retrofit project to receive a LEED Platinum rating in India.

- Spread over 4,684 sq. m (100% air conditioned), achieved 15% reduction in energy use
- Achieved an EPI of 152 kWh/sq. m, comparable to international standards
- The energy cost constitutes less than 6 % of total operational costs

CEO Kamal Meattle was instrumental in bringing innovative measures for improving indoor air quality at PBC-STIP. Areca Palm that converts CO₂ to oxygen during the day, the Mother-in-law's Tongue that carries the conversion in the evening and the Money Plant that absorbs formaldehydes and volatile chemicals, are distributed across its facilities today.

- The 25-year old building has 1,200 plants for 300 building occupants and has been declared New Delhi's healthiest building in 2008
- The Business Centre records lower incidence of respiratory problems, eye irritation and headaches. The productivity of occupants is also found to have increased by 20%

The Delhi government conducted a pilot project at PBC-STIP to reduce the load on electricity by storing chilled water in the basement at night to be used for cooling during the day

IGBC and LEED-India

The **Indian Green Building Council (IGBC)** promotes IGBC Green rating for new constructions and major renovations of existing commercial buildings. In 2007, IGBC introduced the **Leadership in Energy & Environmental Design (LEED)** building rating system in India²⁶. LEED-India essentially utilises the LEED International framework, but incorporates India-specific requirements. 'LEED 2011 for India' was recently launched for making LEED-India more in tune with local building characteristics, Indian regulations and standards and to promote natural ventilation in the buildings (IGBC 2011). Through LEED-India and IGBC Green rating, IGBC promotes a

whole-building sustainability approach – comprising site development, water savings, energy efficiency, materials selection and indoor environmental quality. IGBC offers 100% refund of certification fee for government building projects on achieving its Platinum rating.

- ▶ LEED-India has separate ratings for the Core and Shell buildings (i.e., buildings where the owners do not control all aspects of a building's design and construction – for example, an IT park)
- ▶ IGBC has specific ratings for commercial buildings in Special Economic Zones (SEZs) and

²⁵ MNRE.2009."Revised Scheme for Energy Efficient Solar/ Green Buildings" (Issued vide sanction No. 3 / 5 / 2008-UICA (SE) dated 5 February, 2009)

²⁶ The LEED-India rating system is managed by IGBC and is promoted by Confederation of Indian Industry (CII) and Godrej Green Business Centre. LEED-India is based on LEED version 2.0 / 2.1 of the US (which uses ASHRAE 2004 codes) while LEED 3.0 is now available, that refers to ASHRAE 2008 codes.

for factory buildings. These ratings aim to address national priorities and quality of life in industrial facilities. IGBC improvises on the Green SEZ guidelines set by the Ministry of Commerce and Industry

- ▶ Based on the points earned, buildings are certified Silver, Gold or Platinum
- ▶ LEED-India and IGBC refers to ECBC for energy efficiency rating credits for buildings

Trendsetters from India

- ▶ ITC Gardenia, Bangalore, is the world's largest LEED Platinum hotel
- ▶ Tamil Nadu's legislative assembly building is the first legislative assembly in the world to have achieved a green rating. It has the IGBC Gold rating
- ▶ Delhi's Indira Gandhi International Airport Terminal T3 building is the world's first and largest LEED Gold rated terminal building

Grundfos Pumps Pvt Ltd, Chennai - the first LEED Gold Rated Building in India

Completed in March 2005, the Grundfos facility (Sriperumbudur, Chennai) spread across 3,252 sq. m achieved the first LEED India version 1.0 Gold rating (for new constructions).

- 100% of the treated water on-site is reused for landscaping and toilet flushing
- Metering system for measurement and monitoring of all building systems, continuous monitoring of the building post-occupancy as well
- Deploys high performance glazing, low U-value walls and roof, energy efficient HVAC systems and CFL, T5 and LED-based low energy lighting systems
- High reflecting and high Solar Reflective Index roofing products and shading by mature vegetation reduce urban heat island effects
- Retention basins for storm water channels
- Up to 98.77% of total construction waste debris has been recycled or reused while 10% of the building materials from recycled contents – aluminum, steel, glass, brick, fly ash cement are salvaged from old offices

Achievements

Environmental Quality	Total Possible Points	Total Points Achieved
Sustainable Site	14	9
Water Efficiency	5	3
Energy & Atmosphere	17	5
Materials & Resource	13	9
Indoor Environment Quality	15	12
Innovation & Design Process	5	4
Total Points	69	42

Conservation Results

Electricity consumption reduction by 25% in 2008, further 15% in 2009

Water consumption reduced by 38%

Daylight is used about 95% of the time in the facilities

Sources: Case Study: Grundfos Pumps Pvt Ltd, Chennai, EN3 Consultants; Green efforts of Grundfos to sustain Renewable Energy, Prasanna P, Sri Krishna Institutions, Coimbatore, 2009

“The green building movement in India has the potential to become a success. An enabling environment conducive for the growth of the sector is what is necessary. India has made tremendous progress in the green building space over the last few years. While it is commendable that over a thousand buildings are registered to be green rated, measuring the success of a movement such as this should not be confined to just the number of projects or square feet. We need to measure this against the overall infrastructure development that is happening in India. With the building industry continuing to grow for the next 20 years or so, we need to ensure that the entire development is done in an environmentally responsible manner and make sure that there is long term sustainability of these green footprints. We have to “sustain sustainability” to ensure true achievement.”



Deepa Sathiararam

*Executive Director, En3 Sustainability Solutions
Past President, ASHRAE South India Chapter*

3.3. Rating Systems for the Residential Sector

Most rating systems have largely focused on the commercial sector since energy forms a high proportion of operating costs and ratings could be leveraged by builders and construction companies to charge premium rates. It is only recently that the residential sector's energy performance is being rated. The sudden and unprecedented demand for housing and the growth of large housing complexes in urban areas have already created environmental stress on land and water. Green rating systems drive energy and water conservation, improve air quality, optimise the use of daylight and add value to the living space.

- ▶ IGBC Green Homes were the first rating programmes for homes developed in India and cater to individual and multi-dwelling units
- ▶ LEED-India is applicable to residential buildings of four or more habitable storeys
- ▶ GRIHA provides rating for residences, multi-family high-rise buildings and housing complexes
- ▶ IGBC and LEED provide pre-certification at the design stage based on the project's intention to conform to the requirements of the rating system. Pre-certification aims to create an edge for market-attraction
- ▶ IGBC Green Townships Rating System is applicable for large developments and townships with at least 25% of the built-up area earmarked for residential use
- ▶ The Eco-Housing rating and certification system developed by **International Institute of Energy Conservation (IIEC)** has 15 projects in Pune registered for certification

Green rating of residential sector

- T-Zed Homes in Bangalore by Biodiversity Conservation India Limited (BCIL) won the IGBC Platinum rating in 2009, the first project in the world to be rated after construction
- RMZ Group is the first developer in India to be awarded LEED Pre-Certified Platinum Rating (Core & Shell) green building in India for Ecospace, Kolkata, in 2007
- Chennai's MARG Swarnabhoomi a pilot, IGBC Township programme is to be the first Platinum-rated city in India

“ In the last two decades, we have been trying to interlink several trends of sustainable development (SD) at ITC Welcome Group. Instead of adding incrementally to our established green work, we formulate new questions and reframe existing debates by conceptualising transformative ideas of change as we attempt to set a stage for other stakeholders. Sustainable development requires all stakeholders to work towards the restoration of our natural resources.”

Niranjan Khatri

General Manager, ITC Welcome Group

3.4. Eco-Housing Partnership

Eco-Housing is a unique green building programme for mainstreaming sustainable housing by scaling up energy and resource efficient technologies and practices through focused financing efforts. It was first launched in India by the **Pune Municipal Corporation (PMC)** and supported by the **International Institute for Energy Conservation (IIEC)**²⁷. The programme puts forward innovative financing mechanisms for promoting residential sustainability.

- ▶ Central to the programme are rebates in municipal taxes and development charges.
- ▶ PMC rebates for premium charges are levied by the local authority on Eco-Housing projects.
- ▶ The builder bears the incremental initial cost of including sustainability measures for new constructions, which is about 10-15%, to be recovered through energy cost over 2-3 years²⁸.

The feasibility of Eco-Housing projects has also been examined in the Maharashtra State Housing Policy. Lack of easy financing for sustainable homes is a barrier in creating sustainable transformation in the residential sector. On the other hand, strong awareness and interest from homeowners remain central to promoting Eco-Housing rating.

Financing of EE Buildings: KfW²⁹ line of credit for EE

projects addresses EE in hotels, public buildings, interest subsidy for ECBC-compliant buildings, tax and duty exemptions for star-rated appliances and equipment, and income and corporate tax incentives for ESCOs/ Venture Capital funds. KfW has a loan agreement of EUR 52 million³⁰ with the National Housing Bank (NHB) for promoting energy efficiency projects in the residential space (Hindu 2011).

Examples of financing Green Buildings

- Bank of Maharashtra and ING Vysa offer Eco-Housing mortgage products
- State Bank of India provides incentives on loans for IGBC-certified homes
- PMC offers payback of 10-15% on total premium paid by builders

4. Creating EE Standards for Buildings

For the rating of buildings to be successful, energy use base-lining and benchmarking is necessary. Base-lining is necessary to understand the current energy use trends and benchmarking for creating comparative improvements against best performing buildings. Energy uses for different building categories vary owing to their distinct energy use needs and in most cases are influenced by the users' thermal comfort requirements.

²⁷ Supported by USAID and the Global Development Alliance (GDA)

²⁸ Pandit, N; Patankar, M; Prem, I, A.2010. Financing Eco-Housing in India: A Review, Housing Finance Journal - Winter 2010

²⁹ KfW (Kreditanstalt für Wiederaufbau) – German banking group that supports German aid work and works with GIZ

³⁰ EUR valued at February, 2011

4.1. Energy Benchmarking

Energy benchmarking acts as a low-cost, initial effort to evaluate buildings' energy performance and to optimise their energy use. However, until recently, little or no information was available on actual energy consumption for commercial and residential buildings in India. Besides limiting the understanding of energy consumption dynamics in buildings, it hinders the opportunities for energy conservation through measurement and verification. A National Benchmarking Survey conducted by BEE³⁰ in 2010, looked at 861 commercial buildings across different climatic zones and across different building types. Table 4 provides an overview of annual energy usages and benchmarking indices.

No. of Buildings	Building Type	Floor Area (sq. m)	Annual Energy Consumption (MWh)	Benchmarking Indices	
Office Buildings				kWh/sq. m/yr	kWh/sq. m/hr
145	One shift buildings	16,716	2,092	149	0.068
55	Three shift buildings	31,226	8,883	349	0.042
88	Public sector buildings	15,799	1,838	115	0.045
224	Private sector buildings	28,335	4,499	258	0.064
10	Green buildings	8,382	1,590	141	-
Hospitals				kWh/sq. m/yr	kWh/bed/yr
128	Multi-specialty hospitals	8,721	2,453	378	13,890
22	Government hospitals	19,859	1,365	88	2,009
Hotels				kWh/sq. m/yr	kWh/room/yr
89	Luxury hotels (4-5 star)	19,136	4,866	279	24,110
Shopping Malls				kWh/sq. m/yr	kWh/sq. m/hr
101	Shopping malls	10,516	2,341	252	0.05642

Table 4: Benchmarking overview – Averages for different commercial buildings (ECO-III 2010b)

The study noted that multi-specialty hospitals have the highest EPIs (about four times higher than that of government hospitals) followed by 3-shift office buildings and 4- and 5-star hotels. With such detailed analysis, the study can serve various purposes:

- ▶ A decision-making tool where the benchmarking indices (like kWh/sq. m/year, kWh/sq. m/hour, kWh/bed/year, kWh/room/year, etc.) can help policy makers, building designers, ESCOs, energy auditors, energy analysts and researchers get a better understanding of energy use in this sector.
- ▶ It can help decide on conducting expensive investment grade audits.
- ▶ Provide a favourable ground for inviting building owners for discussing the scope of energy conservation. Though a large number of energy audits have been conducted for commercial buildings, the proportion of owners who choose to implement the audit-recommendations are very low.

4.2. Standards and Labelling of Appliances

Table 5 shows the growth of household appliances penetration during the last two decades. Residential energy demand accounts for almost 22 % of the total electricity demand in India and contributes almost fully to the peak load of utilities. BEE introduced the Standards and Labelling (S&L) programme in 2006, to tap the energy saving potential of such growth trends by mandating appliances' efficiency and hence affecting consumer choices.

³⁰ In partnership with Building Energy Benchmarking study undertaken by the USAID ECO-III Project

Appliance	1993 (NSSO ³¹ Survey)	2005 (NSSO Survey)	2007 (DSCLES ³² Survey)
Ceiling Fan	566	818	1094
Air Cooler	64	182	483
Air Conditioner	NA	31	92
Refrigerator	123	319	801
Washing Machine	41	NA	454

Table 5: Appliance penetration per 1,000 households
(cited in GTZ 2010)

BEE mandates display of labels on specified appliances/equipment for enforcing minimum efficiency standards and prohibits manufacture, sale, and import of products not meeting the standards. This raises the bar for equipment manufacturers.

- ▶ BEE chose refrigerators as its initial target for energy efficient labelling owing to their high energy savings potential
- ▶ Labelling is now mandatory for frost-free refrigerators, tubular fluorescent lamps, air conditioners and distribution transformers
- ▶ Colour television sets, ceiling fans, water heaters, direct cooling refrigerators, LPG stoves and a variety of pump sets are presently under the voluntary phase

4.3. Regional Energy Efficiency Centres (REECs)

The green movement in the buildings sector, which in the past sought to tailor international programmes and schemes to suit the Indian context, has now moved towards fostering local research and development. Two REECs focusing on buildings and appliances sectors were set up with the support of US AID ECO-III project in India.

These REECs aim to provide institutional requirements in testing and certification; raising awareness; conducting research and development on energy efficient technologies; facilitating inter-disciplinary collaboration; and catalysing the growth and development of the energy efficiency market³⁴.

- ▶ Centre for Energy Efficiency for Domestic Appliances is at the West Bengal Renewable Energy Development Agency (WBREDA), Kolkata

- ▶ In March 2011, BEE launched a voluntary endorsement label (BEE STAR version 1.0) for computers and laptops (on the lines of US EnergyStar version 5.2 for notebooks)³³
- ▶ Also, S&L of appliances is fundamental in promoting ECBC compliance where the prescriptive approach simply needs all the appliances and building materials used to follow the minimum energy efficiency standard

McKinsey (2009) projects that household energy demand in India will spike up to 1300 TWh in 2030, where 30-40% energy saving will be possible through using EE appliances. However, a survey on Indian households in 2008 indicated very low penetration of star-rated appliances. Of the 1,600 households surveyed, only 7.5% of households had star-rated refrigerators and less than 1.5% had labelled air conditioners. To address such awareness issues, BEE conducted a national education campaign on star labelling for air conditioners, and trained 5,000 salespersons at showrooms across India in an effort to enable customers make informed decisions.

- ▶ Centre for Buildings is at the Centre for Sustainable Environment and Energy at CEPT University, Ahmedabad (this REEC is also supported by MNRE and Government of Gujarat)

Besides showcasing various EE appliances, WBREDA REEC has produced consumer information guides on buying and maintaining air conditioners, ceiling fans and home refrigerators. It has also initiated a Baseline Study for home appliances to establish the current scenario at the state level and the focus areas for the REEC's long-term strategy.

³¹ National Sample Survey Office (NSSO)

³² DCM Shriram Consolidated Ltd. Energy Services (DSCLES), now known as Dalkia Energy Services Limited

³³ BEE Launches Endorsement Labels for Notebooks and Laptops <http://www.smechannels.com/news/bee-launches-endorsement-labels-for-notebooks-and-laptops.aspx> Accessed on 5-Apr-2011.

³⁴ REEC for Buildings, Ahmedabad, <http://eco3.org/reec-buildings/> Accessed on 15-Feb-2011

The CEPT-based REEC is advising ULBs on the integration of ECBC into building bye-laws and is researching how to achieve uniform implementation of ECBC, in particular:

- ▶ Establishing key industry testing facilities for measurement of buildings' product performance
- ▶ Cost-benefit analysis of various ECBC measures and their techno-economic-political implications
- ▶ Developing bundles-based building groups for partial ECBC compliance for new constructions (Rawal 2010)

5. Energy Efficient Solutions for Buildings

There are a variety of solutions and services available in the market that impact building design, appliances, operation and maintenance of building components, etc. Various stakeholders like the industry, Government and academic institutions are engaged in the development of these solutions. As it is not within the scope of this report to cover all these solutions, a few are described below.

5.1. Lighting

Lighting accounts for 15% of total energy consumed in India and forms a major component of the peak load. The commercial sector lighting demand contributes 25-40% of the building energy requirement. Lighting technologies, including Compact Fluorescent Lamps (CFLs), Light Emitting Diodes (LEDs) and high efficiency lighting systems can significantly reduce energy consumption.

- a) The CFL market in India is valued at INR 800 billion and is growing at 18% annually. CFLs can save energy by up to 80% compared to Incandescent Lights (ICLs). CFLs have emerged as energy efficient alternatives to ICLs in recent years, but the cost per unit has been a barrier to large-scale adoption in the residential sector.
 - ▶ CFL sales growth of 25-30% indicates changing consumer preferences (incandescent bulbs saw 4-5% growth) (BEE 2009)
 - ▶ The commercial sector drives CFL sales where electricity tariffs are high and has longer duration of usage than the residential sector (quick return on investments)
- ▶ Of the 1.22 billion lighting units manufactured in 2009, 21% were CFLs

Bachat Lamp Yojana (BLY)

BLY is a BEE Demand Side Management programme, to deploy high quality CFLs in the residential sector. It was initiated in 2009:

- Voluntary programme through utilities for mass outreach to households
- Distributed at subsidised cost of INR 15 per unit (original cost about INR 100)
- To reach out to 192 million households across India in exchange for ICLs
- A public-private partnership between the Government of India, the electricity distribution companies and private sector CFL vendors
- Targets 400 million light points in India by 2011; about 20 million CFLs have already been distributed

With an electricity saving potential of 20,000 MW (by 2011) BLY is the largest CO₂ reduction 'Programme of Activity' registered till date with CDM. The sale of the Certified Emission Reductions (CERs) from the BLY programme will enable BEE to cover the costs for subsidising CFLs. Replacing 10 ICLs would create 1 tonne CO₂ reduction and BLY aims to replace 400 million light points (40 million tonnes CO₂ reduction).

If 962 million ICLs manufactured (in 2009) are completely phased out, lighting efficiency alone in India can be reduced by about 6-7% of annual CO₂ emissions in the country

b) LED penetration in India, unlike the CFL market, is at a nascent stage and is yet to overcome both technological and market barriers. With the technology undergoing continuous improvement and its luminous efficiency doubling every 18 months, LEDs are expected to become more efficient than fluorescent lighting in the next few years. The present rate of import duty on LEDs of 30% makes them unaffordable. Often, import of sub-standard products and low consumer awareness impedes the market growth. The MoP identifies the following market barriers:

- ▶ Limited availability of technology and high initial cost
- ▶ Absence of national standard, lack of testing protocols and facilities
- ▶ Lack of fiscal or demand incentives attracting manufacturers to the country

Through suitable policy interventions to offset high first-costs and technological standardisation, ELCOMA³⁵ estimates a 12-14% growth potential for the Indian LED market per annum. Following are a few instances of LED promotion in India:

- ▶ BEE's LED village campaign sought to replace 3-4 lamps per household and street lights where state agencies ask manufacturers/vendors for performance guarantee up to 5 years
- ▶ LED demonstration village-models have been launched in Tinsukia (Assam), Parakkal (Puducherry) and are planned for Anapur (U.P) and Mattur (Karnataka)
- ▶ Demonstration models enable comparison with the conventional systems and facilitate use of newer products and urge local manufacturing of LED lighting

5.2. Buildings Energy Management Solutions

Building Management System (BMS) is a centrally administered electronic system that monitors and controls energy use. BMS incorporates sensors, actuators, information management and communication networks to enable optimal use of a buildings' energy systems like lighting, electrical systems, chillers, cooling towers, chilling water pumps, condenser water pumps, fan coil units, plumbing systems, water management systems, exhaust systems, fire and security systems and power backup systems.

- ▶ Developed for fire and security measures, BMS is now essential in controlling energy utilisation across vast spaces
- ▶ Computerisation of these systems enables elaborate sub-systems to be included in the BMS domain
- ▶ Integrated Energy Management Solutions provide wider energy conservation solutions required for optimising energy use across various domains

An Energy Efficiency Indicator survey³⁶ in India finds that with increasing energy prices, commercial facility managers are increasingly investing in energy conservation measures. The survey was done across commercial real estate in major cities like Bangalore, Chennai, Delhi, Hyderabad, Mumbai and Pune. About 83% of the facility managers or other decision makers, who responded, plan to invest up to 10% of

their total capital expenditure budget on energy efficiency measures, indicating increasing demand for buildings energy management solutions. For instance, Data Centres (DCs) are increasingly central to various office building and have high energy demands. They are driven by power redundancies to avoid energy supply failures and they need low temperature environments. Hence DCs deploy BMS extensively for energy use control.

Smart Grids: (detailed in Chapter VIII, section 5) India recently entered the Smart Grids arena to address its energy distribution issues. To enable intelligent grids, integrated energy management solutions are deployed extensively. This involves smart metering systems, sensors and controls in facilitating consumers to make decisions based on their energy use and requirements. BMS solution providers like **Schneider Electric, Johnson Controls, Siemens** and

³⁵ Electric Lamp and Component Manufacturers' Association of India (ELCOMA)

³⁶ India Energy Efficiency Indicator Survey, 2009, Johnson Controls

Honeywell, among others, are actively engaged in this area while collaborating with IT solutions providers like **IBM, CISCO** and others.

Netmagic Solutions Pvt Ltd, Chennai – The first LEED Gold rated Data Centre in India

Netmagic finds just 10% extra cost in achieving green rating compliance.

- Gained 20% higher EE by innovative measures integrated at the design stage
- Task lighting and lighting controls used for comfort and high productivity
- Smart meters to measure and monitor energy consumption of the building
- Lighting density reduced by 8 W/sq. m as against 11 W/sq. m
- High reflective paints on roof tops – indoor temperature reduced by 3-4°C

Source: Glazette 2011

5.3. Cool Roofs

“Cool roof demonstration by IIIT Hyderabad reduced average summer-time daily maximum roof-surface temperature of a two-storeyed building from 55° C to 41° C. The air conditioning energy for the top floor would reduce by 14-26% for commercial buildings with cool roof compared to black roof in Hyderabad. These successful pilots have the impetus to scale-up the intervention at a policy level.”

Prof. Vishal Garg

Head & Associate Professor, Centre for Building Science
International Institute of Information Technology (IIIT)

Light coloured buildings and ‘cool roofs’ are time honoured techniques for reducing indoor temperatures in various warm regions. Roofing materials with high reflective properties can reflect up to 85% of incident radiation, such that the sun’s heat is reflected back into the sky instead of transferring it into the building (see Figure 10).

- ▶ Since medieval times, buildings in warmer regions like Rajasthan and Gujarat have used flat white roofs
- ▶ Satyam Training Centre in Hyderabad covered their roof with white coating which resulted in reduction of air conditioning electricity by up to 20%
- ▶ *Cool Roofs for Cool Delhi*, a Design Manual has been developed by BEE (Garg 2011)

Emphasising the relevance of cool roofs in countries like India, the Lawrence Berkeley National Laboratory (LBNL) research finds that world-wide reflective roofing can produce a global cooling effect equivalent to offsetting 24 Giga tonne CO₂ over the lifetime of



Figure 10: Cool Roofs demonstration (IIIT 2010)

the roofs³⁷. Cities generally are around 2°- 8°C warmer than surrounding areas due to dark materials, including roofs, that absorb solar radiation as heat during the day and release it at night as heat. This phenomenon removes the opportunity for air to cool down at night and results in higher temperatures being maintained longer. Cool roofs have been proven to reduce such heat island effects.

³⁷ Global model confirms: Cool roofs can offset carbon dioxide emissions and mitigate global warming
<http://www.physorg.com/news198771089.html> Accessed on 1-Dec-2010

5.4. Energy Efficient Windows

Windows are critical for aesthetics, lighting and ventilation, so their design and glazing play a critical role in achieving energy efficiency in heating or cooling of buildings. Glazing accounts for 90-95% of total window area. Hence, energy efficient design of windows need equal consideration of the vision and opaque/frame areas so that natural lighting is not lost in the energy conservation effort.

The CEPT-based REEC has signed an MoU with the **Glazing Society of India (GSI)** to work towards a standards and labelling programme of various building materials such as glass, insulations, walling materials, roofing materials and components such as doors, windows, curtain glazing and skylights (Rawal 2010). India has seen an increased trend of large new constructions with vast portions of glass surfaces. While this could be aesthetically appealing and also

economical to construct, India's tropical climate brings high levels of solar radiation that create a large greenhouse effect produced by glass. This increases the load of HVAC in the buildings. Thus, with increased emphasis on energy efficient building designs, there is a pressure to use mixed model buildings that use free cooling and climatic conditions in a favourable manner.



Energy Efficiency in Industries

Overview

This chapter discusses:

- ▶ Policy initiatives and energy conservation measures deployed in the sector
- ▶ Industry energy usage
- ▶ Energy conservation initiatives in various sectors
- ▶ Achievements and barriers towards EE

“Energy conservation in the cement industry was achieved without any public mandate. It was driven commercially with extensive co-operation within the cement industry, the larger industry and academic institutions like the IITs. Power consumption is a function of the final finished product and the industry worked on these issues with the IITs and delved into the technical problems. The progress achieved was shared among stakeholders and quickly disseminated. Most of the EE efforts occurred after the cement industry was decontrolled.

On the other hand, a computation model that I did for the sugar industry in 1990, showed a reduction of steam consumption to 29-30%, while people scoffed at this possibility then. But today 35-36% is achieved in sugar mills. However, this has been achieved only in 3 or 4 mills out of 400-odd sugar mills in the country, while 41-42% steam consumption is the norm in a large number of mills. If steam consumption at 50% can be brought down to 35%, the industry has a lot to gain.

BEE's Perform, Achieve & Trade scheme should incorporate provisions for real-time monitoring of energy savings in the Designated Consumers. In Dalkia's chiller upgrade programme with the World Bank, about 370 chillers are being monitored across the nation and real-time carbon emission data will be sent to the World Bank. Similarly, the PAT Scheme should deploy real-time monitoring towards creating a database which provides:

- ▶ *A continuous, auditable and transparent record of savings over the stipulated 3 years*
- ▶ *A fair basis for setting the cap and floor price for ESCert valuation in the PAT scheme*

This in turn will ensure that an industry which has made insignificant savings does not have a windfall, neither does a small industry which has saved consistently against all odds get penalised simply because the savings look relatively small.”



Dr. G C Datta Roy
CEO, Dalkia Energy Services Ltd

The Indian industry accounts for 29% of the country's GDP and is one of the largest consumers of energy. According to the CEA, the sector accounted for 23% of total electricity used in the country in 2009. Industries generated about 412 million tonnes of CO₂e GHG emissions in 2007 (MoEF 2010). As Figure 11 indicates, though India's energy intensity in the manufacturing sector has fallen consistently over the last 20 years, the total energy consumption of the sector is continuing to grow, indicated by the rapid growth in the per capita CO₂ emissions of the industry³⁸.

Though Micro, Small and Medium Enterprises (MSMEs) account for 80% of industry (in number terms), a few large/heavy industries alone consume more than 60% of the energy used by the industrial sector in the country. If appropriate demand and supply-side measures are applied across all industry sectors, conservative estimates indicate a 26% energy savings potential (BEE 2009b). TERI (2008)

estimates immense opportunities for energy conservation in the industries by 2030:

- ▶ 5-10% energy savings simply by better housekeeping measures
- ▶ 10-15% savings through low cost retrofits and use of energy efficient devices
- ▶ More than 40% energy savings through major retrofits and process modifications

However, energy efficiency in the sector can only be achieved through a concerted effort primarily through favourable policies, financial mechanisms, and through the initiatives of industrial enterprises themselves. Besides contributing to the nation's socio-economic-environmental well-being, these industries stand to benefit from energy savings of 23.8 billion kWh, while process efficiency measures can save 25.2 billion kWh³⁹. In total, the industry sector's energy savings investment potential is about INR 121 billion.

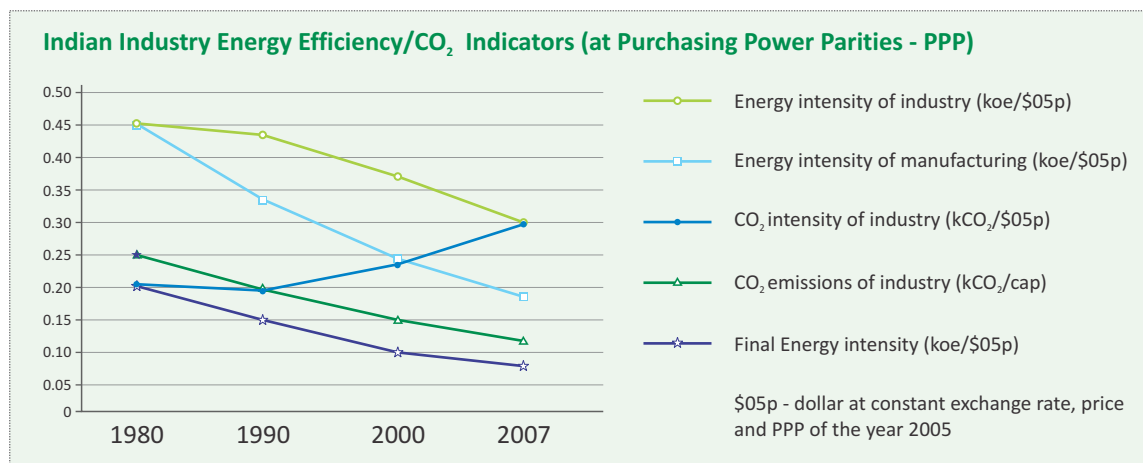


Figure 11: Energy intensity and CO₂ emissions in Indian industry[†]

1. Major Energy Efficiency Policy Initiatives for Energy Conservation

This section provides an overview of key policy efforts and regulatory initiatives towards improving energy efficiency in Indian industries.

³⁸ India Energy Efficiency/CO₂ Indicators, World Energy Council, <http://www.worldenergy.org/documents/nde.pdf> Accessed on 13-Feb-2011. The Energy consumed per unit of output of the GDP (measured at 6,500 Btu/USD 2,000 – PPP in 2007) (EIA, 2010)

³⁹ WRI ESCO Survey, 2008, Powering Up: The Investment Potential

1.1. The Energy Conservation Act 2001 (EC Act)

The EC Act empowers the Central Government to notify energy intensive industries, identified as **Designated Consumers (DCs)** to cut down their energy use.

- ▶ Thermal Power Plants, Fertiliser, Cement, Pulp & Paper, Textiles, Chlor-Alkali, Iron & Steel, Aluminium and Railways are identified as DCs
- ▶ DCs consume about 45% of the total commercial energy used in the country

The EC Act makes a provision for the Bureau of Energy Efficiency to prescribe and enforce energy consumption norms and standards. It permits the government to direct any DC who does not fulfil these energy consumption norms and standards to prepare a scheme to conserve energy, and implement such schemes.

- ▶ More than 500 industrial units and other establishments identified as DCs consuming energy more than the threshold level have been notified
- ▶ In 2007-08 DCs (excluding the Railways) accounted for about 54% of the total energy consumed in the country (see Figure 12)

Under the National Mission of Enhanced Energy

Efficiency (NMEEE) the BEE has started implementing various EC Act recommendations in DCs. Each designated consumer is required to:

- ▶ Report their energy consumption to BEE and to the respective state nodal agencies known as the **State Designated Authority (SDA)**
- ▶ Assign an energy manager for implementing energy conservation policy and measures
- ▶ Submit a 3-year plan for implementing financially viable measures from the energy audit report
- ▶ Hire an energy auditor to independently validate the submitted specific energy consumption
- ▶ Submit a report on the status of implementation as well as verified energy and cost reductions

BEE has developed guidelines for industry-specific energy management practices with inputs on auditing, budgeting and setting up of the energy management cell.

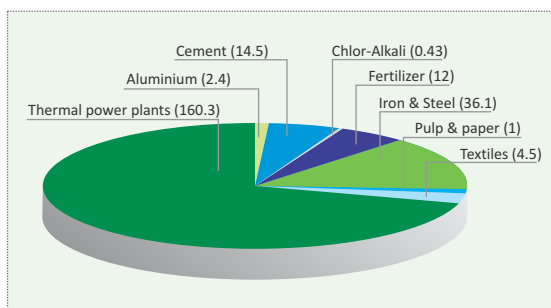


Figure 12: Energy consumption distribution of DCs (in MTOE) (BEE, 2011a)

Critical Role of DCs

- DCs contribute to 25% of the nation's GDP
- Economic growth and population increase adds immense pressure on these sectors to deliver
- Thermal power will continue to be India's main source of electricity for decades to come
- Infrastructure development drives iron & steel and cement demand growth, aluminium is essential in fertiliser production

1.2. Perform, Achieve & Trade (PAT) Scheme

The Perform, Achieve and Trade (PAT) scheme, under NMEEE, is designed to be a market-based mechanism for achieving energy efficiency in energy intensive sectors such as DCs⁴⁰. Under this scheme, **Specific Energy Consumption (SEC)**⁴¹ reduction targets are set for all DCs. Sector-wise energy use reduction targets would be identified among the DCs, keeping in view their historical energy consumption scenario in each industry

⁴⁰ Though Railways are identified as a DC, they are not included in the evaluation

⁴¹ Energy required to produce one unit of a product.

segment, sustainability of the energy trading market, etc. Figure 13 gives an overview of PAT scheme approach towards reduction targets. DCs are required to undertake energy audits of their plant and/or are expected to reduce energy consumption by 5-10 % over the stipulated 3 years.

ESCCerts & Trading: Through independent and authorised bodies, BEE will verify the energy savings of the DCs and issue Energy Savings Certificates (ESCCerts)

- ▶ ESCCerts will be issued to units that exceed the target reduction from the baseline SEC during the stipulated period of 3 years, based on the quantum of energy saved
- ▶ ESCCerts can be traded, allowing those who exceed targets to monetise their success by selling them to those who are unable to meet their targets
- ▶ ESCCerts will be in demat form and each ESCert will be equivalent to 1 Million Tonne Oil Equivalent (MTOE)
- ▶ Trading will be through two power exchanges (IEX and PXIL⁴²), with the objectives of exploring bilateral trading

PAT, commenced from April 2011, aims to create business transactions worth INR 7,500 billion through savings of about 10 MTOE (avoided capacity of 5,623 MW, about 3.5% of total installed capacity in India) over its first compliance period until March 2014. Non-compliance penalty will be INR 1 million measured in terms of the market value of each MTOE.

Note: Other energy intensive sectors such as petroleum refineries, petrochemicals, gas crackers/naphtha crackers, sugar, chemicals, port trusts, transport (industries and services), hydro power stations, electricity transmission and distribution companies, and commercial buildings and establishments may be added to the list of DCs and included in the PAT scheme in a phased manner.

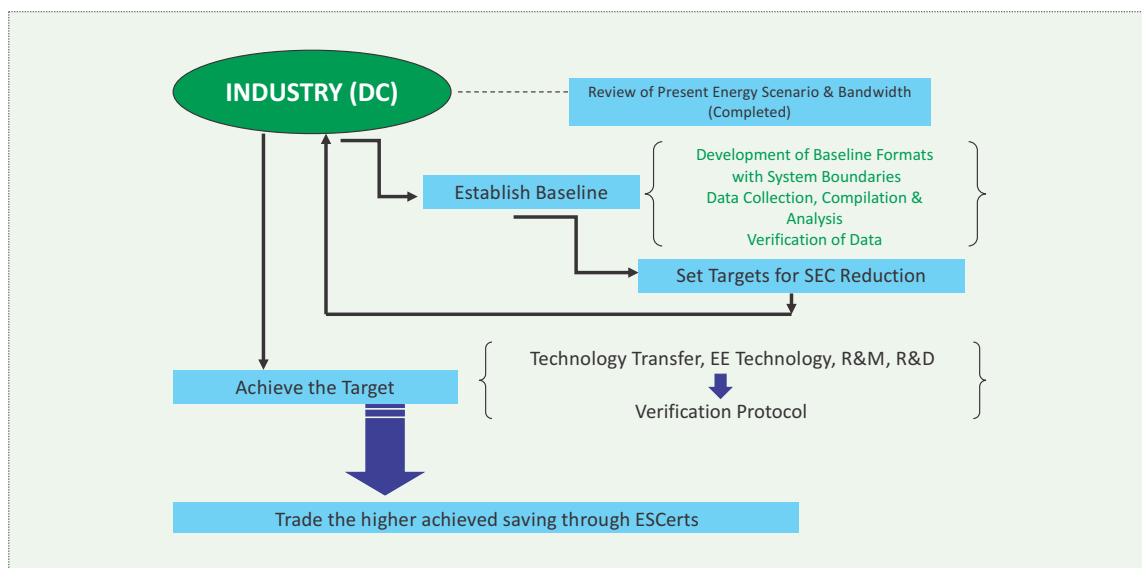


Figure 13: PAT scheme approach (BEE 2011a)

⁴² The Indian Energy Exchange (IEX), Power Exchange India Ltd (PXIL)

1.3. National Energy Conservation Awards (NECA)

- ▶ From 123 entries in 1999, participation in the programme increased to 592 in 2010
- ▶ In 2010, BEE awarded 22 industrial sectors and 7 other sectors, including buildings and Star labelled appliances for their exemplary achievements (EMT 2010)
- ▶ According to BEE, between 1999 and 2010, through EE investments these projects resulted in savings of 14,535 million kWh⁴³ (EMT 2010)

NECA 2010

Some of the 2010 winners are Hindalco Industries Ltd, Amul India, Tata Motors Ltd, ACC Ltd, LG Electronics, Jindal Steel and Power Ltd, ITC Ltd, Reliance Industries Ltd, MRF Ltd, BSNL Ltd.

2. Energy Conservation in DCs

DCs like iron and steel, aluminium, cement, fertiliser, pulp & paper, and glass together account for more than 60% of total industrial energy consumption (BEE 2011b). These industries also have proportionately higher levels of carbon emissions. As Table 6 shows, energy forms a very high percentage of their production cost. Many of these sectors have historically deployed energy saving measures. The following sections discuss each of the DCs in some detail and also examine various energy conservation initiatives that are in place.

Sector	Energy Cost as % of Production Cost
Cement	43.7
Caustic Chlorine	40.7
Aluminium	33.4
Paper	23.7
Fertiliser	18.4

Table 6: Energy as a percentage of production cost in some sectors (ASSOCHAM 2006)

2.1. Aluminium

The aluminium industry in India is highly consolidated, with only five large plants in operation in the country. The smelting process of aluminium in India has around 40% savings potential. Various factors affect the realisation of the savings:

- ▶ Plants operate their own captive power plants that produce electricity at very low efficiencies
- ▶ About 40% of plants use a low efficiency technology called self-baking anodes, instead of the higher efficiency pre-baked anodes
- ▶ Bauxite ores in India have a high share of calcium necessitating more energy for conversion
- ▶ Recycling of aluminium consumes about 5% of the total energy required to produce virgin aluminium, yet recycling forms a low proportion of the production (LBNL 2011)

Energy use in India's Aluminium industry

- One of the highest consumers of electricity in the metal industry
- Most energy intensive on a per-weight basis, ranging between 75 GJ/tonne and 83 GJ/tonne
- Global specific energy consumption of best plants is 13,000 kWh/tonne; while India consumes 15,000 kWh/tonne

⁴³ This saving was achieved from the conservation of about 2.7 million kilolitres of oil, 9.1 million tonnes of coal and 22 billion cubic meters of gas (EMT 2010)

Often, the high cost of technology is an important barrier to the introduction of more energy efficient equipment in this sector. Major EE measures include the use of Variable Frequency Drives (VFD) in various processes, air filtration, installation of energy efficient screw compressors, automatic control of various processes and optimised operations.

EE Achievements at NALCO and Hindalco Aluminium Plants

In 2009-10, NALCO, a Navratna PSU under the Ministry of Mines, undertook a cost savings and energy efficiency project at its smelter plant in Orissa. One of the key energy conservation initiative was the Energy Conservation Cell to monitor energy consumption pattern and future planning. NALCO achieved an annual savings of INR 155.8 million in fuel oil and energy consumption. These efforts were recognized when NALCO won the first prize in the aluminium sector at the NECA in 2010.

Energy Efficiency projects in the sector have large potentials for accrual of carbon credits and many are already registered with the UNFCCC (EMT 2010).

Hindalco won the NECA every year since 2007

Fuel switching, process modifications and process improvement through small group activities are some of the EE initiatives undertaken. Process optimisation, sustenance and involvement of more people has been identified as integral to all conservation objectives.

2.2. Cement

India is the second largest producer of cement in the world, accounting for 6% of the world production. The energy costs are about 40% of total manufacturing costs. About 80 cement plants in the country have been identified as DCs for the PAT scheme. The specific energy consumption in the sector is comparable to global standards. SEC declined initially due to the replacement of wet processes by the more efficient dry process (EMT 2010).

Historical Improvements: In the 1990s, cement prices were stagnating with no increase in demand while production costs spiked due to electricity and coal prices. This drove cement plants to embrace EE that brought substantial reduction in SEC.

- ▶ Demand for cement attracted large investments in new plants, latest technology and EE
- ▶ Retrofitting often deploy multi-stage heaters, high efficiency coolers, better operational quality and optimisation and up-gradation of process control facilities
- ▶ Better monitoring and active employee participation have considerably brought down energy use in the sector

However, audits by the National Council for Cement and Building Materials, in 36 cement plants, over five years indicated an energy conservation potential of

Energy use in India's Cement industry

- SEC of cement production reduced from 120 kWh/tonne in 1991 to 77 kWh/tonne in 2006-07
- Coal and electricity – main sources of energy
- Used 16 million tonnes of coal and 11 billion electricity units in 2005

4-210 kcal/kg clinker and 0.78-27 kWh/tonne. This could create an annual cost savings of INR 94.5 million for a 4,300 tonnes per day (tpd) plant and mitigate 141.3 kg CO₂/MT by using low-carbon cement by deploying waste heat recovery systems, better operational control and optimisation, increased proportion of blended cement, and use of better quality coal.

Coromandel Cements - successful methodologies to reduce energy usage and waste

- Energy use assessment team consists of members drawn from several existing committees
- Focus areas are selected with input/support from top management
- The staff is informed about the need to reduce energy usage and training sessions are held
- Assessment team develops baseline and there is stress on continuous improvement

Results: In 2003-04, coal and electricity usage was reduced by 98.5 tonnes and 2.6 million units respectively. The total savings from EE measures was USD 233,868 as against an investment of USD 107,397.

Sources: BEE and FV-EVI Green Business Survey 2009-10

2.3. Chlor-Alkali

Around 20 chlor-alkali plants in the country have been identified as DCs. The chlor-alkali industry mainly produces caustic soda, soda ash and chlorine⁴⁴. Electricity accounts for about 60% of the total costs in caustic soda production. The raw materials used for the production of these chemicals are salt and water, which are relatively inexpensive. A few energy efficiency interventions deployed in the country are given below:

- ▶ Redistributing heat, using good insulation, advanced instrumentation and control systems, along with revamped electrical systems
- ▶ Hydrogen, a by-product of caustic soda production, is for onsite power generation
- ▶ New production technologies like zero-gap membrane process and oxygen depolarised cathodes result in more efficient use of energy
- ▶ Brine recycling and use of variable speed drives
- ▶ Minimisation of exposed area of equipment reduces heat loss

In the soda ash industry, about 17% energy savings is estimated. EE can be improved by cogeneration, waste heat recovery and energy minimisation

Energy use in Chlor-Alkali Production in India

- SEC of most efficient units of the chlor-alkali industry are on par with EU efficiencies⁴⁵
- Production process wastes about 50% as heat, which then requires additional cooling
- Production via energy intensive mercury cell and diaphragm to be phased out by 2012
- Energy efficient membrane cell process is already deployed in 93% of the production⁴⁶

techniques like elimination of energy losses, using efficient equipment and control systems, good quality raw materials, etc.

⁴⁴ Caustic soda (sodium hydroxide), soda ash (sodium carbonate) and chlorine from brine (saltwater)

⁴⁵ Specific energy use for efficient production of caustic soda is 2,250 kWh/ tonne and 11.3 GJ/ tonne for soda ash

⁴⁶ Membrane cell technology with SEC of 2,250-2,900 kWh/tonne

2.4. Iron and Steel

Iron and Steel is one of the most energy intensive industries. India is the fifth largest producer of steel⁴⁷ in the world and the largest producer of sponge iron⁴⁸. Low efficiencies are mostly due to the use of older technology, poor quality of raw material (high alumina and silica ratio in iron ore), low quality coal and low rate of recycling. Following are some of the energy saving interventions deployed by the industry:

- ▶ The older ingot process of casting and shaping crude steel is increasingly being replaced by the more efficient continuous process, the degree of penetration of the continuous process has increased from 12% in 1990, to 66% in 2007 (LBNL 2011)
- ▶ However, 70% of the plants in operation are still blast furnace plants (Jain 2010)
- ▶ Shifting from the older blast furnace to the more modern direct reduction (electric furnace) improved energy efficiency (LBNL 2011)
- ▶ Efficient technologies that have been adopted by the industry include coke dry quenching, pulverised coal injection and natural gas injection during iron production, high efficiency motors, pumps and blowers, furnace insulation and replacement of electric heaters with fuel fired heaters
- ▶ An estimated savings of 484 Gcal/yr at the plant level is possible by adopting the best available technologies and practices in coke making, sintering⁴⁹, iron making, etc (Jain 2010)

Energy use in India's Iron and Steel Sector

- Energy forms 30% of operating costs
- The sector consumes 10% electricity and 27% of coal in the country annually
- Has an average SEC of 30 GJ/tcs, which is twice the world's leading plants
- As production increased by more than five times over the last 30 years, electricity demand grew by 8% per year
- Iron-making processes like coking, sintering and the blast furnace together consume about 61.3% of the energy used in the plants

Source: Jain 2010; PCRA 2010.

Waste Heat Recovery in Sponge Iron plants

Hot flue-gases generated during the production of sponge iron are used to generate electricity through Waste Heat Recovery (WHR) of these gases. Sponge iron plants with a capacity of 60,000 tonnes per annum have a large potential to install viable WHR units and reduce the SEC considerably from the present 90-130 kWh of electricity per tonne.

- One of the first sponge iron plants to install a WHR plant was the Orissa Sponge Iron Ltd (OSIL)
- In 2001, with funding from IREDA, OSIL was able to meet the company's entire power requirements through WHR
- OSIL has recently implemented a 10 MW WHR project through the CDM
- Similarly, Mahendra Sponge and Power Private Limited (MSPPL) installed an 8MW WHR plant in 2003
- In addition to providing power for its own sponge iron unit, the power plant sells 3MW of surplus power to the Chhattisgarh State Electricity Board
- This project is expected to save 21,000 tonnes of CO₂ emissions per year
- Subsequently, 30 WHR projects have been initiated through IREDA

As of 2007, 20 WHR projects from India were registered under the CDM board of the UNFCCC.

⁴⁷ Jindal, TISCO, SAIL, etc., have integrated manufacturing facilities and each individual plant can have an installed capacity of 0.5 million tonnes per annum or more

⁴⁸ Sponge Iron (Direct Iron) is produced from direct reduction of iron-ore into pellets/lumps

⁴⁹ Powdered ore is formed into a coherent mass by heat and pressure

2.5. Fertiliser

India is the third largest producer of fertiliser in the world (MoCF 2010). The fertiliser industry consumes about 8% of the total fuel consumed in the manufacturing sector and 60-80% of manufacturing costs is attributed to energy⁵⁰. Though energy intensity in India's plants are still high compared to world averages, it has decreased over time largely owing to advances in process technology, better stream sizes of urea plants and increased capacity utilisation. Energy is consumed in the form of natural gas, associated gas, naphtha, fuel oil (FO), low sulphur heavy stock and coal for process.

Use of Non-Natural Gas: In India, Ammonia production relies highly on non-natural gas from naphtha and FO which affects the energy intensity of fertiliser production (GOI 2003). Globally, natural gas accounts for 83% energy use in fertiliser plants, while it accounts for less than 50% of the total fuel used in India.

- ▶ To mobilise the fertiliser units to gas, the MoCF has announced a policy where there will be no mopping up of energy efficiency gains for a fixed period of five years for naphtha-based as well as FO-based units
- ▶ The policy provides a one-time capital investment for switching to gas, in recognition of the high cost associated with such a conversion

- ▶ Policy aims to dis-incentivise cost of production of non-gas based units and to facilitate their early conversion to gas (MoCF 2010)

Subsidies and EE in the Fertiliser industry

- Ammonia is the key component of nitrogenous fertilisers, which requires about 80% of the energy consumed
- Fertiliser subsidy for 2009-10 was close to INR 5,230 billion, about 0.9% of GDP⁵¹
- Subsidies incentivises manufacturers of their production cost, hence energy issues are not prioritised

2.6. Textiles

The textile industry in India is one of the largest industries in the country, contributing to about 4% of the GDP and having direct linkages to the agricultural sector and the rural economy. Around 136 textile plants in the country have been identified as designated consumers.

Efficiency can be improved by monitoring boiler efficiency, flash steam recovery, utilisation of correct steam pressure, steam trapping, etc. Other areas for energy savings are the operation of compressed air systems, ring frames, power quality and distribution of electricity in the plant. As large numbers of motors/pumps are used, motor efficiency also plays a crucial role in energy conservation.

Energy use in Indian Textile industry

- Energy accounts for about 17% of total textile manufacturing costs, second only to raw material costs
- Electricity contributes to the majority of the energy used, where 80% of it is used for operating electric motors.
- The sheer number of textile units results in a large aggregate consumption and also indicates the large energy savings –about 15-25% energy saving potential

WELSPUN India Limited (WIL), Vapi, Gujarat

WIL is a composite textile mill that produces cotton yarn, terry towels and rugs for export and is one of the largest Home Textiles producers in Asia, amongst the top four producers of terry towels in the world.

Source: BEE Best Practices

http://www.bee-dsm.in/BestPractices_3_15.aspx

Energy conservation measures undertaken by WIL in 2009-10	Investment (INR million)	Annual Savings (INR million)
Power Saving on Refrigerant Air Dryers	3.41	7.4
Power Saving on Autoconer	0.3	0.6
Power Saving on Pumping Station	NA	0.44
Total	3.71	8.44

⁵⁰ The absolute energy consumption by this sector is estimated at 628 million GJ annually

⁵¹ Details of Subsidies (Expenditure Budget 2010-11) www.faidelhi.org/Budget/trend%20in%20subsidies-10-11.pdf Accessed on 13-Feb-2011

2.7. Pulp and Paper

India's pulp and paper industry is growing at about 7-8% per annum, as against the global average of about 2%. About 22 paper and pulp plants in the country have been named as DCs. The pulp and paper industry is the sixth largest user of energy in the country, accounting for about 7% and 3% of the country's coal and electricity consumption, respectively.

- ▶ Large quantity of waste and pulp generated during the manufacturing process is used for co-generation
- ▶ The type of paper produced, the boiler type and pressure vessel used, the multiplicity and down time of machinery affects efficiency
- ▶ Energy conservation practices include recovery of chemicals and water heat, using variable speed drives, efficient boilers, efficient motors and pumps

Energy use in India's Paper and Pulp Sector

- SEC of paper industry in India is around 52 GJ/tonne of product, almost double that of American and Scandinavian units
- Energy adds up to 25% of total manufacturing costs where savings up to 20% can be realised
- Increasing the share of waste paper technology over raw wood has grown at 8% per year between 1995 and 2005 (LBNL 2011)

Examples of low cost and quick payback EE measures in the Pulp and Paper industry

- Chipper dust (from wood chips for paper) is used to supplement coal firing for steam production, resulting in a reduction in coal consumption to the tune of 3,312 tonnes
 - ✦ With minimal investment, a cost saving of INR 4.14 million was achieved
- In an integrated paper plant, three 75 HP turbine pumps used for raw water intake were replaced with three 125 HP turbine pumps
 - ✦ There was a net reduction in power consumption of about 1,000 units a day, resulting in annual savings of INR 1.6 million
 - ✦ The investment required was INR 1.5 million with a payback period of about 1 year

2.8. Thermal Power Stations

As of November 2010, India had a total installed power generation capacity of 167,000 MW. Around 147 power plants in the country have been identified as DCs where 64.6% are thermal generation stations that use coal, gas and oil.

- ▶ Coal continues to be the primary fuel for power generation⁵²
- ▶ Coal-fired power plants account for 53% of the total power produced in the country

Despite having the fifth largest generation capacity in the world, India suffers from chronic electricity shortages, with peak shortage being around 10-12%.

Hence, there is an urgent need for EE interventions like super critical power plants that have higher efficiencies, new generation gas turbines that operate at higher temperatures, high efficiency blade designs and waste heat recovery from gas turbines to generate steam to drive steam turbines, thus generating more electricity from the same input power. In addition, reduction in transmission and distribution losses (33% in 2008-09) is crucial. The eleventh Five Year Plan aims at reducing Transmission and Distribution losses to about 15% by March 2012.

⁵² Integrated Energy Policy (IEP) projects coal to be the major fuel for the power sector over the next two decades

India's first super critical Power plant

Power plants in India have begun the adoption of new efficient technologies and operating processes to improve plant efficiencies. Adani Power Ltd (APL), a 660 MW power plant, is India's first super critical power plant which operates at higher temperatures and pressures.

- APL is 25 % more efficient than conventional sub-critical power plants
- Production processes have about 20% reduction in CO₂ emissions

APL is the world's first super critical technology based project to be certified for carbon credit (UNFCCC)⁵³.

2.9. Railways

The Indian Railways is one of the largest single consumers of electricity in the country – around 2.5% of the total energy consumption; it is also one of the largest consumers of diesel in the country. The fuel cost in 2008-09 was INR 1,343 billion, accounting for 25% of the total costs. Energy efficiency and operational efficiency in the Indian Railways is lower than in countries like the USA and China, primarily due to slow or non-adoption of advanced technologies.

EE and environmental sustainability are now a key part of various present and all future plans of the railways sector. Some measures that have been undertaken recently are:

- ▶ Replacing 26 million incandescent lamps with CFLs
- ▶ Regenerative braking has been introduced in trains in the Mumbai Suburban System
- ▶ Increased adoption of high horsepower and fuel efficient diesel locomotives
- ▶ Constructing dedicated freight corridors

Future plans for EE:

- ▶ Use of EE measures to improve traction efficiency by 15%, an energy mix with a 10% renewable energy contribution, and induction of new, more efficient locomotives
- ▶ Non-traction proposals include the use of energy efficient air conditioning, energy auditing of major work centres, and introduction of green building concepts

Energy use in Indian Railways

- In 2005-06, the Indian Railways consumed about 12,700 kWh electricity, 2,118 million litres of High Speed Diesel and 9,000 tonnes of coal
- About 87% of the energy consumed was used for traction⁵⁴
- The sector's electricity demand⁵⁵ is growing at 7% annually and by 2020 its demand would have grown to 37,500 million kWh
- Large energy use by production units, loco sheds and workshops
- Railways consume significant energy at night too
- The SEC for the railways was 117 kJ/ passenger-km and 157.2 kJ/net tonne-km for passengers and freight, respectively

⁵³ Business Standard.2010.Adani Synchronises 660-MW Supercritical Plant <http://www.business-standard.com/india/news/adani-synchronises-660-mw-supercritical-plant/120093/on> Accessed on 15-Jan-2011

⁵⁴ Traction is the act of drawing a body along a plane by motive power, and is used here with reference to railway locomotives

⁵⁵ Railways consumed about 12,242 kWh in 2008-09 and 2,312 million litres of diesel in 2008.

3. Energy Efficiency in Other Large Industries

Besides the designated sectors, various other industries also account for significant energy consumption. Some of them have very high energy intensive operations and the others discussed here may not be energy intensive, but nonetheless consume a lot of energy due to their size.

3.1. Oil Refineries

India is an exporter of refined petroleum products and is estimated to have an oil refining capacity of 240.96 million tonnes per annum (MTPA) by the end of the eleventh Five Year Plan. The **Reliance Oil Refinery** at Jamnagar in Gujarat is currently the largest oil refinery in the world. The oil refining industry in India consumes about 7.5% of the total energy consumed by the industrial sector.

Various energy efficiency improvement programmes have led to the reduction of energy consumption per million tonnes of petroleum product outputs over the last two to three years. Analyses show that efficiency improvement of 10-20% is possible.

- ▶ Major areas for EE improvement are utilities (30%), fired heaters (10%), process optimisation (15%), heat exchangers (15%) and motor and motor applications (10%)
- ▶ Good desalting practices, lower operating temperatures, pressure and steam stripper optimisation, installation of process control systems, reduction of vacuum pressure, energy efficient designs for various equipment are a few energy conserving measures being deployed

Energy use in India's Oil Refineries

- Total energy consumption in Indian refineries in 2007-08 was about 316 trillion Btu
- Major energy consuming processes in a refinery are crude distillation, hydro treater, reforming, vacuum distillation, thermal cracking, catalytic cracking, hydrocracking, alkylate and isomer production
- Energy use varies based on the type of crude processed, the product mix, the complexity of the refinery as well as the sulphur content requirement of the final products
- For India to conform to Euro III and IV standards for transport fuel, the country needs highly intensive processing units

3.2. Sugar

India is the second largest producer of sugar in the world, next to Brazil. At the end of 2007, there were 608 sugar factories in the country. Molasses and bagasse are important by-products of sugar production. Molasses are utilised in the production of chemicals and alcohol and bagasse is used as a raw material in the paper and pulp industry in addition to being used as fuel for captive power plants.

The primary energy needs of sugar mills are steam and electricity, providing energy for crushing mills, juice clarification and screening, evaporation, sugar crystallisation, boiler houses, drying, grading and bagging.

Scope for EE in Sugar mills:

- ▶ Efficiencies of up to 20%, or the equivalent of 650 MW, can be achieved
- ▶ Technology measures for improving energy efficiency in the sugar industry include improved steam generation systems, direct production of white sugar, recovery of steam, using AC mill drives and membrane filtration among others

Energy use in Indian Sugar industry

- SEC of Indian sugar mills ranges from 0.7-0.87 kJ/tonne, against a world average of 0.5-0.6 kJ/tonne
- High SEC is due to old mills and out-dated equipment
- Sugar mills usually cogenerate power from bagasse, reducing power demand from utilities as well as reduced T&D losses over the grid

3.3. Automobiles

The automobile manufacturing sector is characterised by large manufacturing and service areas and a fairly large electrical distribution network. Energy cost as a proportion of manufacturing may not be high but in absolute terms it is substantial. The industry is growing at an average of 17% per annum and is expected to be in the order of USD 122-159 billion in 2016 (current value USD 34 billion). Manufacturers have begun to implement various measures like:

- ▶ Compressed air, painting and pre-treatment, heat treatment and annealing furnaces, utilities, and transaxle and engine shop (NPC 2007)
- ▶ **Maruti Udyog** in 2010, announced that the energy consumption per vehicle at its Gurgaon factory had reduced by 26% since 2004 due to innovative measures that reduced consumption of energy and water

Energy efficiency measures in Tata Motors passenger car business unit, Pune

The Tata Motors passenger car unit in Pune has 27 shop sub-stations, with a connected load of 95MW and a peak demand of 22 MVA. This unit has implemented 156 energy conservation measures from 1996-2006, resulting in savings of INR 227.6 million annually. From 1,174 kWh/car in 2000-01, the SEC reduced to 631 kWh/ car in 2005-06.

Tata Motors benchmarks itself against international car manufacturers for energy management

- Deploys Japanese and German firms for process and facility audits to enable productivity and quality improvements
- Use of efficient motors, VFDs for all blowers, painting robots, fan-less cooling towers, selective operation of compressors, implementation of Integrated Production Management System (IPMS) for scheduling and sequencing, collection and recycling of waste thinner, etc

Results

- Robotic painting installed at a cost of INR 0.20 billion created an annual saving of INR 0.21 billion
- Fan-less cooling towers that cost INR 0.15 million, created savings of INR 0.46 million per annum
- A maintenance employee suggested the use of parabolic reflectors for tube lights in office spaces that resulted in 50% reduction in office lighting load

Employee driven EE: In 2005-06, 16,000 suggestions were received and resulted in savings of INR 20 million; INR 0.5 million was given out as awards for these suggestions.

Source: Tata Motors, Energy Manager Training, 2007 www.emt-india.net/Presentations/3L_Auto/02Pune/07_1_TataMotor-Pune.pdf

3.4. Pharmaceuticals

India's pharmaceutical industry is growing at 9% per annum since 1996. About 80% of the energy goes into R&D, bulk manufacturing and formulation and finishing, a large part of which is accounted for by the energy consumed in the HVAC system⁵⁶ (Goswami & Butler 2007).

Many pharmaceutical companies operating in India, both Indian and foreign, are now incorporating energy efficiency measures. Following are a few instances:

- ▶ **Pfizer** adopts newer technology for efficient operations and reduces and recycles waste
- ▶ **IOL Chemical and Pharmaceuticals Ltd.** won multiple NECA since 2007 for achieving steady decline in energy consumption at its manufacturing units and increased power-efficiency of equipment and processes

⁵⁶ *Drug making is highly process driven from discovery research to pre-clinical testing, clinical manufacturing to bulk active substance manufacturing, and then to formulations/finishing facility. Also warehousing and administrative offices support the drug discovery and drug manufacturing. These functions, facilities, and processes vary widely and have very different energy requirements and usages.*

3.5. Fast Moving Consumer Goods (FMCG)

The FMCG sector is the fourth largest sector in the economy. FMCG companies in India have voluntarily begun initiatives to reduce energy consumption.

EE in select FMCGs:

Dabur has been undertaking a host of energy conservation measures:

- ▶ Energy conservation projects resulted in a 13.8% reduction in the company's energy bill in 2008-09
- ▶ Reduction was achieved despite an 8-9% volume increase in manufacturing, while there was an average 11.7% increase in the cost of key input fuels
- ▶ Bio-fuels in boilers, generation of biogas and installation of energy efficient equipment helped lower the cost of production, created effluent reduction and improved hygiene conditions and productivity⁵⁷

Amul Dairy cooperatives initiated various EE methods for milk processing and distribution. Retrofits like replacement of energy intensive old boilers with fully automatic new boilers was carried out.

- ▶ Fuel switching of furnace oil with natural gas, power generation from natural gas, installation of vapour absorption system to generate refrigeration through waste heat from gas engine
- ▶ Introduction of frequency drives and modification of process lines
- ▶ Amul won the Certificate of Merit at the NECA in 2009
- ▶ Tree plantation programme for afforestation, installation of bio-gas plants for curbing methane emissions and installation of solar power packs at village levels are other notable initiatives⁵⁸

ITC has deployed a rigorous process of audits supported by benchmarking; specific energy consumption has been reduced year-on-year. In addition, about 31% of ITC's energy consumption is from renewable sources⁵⁹.

3.6. EE in Telecommunications Industry

India has 330,000 telecom towers, which are expected to grow to 550,000 by 2015⁶⁰. The telecom industry in India uses about 2 billion litres of diesel (USD 1.15 billion). This creates 5 million tonnes of CO₂ emissions (approx.) annually. **Indus Towers**⁶¹ has a portfolio of more than 110,000 towers, making it the world's largest telecom tower company (GSMA 2011). Indus Towers has been targeting CO₂ emission reduction through various measures:

- ▶ Use of solar, wind, fuel cells, natural gas, biomass and geothermal. Deploys Solar Hybrid solutions in 720 sites and targets 2,500 sites by 2012
- ▶ Sharing of sites by multiple operators helps optimise energy use. By involving 2-3 operators, energy cost can be reduced by 20-30% for each operator
- ▶ PNG and LPG based generators to substitute diesel
- ▶ Maximising outdoor cell sites to reduce the need of air conditioning, thus reducing the energy cost by 20-25%

⁵⁷ Dabur Vision, <http://www.dabur.com/About%20Dabur-Vision>

⁵⁸ Amul.2011.Chairman's Speech: 37th Annual General Body Meeting held on 21st June <http://www.amul.com/chairmanspeech.html> Accessed on 13-Feb-2011

⁵⁹ ITC Sustainability Report. 2009. <http://www.itcportal.com/sustainability/sustainability-report-2009/index.aspx> Accessed on 20-Jan-2011

⁶⁰ Consultation Paper on Green Telecommunication, TRAI, February 2011

⁶¹ A joint venture between Bharti Infratel Ltd, Vodafone Essar Ltd, and Aditya Birla Telecom Ltd

Energy facts of India's Telecom towers

- 40% of power requirements through grid electricity
- 60% by diesel generators
- Lack of availability and inconsistency of grid power
- Rapidly increasing subscriber base and mobile phone penetration rate are widening telecom networks
- Off-grid areas use diesel generators

Results from a 'Green Power Feasibility Study' by Indus Towers for 362 off grid-sites (GSMA 2011):

Estimated capital required for green solution implementation	USD 25.4 million
Current total energy cost for off-grid sites	USD 7.6 million/yr
Total energy cost for off-grid sites after implementing green solutions	USD 1.3 million/yr
Total energy cost to be saved at off-grid sites by implementing green solutions	USD 6.3 million/yr
Payback period for 188 sites (average ROI 25%)	Less than 4 yrs

“In India, only large companies have initiated the practice of Sustainability Reporting (SR) and these are primarily those that have diversified business in other countries. International organisations with a global mandate for reduction/conservation follow sustainable measures more strictly than others, irrespective of the country that they operate in. There is almost no presence of SR in middle and lower size companies. Many of these organisations limit themselves to the ISO 14001 certification. But in the large industry segment a few Indian companies like ITC, Tata Chemicals, and Hindustan Unilever among others, have done a better job with managing their triple bottomline objectives. SR costs money which organisations do not necessarily budget for, as SR is not a priority.”

Manvel Alur
Founder,
Environmental Synergies in Development (ENSYDE)



Energy Efficiency in Micro, Small and Medium Enterprises (MSMEs)

Overview

This chapter discusses

- ▶ The significance of Micro, Small and Medium Enterprises (MSMEs) in India
- ▶ Energy Conservation Programmes MSMEs – initiatives by government bodies, international agencies and financial institutions to promote EE among MSMEs
- ▶ Capacity Building Programmes and Financing

“The Micro, Small and Medium Enterprises (MSMEs) sector in India plays a significant role in terms of sustainable and balanced growth, employment generation, development of entrepreneurial skills and rural industrialization. The modern MSMEs, particularly in auto components, electrical & electronics, engineering, IT, etc. are more progressive and forward looking. However, majority of the MSMEs, particularly in traditional clusters, such as textile processing, leather tanning, foundry, forging, ceramics, electroplating, steel re-rolling, etc. are required to switch over to more efficient and sustainable technologies and production processes.

Realising the fact that the sustainable growth and development of MSMEs is critical to the economic development of India, SIDBI has undertaken several initiatives to promote lending for green and energy efficient technologies in the MSME sector. SIDBI has been operating focused lending schemes for promoting investment in clean production and EE technologies/production processes under bilateral lines of credit from international agencies. These focused schemes have two pronged approach, i.e. concessional lending to encourage investment in green and efficient technologies, and launching of cluster specific information dissemination. SIDBI along with BEE is implementing a World Bank-GEF project on Financing EE for MSMEs in five clusters in India. All SIDBI endeavours are founded on the belief that clean and energy efficient processes will make Indian MSMEs more competitive and resilient to shifts in policy changes arising out of environment action plans.”

Ajay Kumar Kapur

Chief General Manager,
Small Industrial Development Bank of India (SIDBI)



1. The Role of MSMEs in India

The MSMEs sector has a crucial role in the development of the Indian economy (see Figure 14). According to the fourth census of the MSME sector, it employs 59.7 million people across 26.1 million enterprises and constitutes more than 80% of all the industrial enterprises in the country⁶². It is estimated that MSMEs contribute to 45% of the manufacturing output and 40% of the total exports (Sood 2009).

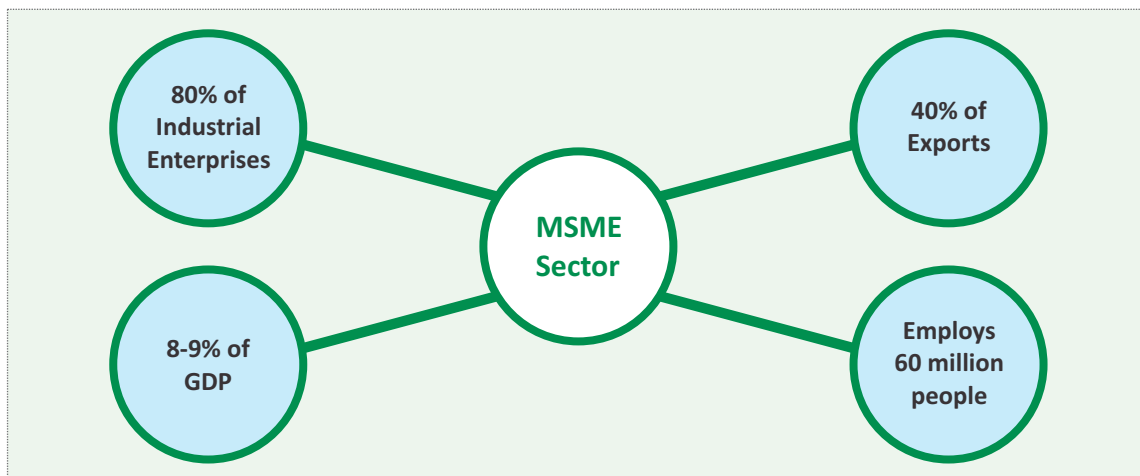


Figure 14: MSME sector and its roles

Industrial units are classified into micro, small and medium based on the quantum of investment in plant and machinery:

- ▶ Micro enterprises: Less than INR 2.5 million
Example: soap making, handicrafts
- ▶ Small enterprises: INR 2.5-50 million Example: sericulture, plastics
- ▶ Medium enterprises: INR 50-100 million
Example: textile goods, foundries, biscuits (GEF 2009)

Most of these enterprises are found in clusters⁶³; there are about 600 modern clusters and some 2,000 rural and artisan-based clusters in India (ECO-III 2009).

- ▶ Many are family-owned, traditionally driven units, spread across the nation
- ▶ Higher concentration in the north-western states, with more than 50% of total MSME units
- ▶ Most units are small in size and labour intensive

Table 7 shows that energy is a substantial part of production cost in MSMEs' especially in the energy intensive sectors such as mineral processing (ceramics, tiles, pottery, brick, glass etc.), metallurgical and metal industries (foundries, forging, alloys, heat treatment, steel re-rolling, etc.) and agro and food processing (bakeries, dairies, rice mills, etc.). These sectors rely on electricity and large quantities of fossil fuels (furnace oil, diesel, natural gas and coal) and/or biomass to meet their energy requirements (GEF 2009). A BEE survey in 2008-09 found that 35 clusters alone (about 5,000 MSME units) consumed an estimated total energy of around 60 MTOE/year (Sood 2009).

Sector	Share of Energy Cost (%)
Ceramics	30-40%
Brass	20%
Dairy	15%
Iron Foundries	15%
Forging	5-12%

Table 7: Energy cost of production in MSMEs

⁶² Ministry of Small and Medium Enterprises www.ingenicoindia.com/ministry_small_medium.html Accessed on 1-Apr-2011

⁶³ A cluster is a geographic concentration of firms defined by a product range and a place with forward linkages (customers and selling agents) and backward linkages (raw material, suppliers, etc.) associated with production activities. The concept of clusters emerged in India about 15 years ago (UNIDO 2001).

1.1. State of EE in MSMEs

MSMEs face global competition and prices along with unsubsidised energy costs. So MSMEs must become competitive by upgrading technology, reducing energy usage and costs. **Energy efficiency, particularly in this sector, can lower production and maintenance costs significantly. Better environmental and legal compliance and therefore better working conditions also result from energy efficiency improvement.** About 15-40% energy savings potential is identified in MSMEs across different clusters. Energy intensive sectors like foundries have 20-25% energy conservation potential (BEE 2009b). While an individual enterprise by itself may not consume large quantities of energy, when considered as clusters there are large

opportunities for improved energy use. However, historically, the following barriers have prevented EE in MSMEs:

- ▶ Use of obsolete and/or inefficient technologies that are low in productivity
- ▶ The perception that energy efficiency changes are financially unviable
- ▶ Lack of EE awareness and of technical and managerial expertise
- ▶ Lack of scientific data on MSME energy usage and consumption patterns affects quantifying the exact energy potential in the sector

1.2. Drivers of EE in the MSME Sector

There have been various interventions in the past to address the EE issues of MSMEs. In association with the Government of India, bilateral/multilateral programmes, national agencies and financial institutions have engaged in creating an EE transition in the MSME sector. For instance the **United Nations Industrial Development Organisation (UNIDO)** has been working on MSME cluster development in India since 1997 and 16 clusters have been upgraded using an UNIDO proven six-step strategy (GEF 2009). The following bodies have worked on energy conservation in MSMEs in India:

- ▶ **International engagements that seeded MSME EE programmes:** Swedish Development Cooperation Agency (SIDA), Indo-German Energy Programme (IGEN), Kreditanstalt für Wiederaufbau (KfW), Japanese International Cooperation Agency (JICA), United States Agency for International Development (USAID)⁶⁴
- ▶ **National agencies that worked at grassroots level:** National Productivity Council (NPC), The Energy and Resources Institute (TERI), Petroleum Conservation Research Association (PCRA), National Small Scale Industries Corporation, Winrock International, National Institute for Secondary Steel Technologies, etc
- ▶ **Financing institutions and banks (national and international):** State Bank of India (SBI), Small Industries Development Bank of India (SIDBI), Indian Renewable Energy Development Agency

(IREDA), ICICI Bank, Global Environmental Fund (GEF), Japanese International Cooperation Agency (JICA), among others, have been funding and supporting EE projects in MSMEs

SIDBI was formed in 1991, as a subsidiary of IDBI Bank and initiated cluster development under its agenda for promotion and development of MSMEs for addressing awareness of new products, processes and technologies, skill upgradation, development of technology related common facilities for the cluster, provision of unit specific modernisation packages and promotion of energy conservation and introduction of environment friendly technologies for MSMEs (UNIDO 2001). The Ministry of Micro, Small and Medium Enterprises (MoMSME) cooperates with the BEE, PCRA and SIDBI for the massive efforts needed in this area.

⁶⁴ *SME Sector Perspective, India, Energy Research and Social Advancement Foundation www.ersaf.com/pdf/sme.pdf Accessed on 13-Feb-2011*

2. EE Programmes for MSMEs in India

The following section discusses a few examples of the bilateral and multilateral interventions in the MSME sector which has created a wealth of knowledge and experience. However, these efforts did not necessarily make a major impact on EE achievements. BEE is now attempting to converge these initiatives.

2.1. BEE Small and Medium Enterprise (SME) Programme

The majority of MSMEs in India are run by entrepreneurs and are typically leanly staffed. Most of them do not have the knowledge or the manpower to deploy EE practices on their own. The BEE SME Programme aims to address potential impediments in deploying EE measures in MSMEs.

- ▶ **Energy Use and Technology Analysis:** In select MSME clusters to understand the status of technology and energy use and to identify EE measures, technology audit in the units to identify viable technology, expertise and best practices
- ▶ **Capacity Building:** For local service and technology providers
- ▶ **Implementation of EE measures to prepare bankable Detailed Project Reports (DPR):** For MSME units, for matching expertise of local service providers to specific projects among these
- ▶ **Facilitation of Innovative Financing Mechanisms:** Financing arrangement in the form of risk mitigating measures for EE projects in the clusters

MoMSME finances the implementation of the technologies identified in these DPRs and SIDBI subsidises implementation of these technologies. SIDBI also trains BEE-identified executing agencies for preparing and peer reviewing the DPRs. BEE completed the situational analysis for 35 clusters on savings potential and impact analysis of interventions and initiated EE implementation in 25 clusters (BEE 2009b). Figure 15 indicates the cluster units under the Programme.

For example, in the ceramic cluster, an energy conservation manual was developed in 2010 by **See-Tech Solutions Ltd**, a BEE executing agency, after audits in 75 ceramic units. This manual details process-wise energy cost in ceramic manufacturing, compares their energy consumption with the benchmark and identifies suitable technologies and their suppliers to reduce their energy consumption

and thereby the energy cost⁶⁵. The manual was followed by a DPR that See-Tech prepared for Kiln insulation improvement in the ceramic cluster to enable financing of the EE recommendations identified (see Figure 16).

Implementation Partners: GEF collaborates in the BEE SME programme under its India Energy Efficiency Programme (2008-12) for financing and implementation where:

- ▶ GEF partners with UNIDO for promoting energy

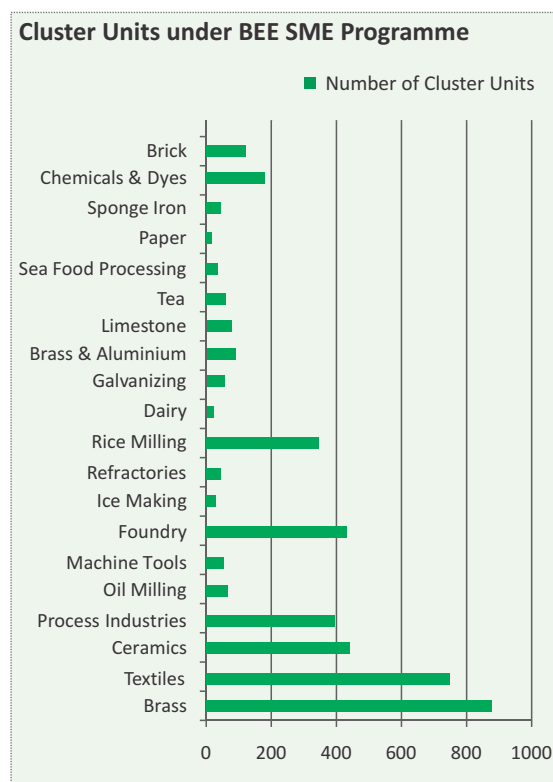


Figure 15: Cluster units under BEE SME Programme (BEE 2009b)

⁶⁵ BEE.2010b. *Manual on Energy Conservation Measures in Ceramic Cluster Morbi, 2010*
www.dcmsme.gov.in/reports/morviceramic/Morbi_ClusterManual_Ceramic.pdf Accessed on 11-Feb-2011

efficiency and renewable energy in selected MSME clusters in India

- ▶ GEF partners with the World Bank to support the development of EE investment proposals in SMEs primarily for identifying, preparing and financing EE proposals at the local level

In 2011, this effort was boosted through co-financing

of USD 25.7 million from the Government of India (BEE, MNRE and MoMSME), UNIDO (USD 0.5 million) and GEF (USD 7.172 million) for promoting EE and renewable energy in MSMEs. **The project is expected to save 276,600 MWh a year, and result in 1.2 million tonnes of avoided CO₂ by 2015 (GEF 2011).**

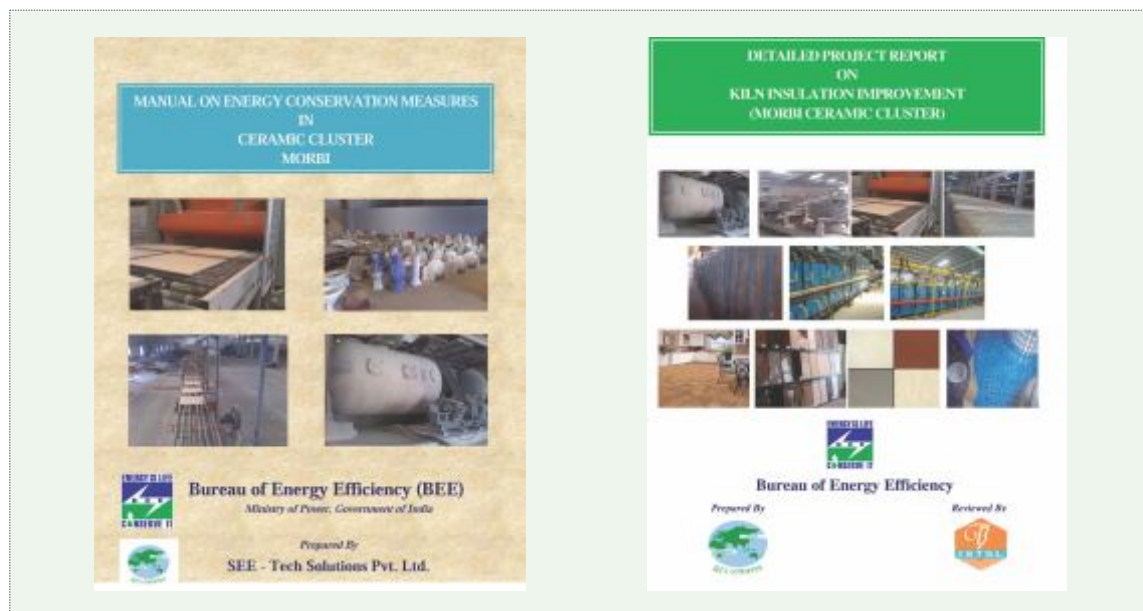


Figure 16: BEE Manual: Energy Conservation Measures in Ceramic Cluster Morbi and DPR on Kiln Insulation Improvement for Morbi Ceramic Cluster

2.2. TERI-Swiss Agency for Development and Cooperation (SDC)

In 1991, SDC developed the **Global Environment Programme (GEP)** to support developing countries in implementing UN conventions concerning the global environment⁶⁶:

- ▶ Under the SDC India programme on Energy and Environment, a strategic partnership was established with TERI in 1994, for development and dissemination of environment-friendly

technologies in selected energy intensive MSMEs

- ▶ TERI-SDC programme CoSMiLE (Competence network for Small and Micro Learning Enterprises) addresses the foundry, glass, brick kilns and thermal and power gasifier industries
- ▶ CoSMiLE created a cumulative CO₂ savings of 250,000 tonnes between 1994 and 2007

⁶⁶ Swiss Development Corporation. http://www.swiss-cooperation.admin.ch/india/en/Home/News/News_Detail?itemID=162620. Accessed on 24-Feb-2011

EE Foundries in Rajkot, Gujarat

TERI, with support of the SDC, has been implementing energy conservation programmes in the Rajkot foundry industry since 2002. Rajkot has one of the biggest foundry clusters with about 500 units employing 20,000 people. Foundries use highly energy-inefficient conventional melting furnaces or cupolas. Rajkot foundries produce 162,000 tonnes of castings, consume 17,000 tonnes of fossil fuel (coke) and emit about 46,000 tonnes of CO₂ per annum.

Energy Conservation at a Foundry unit in Rajkot: About 25% of the energy is consumed in the melting operation by adopting an energy efficient cupola design called the Divided Blast Cupola (DBC). TERI with **Shining Engineers & Founders, Rajkot**, implemented DBC and following are the details of the savings realised in both materials and energy:

Savings in Materials and Energy from DBC implementation in Foundries

Metal Used	Consumption before (% of metallic charged)	Consumption after (% of metallic charged)	Savings after implementation of DBC
Coke usage	9.1%	7.8%	30%
Ferro-silicon	0.21%	Nil	100%
Ferro- manganese	0.13%	Nil	100%
Monetary savings achieved	INR 850 per tonne of molten metal in the foundry unit		
Total savings about 250 tonnes of metal a month)	INR 0.22 million per month (approx. per foundry) (typically foundry unit melts		
Cost for Retrofit Conventional Cupola to DBC	INR 200,000 (Capital Cost of new DBC: INR 1 million)		
Payback Period	Within a year, depending on the amount of metal melted in the foundry unit		

Carbon Conservation Potential

TERI, in association with the local industry association applied for CDM funding for a group of 190 foundry units in Rajkot for a reduction opportunity – 8,302 tonnes of CO₂ emissions.

Such CDM projects are prone to high transaction costs like validation, monitoring and verification. These costs could be more than the price on a per- Carbon Emission Reduction (CER) basis. MSMEs are wary of possible liabilities accruing from non-delivery of CERs. Also the lack of skill set required for data/records maintenance for verification additionally burden CDM efforts in such sectors.

Source: Savings from Divided Blast Cupola: A case study of successful implementation at a foundry unit at Rajkot (Gujarat) Patel, M. H, Shining Engineers & Founders, Rajkot; Economic and social risks associated with implementing CDM projects among SME – a case study of foundry industry in India, Pal, P and Nath, A (TERI) 2006.

2.3. USAID ECO-III Study on SMEs

The USAID Energy Conservation and Commercialisation Phase III (ECO-III) project conducted EE studies in four SME clusters and published a report on implementation of EE in MSME clusters. Under this project, ECO-III took up:

- ▶ Developing EE concepts, establishing a business dialogue between the MSMEs and vendors of EE products and organising meetings/ workshops at the cluster level
- ▶ Facilitating interactions with banks to understand the concerns related to credit worthiness and follow-up for loan applications,
- ▶ establishing a policy dialogue with state-designated agencies, BEE and other key players – financial institutions, industry associations, other donor projects, and other agencies active in the sector (ECO-III 2009)

In ECO-III project it was identified that solution development for EE financing should:

- ▶ Involve the right mix of short-term and long-term options
- ▶ Have the ability to convince users on energy savings and other larger benefits
- ▶ Have a grasp of the capability and capacity of

stakeholders to invest

- ▶ Educate users on the risks, if any, of the Energy Conservation Measures (ECMs)
- ▶ Have persistence towards, and risk absorption capacity by, the participating stakeholders

USAID ECO-III Assessment of Energy Conservation in Steel Re-Rolling Mills (SRRM) in Punjab

Steel Re-Rolling is one of the most important links in the supply chain of iron and steel industries. The secondary steel production constitutes approximately 57% of the total steel production in India. There are about 1,200 SRRM mills in operation.

- Direct energy use in the SRRM sector includes heating fuels and electric energy
- The SRRM units are characterised by out-dated and low-investment technologies and practices

Recommendations for energy conservation measures in SRRM:

- Redesign of furnace and switch to produce gas instead of coal and oil
- Optimisation of operational performance and installing variable frequency drives on blowers
- Increasing the width of existing furnaces
- Installation of new energy efficient recuperators
- Replacement of existing bearings with anti-friction roller bearings
- Replacement of existing coupling with universal spindle
- Adoption of flat belts in place of existing V-belts

- Installation of Y-type lifting table and wall tilter/roller table on roughing stand
- Improvement in the power factor
- Reduction in down-time and idle running of motor
- Replacement of old/rewound motors of fans, pumps and blowers with EE motors

Energy consumption in three SRRM in Punjab

Aggregate Energy TOE [§] / Year	Electricity/ Energy (%)	Thermal Energy Source
820	26	Coal + Oil
290	25	Oil
450	19	Coal

[§]TOE-Tonne Oil Equivalent

Energy and cost savings estimated for the three mills, if furnaces were redesigned to use pulverised coal:

SRRMs	Energy Savings (TOE/yr)	Energy Savings (INR million/yr)	Material Savings (INR million/yr)	Investment (INR million)	Simple Pay-back Period
Mill 1	80	1.64	8.35	19.1	23 months
Mill 2	66	1.54	1.38	2.9	12 months
Mill 3	79	2.28	5.52	4.1	6 months

Source: Implementation of Energy Efficiency in SME Clusters, ECO-III/ USAID, 2009

3. Capacity Building Programmes and Technology Financing for MSMEs

In collaboration with UNIDO, NPC carried out over 350 clean production and energy efficiency assessments in sectors like leather, pulp and paper, dyes and dye intermediates, textile, cement and auto component industries and have assisted MSMEs in implementing viable clean production options⁶⁷. Yet, EE in MSMEs is affected by:

- ▶ The lack of skilled service providers
- ▶ Perceived risk of EE projects and equipment, resulting in most enterprises taking a wait and watch approach
- ▶ Enterprises require a proof of returns before they adopt better processes and technologies

To address various such issues, the **National Manufacturing Competitiveness Programme (NMCP)** was launched in 2007-08 for developing global competitiveness of MSME. The eleventh Five Year Plan allocated INR 6 billion for the initiative and NMCP supports MSMEs in marketing assistance, entrepreneurial and managerial development

through incubators, quality management and tools, awareness building of Intellectual Property Rights (IPRs), lean manufacturing competitiveness, technology and quality up-gradation and information technology⁶⁸.

Focusing on green and efficient technologies, NMCP offers subsidies and support for technology up-gradation in MSMEs. NMCP's **Credit Linked Capital Subsidy Scheme (CLCSS)** made available subsidies worth INR 0.76 billion in 2007-08; in 2008-09 the subsidies grew to INR 1.09 billion and in 2009-10 it was to the tune of INR 1.5 billion.

3.1. Overview of Various Awareness and Capacity Building Efforts for EE in MSMEs

a) In 2005-07, IREDA partnered with **Winrock International India** for EE capacity building initiatives⁶⁹:

- ▶ The training targeted EE stakeholders like policy makers, consultants, energy auditors, equipment manufacturers, NGOs and ESCOs to enable the participants to analyse, prioritise and develop "bankable" EE projects
- ▶ 32 training programmes were conducted across India and 934 officials were trained

b) The BEE SME Programme aims to provide comprehensive capacity building through:

- ▶ Information dissemination workshops in the clusters
- ▶ Preparation of case studies on best practices in clusters
- ▶ Preparation of cluster manual and preparing

Local Services Providers (LSPs) to implement EE projects

- ▶ Training banks to evaluate EE projects

c) SIDBI Programmes:

- ▶ Awareness campaigns in high energy intensive MSME clusters on environment-friendly and EE technologies for the respective clusters, supported by JICA
- ▶ On better production processes, investment required and cost benefit analysis
- ▶ 18 awareness campaigns have been organised in MSME clusters across the country
- ▶ MoU with BEE for creating a shelf of EE technologies for 25 MSME clusters, and awareness creation and capacity building of local service providers for implementing energy efficient technologies (SIDBI 2010)

⁶⁷ TOI.2011.UNIDO helps countries to secure low carbon growth http://articles.timesofindia.indiatimes.com/2011-05-30/edit-page/29597228_1_unido-cleaner-production-green-industry Accessed on 15-Jun-2011

⁶⁸ NMCP.2009.Developing global competitiveness among Indian MSMEs <http://smetimes.tradeindia.com/smetimes/in-depth/2009/Aug/25/nmcp-developing-global-competitiveness-among-indian%20msmes10839.html> Accessed on 20-Dec-2010

⁶⁹ Line of Credit through IBRD/IDA/GEF

d) The ECO-III⁷⁰ project supported the establishment of Regional Energy Efficiency Centre (REEC) for MSMEs at See-Tech Solutions Pvt Ltd in Nagpur. The REEC is now working on:

- ▶ Capacity building for plant workers: training, showcasing tools and software tools
- ▶ Popularising substitution of expensive fossil fuels by cheaper agro-based fuels
- ▶ Base-lining and benchmarking various metallurgical sectors in MSMEs for energy consumption and CO₂ emissions
- ▶ Serving as a platform for sharing best practices, where 150 energy conservation measures will be demonstrated for hands-on capacity

building in EE and renewable energy in industries and buildings

- ▶ Focusing on industrial furnaces as the major energy consuming equipment

e) ICICI Bank launched the India SME Toolkit⁷¹ in August 2007, developed by International Finance Corporation (World Bank Group)

- ▶ Provides information and tools for increasing productivity, efficiency and capacity
- ▶ About 20,000 notifications, 10,000 circulars, 600 draft agreements, 3,600 business forms, and 4,500 legal queries including the portal, CDs, mobile alerts, and training sessions with online modules in English and Hindi

3.2. MSME Financing Schemes

An important concern of MSME units for investing in EE is the high cost, and a lack of focus on energy efficiency among the units and their proprietors. Table-8 provides an overview of various EE financing schemes in India. SME Financing in India is largely a part of regulated lending by a network of state created institutions. MSME clusters typically have similar energy consumption profiles. Therefore, similar energy conservation and efficiency measures are also applicable to them.

a) ESCO Model for MSMEs

MSME clusters are potential sectors for ESCO model of EE implementation. If an ESCO can implement one, or a few, successful projects with a cluster, there is a very high chance that the other MSMEs in the cluster would be interested in similar EE projects. Since design and implementation as well as the risk of performance is undertaken by the ESCO and payments to the ESCO are to be made out of the savings realised, thus reducing the manpower and financial burden on the MSME, this may well prove to be a successful model in the years ahead.

In order to have better penetration of ESCO services, new business models have been suggested and the **The 3 Country Energy Efficiency (3CEE) project** has put forth two pathways: a local industrial association centric approach and a leasing ESCO hybrid. In the first case, the local association, which has the confidence of MSMEs, would act as an interface between ESCO and MSMEs. However, the following barriers are perceived to stand against ESCOs undertaking projects with MSMEs:

- ▶ ESCOs prefer MSMEs bundled together to make the project viable for ESCOs
- ▶ Individual units may be hesitant to trust the

ESCO concept in apprehension of the risk of manufacturing processes being revealed to competitors through the ESCO

- ▶ Units which may be part of a supply chain of larger units may be concerned that the cost reduction achieved by them may lead to their downstream units putting pressure on them to reduce their profit margins
- ▶ The need for refined contract documents that ensure the right clauses about secrecy are present in the contract documents
- ▶ A large number of MSMEs are still in the process

⁷⁰ USAID Energy Conservation and Commercialization Project Phase-III (ECO-III) in India

⁷¹ IFC and ICICI Bank Host Global Conference for Development of Small and Medium Enterprises in India

<http://www.ifc.org/ifcext/southasia.nsf/Content/SelectedPR?OpenDocument&UNID=46B68E952F02869D852573920053C0FA>
Accessed in 15-Apr-2011

of making the transition from informal to formal economy

- ▶ Prevalence of cash transactions and under-reporting of production to avoid taxes makes it difficult to obtain reliable data on operations
- ▶ Production and energy cost are bottlenecks for ESCOs

- ▶ MSMEs may not be able to tap financial institutions for loans, either due to non-availability of the right kind of loans or because they do not have sufficient collateral, resulting in large financial burdens on ESCOs and make them unsure about the credit-worthiness of MSMEs

Agency	Project/ Mechanism	Sector/ Purpose
Donor and Multilateral Financing		
World Bank	Second Renewable Energy Project	For EE and renewable energy
ADB	Industrial Energy Efficiency Project	Industrial EE
Commercial Banks		
World Bank through ICICI Bank	Up to USD 5 million, 7-9%, 3-5 years	EE for industry
The 3 Country Energy Efficiency (3CEE) project, launched in 2003, in partnership with the World Bank, UNEP enabled the development of loan schemes for EE in MSMEs by cooperating with the State Bank of India, Canara Bank, Union Bank of India, Bank of Baroda and Bank of India		
YES Bank	Up to USD 10 million, 3 years, nominal rates	Industry, commercial, agriculture, MSMEs
SBI and other public banks	Nominal rates, 5-7 years	SBI Project Uptech was the first of the five bank schemes to be launched in 2002
Public Sector/ Government Supported		
Urban development funds		For municipal activities like street lighting and water works.
State Energy Conservation Funds	Initiated in 16 states	INR 700 million allocated for state nodal agencies by BEE, the focus in the first year is on waste heat recovery in MSMEs
SIDBI Until now SIDBI assisted 2000 MSMEs through INR 8 billion aggregated assistance through concessional lending for green or EE technologies and cluster information dissemination	▶ Projects financed at 9.5-10 %, less than normal interest rates ▶ Subsidies up to 15-30 % of capital costs under government programmes ▶ Green Loan Scheme for existing borrowers – finances the purchase of EE equipment, energy audits and pollution control services ▶ Up to 50% of net cash accruals of the previous two years (max INR 2.5 million per financial year) at a fixed interest rate of PLR – 1% ▶ TIFAC-SIDBI revolving fund of INR 300 million funds up to 80% of project cost or INR 10 million (rate less than 5% per annum) ▶ Line of credit from JICA (Japan), KfW (Germany), AFD (France) and the World Bank (Source: SIDBI 2010)	
IDBI	In October 2010, IDBI-WRI for financing MSMEs in India for implementing ESCO projects	
IREDA	▶ Project financing, equipment financing, and financing for equipment manufacturing for EE projects ▶ Loans up to 80% of the total project cost at interest rates varying between 10.75% and 12.25% (higher rates for equipment and manufacturing financing) ▶ As of 2010, IREDA had provided financing of over INR 4.6 billion to EE projects ▶ Line of Credit from World Bank, KfW, ADB, AFD and JICA, who also provide lines of credit (Source: IREDA 2010)	

Table 8: Overview of EE financing schemes in India

b) Financing through Emissions Trading

Only 5-10% of Indian MSMEs are registered under the Clean Development Mechanism of the Kyoto Protocol. Considering the large number of MSME units in India, the potential to initiate energy efficiency projects that could become eligible for registering for Certified Emission Reductions (CERs)⁷² is abundant. These CERs would benefit MSMEs by paying for or subsidising the EE initiative and/or by generating additional cash flows.

Projects which are in line with the developmental needs of the country and which utilise renewable energy, EE or other measures for emissions reductions that are additional to what would have otherwise occurred are eligible for receiving CERs. In India, qualification, registration and issuance process approval is done by Designated National Authorities – the MNEF for India.

EE in Rice Mill cluster via Innovative Financing and Carbon Trading mechanism at Pudukkottai, Karaikudi, Tamil Nadu

Implementing Agency: Alliance to Save Energy (ASE) and Renewable Energy and Energy Efficiency Partnership (REEEP)

Rice mill processes like steaming, drying, milling, polishing and de-husking are energy intensive. The Pudukkottai cluster has more than 80 rice mills of different capacities.

Energy Use in Rice Mills	Energy Cost
Energy expenditure	10-12% of the total processing cost of paddy
Electricity consumption	200-800 MWh (depending on the size of the mill)
Other fuel consumption (wood, husk and other biomass materials)	400-800 tonnes per annum
Energy bill	INR 2-5 million per mill (depending on the size of the plant)

The ASE-REEEP supported project objective is to work with mill associations to explore the feasibility of bundling rice mill units in a cluster to improve their EE by introducing bulk procurement of energy efficient equipment and facilitate carbon finance to partially support the implementation cost.

Key highlights

- ▶ Technical assistance and advisory by the ASE, India
- ▶ Mill association is the core link with EE equipment suppliers/vendors as key partners
- ▶ Bundling of interested units based on EE technologies options and opportunities
- ▶ Pilot investment grade energy audit done in five mills to identify EE measures and potential
- ▶ Equipment audits conducted in over 25 mills to assess the applicability of common EE measures for bulk procurement
- ▶ Demonstration of effectiveness of energy efficient technologies done at one of the mills created confidence among mill owners, lenders

and project implementers by applying Measurement and Verification (M&V) approaches consistent with international practices

Bundled approach

- ▶ Rice mill associations are in discussion with manufacturers and suppliers for the best possible deal for bulk procurement at discounted prices
- ▶ Mill association initiated discussion with local banks/SIDBI for bulk procurement financing
- ▶ CDM programme for carbon credits, the revenue from which will supplement repayment of the loan for energy efficiency improvements

Projected savings potential

- ▶ Cost savings: INR 1.5-1.8 million/mill
- ▶ Investment: INR 2.5-3.5 million/mill
- ▶ Simple payback period: 18-24 months
- ▶ CER potential cluster: 30,000 MT (approx.)

⁷² Under the Kyoto Protocol, countries which have committed to emission reductions can buy Certified Emission Reductions (CERs) from developing countries in order to meet their commitments through the Clean Development Mechanism (CDM). Each CER is equivalent to one tonne of CO₂, and can be traded or sold.

Energy Efficiency in Agriculture

Overview

This chapter discusses

- ▶ Energy use in the agriculture sector
- ▶ Energy required for agriculture and its linkages to groundwater use
- ▶ Effect of energy pricing policies on electricity use in agriculture
- ▶ Energy conservation initiatives in the agriculture sector

“ There is an urgent need for strengthening Demand Side Management (DSM) Model Regulations in structuring DSM programmes and creating an obligation for utilities to implement DSM measures. DSM was introduced as a concept to the utilities in the late 80s, although utilities across India are yet to deploy DSM programmes in full scale. Utilities are already using Time of the Day metering (ToD), and now should use this wealth of data in developing load profiles. ToD tariffs require a good amount of understanding of load profiles – seasonal load profiles, daily load profiles (holidays, working days, partial working days, etc). Translating such data into effective pricing needs to be urgently prioritised as ToD ideally requires forecasting of yearly demand, on a year-on-year basis.

BEE has completed 175 investment grade energy audits for Municipal DSM programmes for which Detailed Project Reports (DPRs) have been developed. It now needs to identify the “right” agencies to implement these DPRs. In the Ag DSM, BEE has done audits for pump replacement for which DPRs are made available. This is where utilities shall enter the scene and own the place. Utilities need to float request for proposals for implementing these projects. They are required to identify vendor bodies/ESCOs for replacing the pumps, verifying pump performance, etc. Thus, capacity building of utilities and other stakeholders have to be done to gear them up for various BEE initiatives. Responsibilities and ownership of activities have to be identified and defined. For instance, will the State or the Regulators grant approval for such projects?”

Balawant Joshi

*Director,
ABPS Infrastructure Advisory Private Limited*



The growth in population and increasing disposable income are creating additional pressure on the production of agricultural goods. Mechanisation and irrigation supply will be key drivers of increased food production (LBNL 2009). With increased prevalence and dependence on technology, India is expected to be rapidly mechanised over the next decade. Electricity is used for most of the energy demand in the agriculture sector (see Figure 17), which:

- Uses nearly a third of the electricity produced in the country
- Contributes only to 8-10% of the revenue from electricity sales
- Accounts for 334 million tonnes of CO₂e⁷³ emissions (MoEF 2010).

The total energy consumption in the sector is

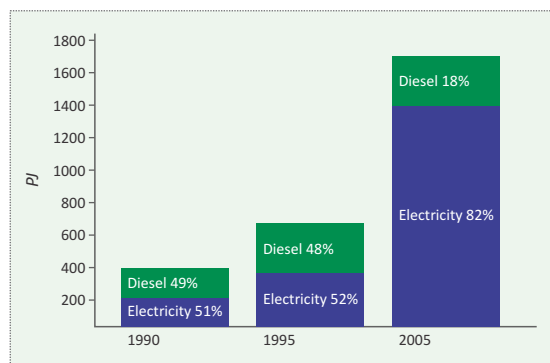


Figure 17: Energy consumption in the agriculture sector (in PJ) (LBNL 2009)

projected to grow at 2.4% annually till 2020, while the demand for irrigation water is to grow by 22% by 2025 (WENEXA 2007).

1. Overview of Agriculture Electricity Pricing

Electricity for agriculture in India is highly subsidised. A flat, unmetered charge based on the horsepower rating of pumps used is applicable for this sector and translates into a low per-unit charge for consumers. This is a legacy from the 1970s when electricity for agricultural use enjoyed a highly subsidised tariff.

The political implications of sops to the agricultural sector, which constitutes the largest vote bank, means that successive governments are unwilling to change this low tariff structure. This is reflected in the energy pricing policies. As Figure 18 illustrates how the industry power tariff increased from 35 paise to 457 paise per unit during 1975-2000, while the agriculture sector saw a mere 10 paise growth in the agrarian state of Andhra Pradesh.

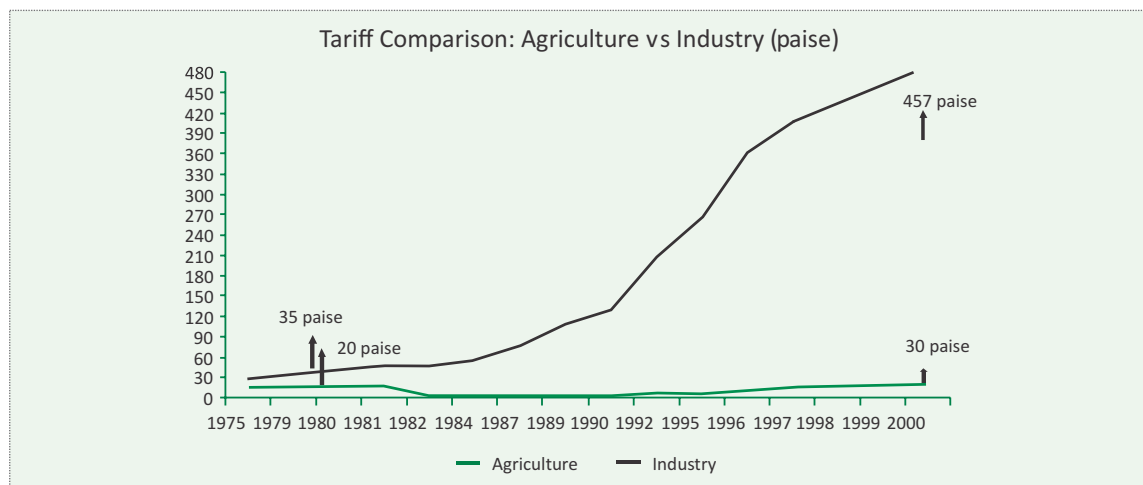


Figure 18: Per unit power tariff imposed on agricultural consumers vs industrial consumers in AP (1975–2000) (India Infrastructure Report, 2008)

⁷³ CO₂ equivalent is indicated here as Agriculture is a source of Nitrous Oxides (NO_x) which are greenhouse gases, besides carbon dioxide

Efforts towards power pricing revision continue to face objection. For example, in 2010, Maharashtra decided against a power tariff hike for the 1.6 million non-metered agriculture energy consumers⁷⁴. The non-revision of electricity cost is borne by the industrial and commercial sectors. Energy dynamics of the agriculture sector is largely influenced by the following:

- ▶ More than 50% of the population is dependent on agriculture even though agriculture accounts for less than 16% of the GDP
- ▶ Provision of free power to farmers is a common populist measure used by politicians to influence the votes from agrarian sectors, causing a considerable burden on the State Electricity Boards and the grid⁷⁵

- ▶ **Poor quality of agricultural power is one of the reasons for low crop yields and the prime reason for low efficiency of pump sets.** The resultant negative impact on farmers' income generates dissatisfaction among the farmer community, leading to farmer lobby groups resisting tariff revisions

Agriculture Metering in India

- ▶ In the mid-1970s, the State Electricity Boards found that installing and reading meters, billing and collection were costly and opted to switch to a flat rate regime
- ▶ A metered alternative was introduced in 1993 at a flat rate of 50 paise per unit but a very small proportion has metered agricultural electricity consumption today

1.1. Low Power Tariff impact on Agriculture and Groundwater

There has been a sharp increase in electricity use in the agricultural sector. The 'Green Revolution' (1965-75) transformed India into one of the leading food producers in the world, primarily driven by the availability of cheap electricity that allowed increased use of ground water irrigation. However, these underlying forces have led to electricity and water wastage that India struggles to contain.

Cheap electricity:

- ▶ Change from metered to flat rate tariff was an important factor for this increased usage
- ▶ The marginal cost of pumping water is zero and farmers have no incentive to reduce their usage of electricity or invest in energy efficient pump sets

Government Subsidies for Agriculture

- ▶ Low tariff and flat rate charges to farmers account for an estimated 10% of the total cost of supply, about INR 240 billion a year
- ▶ This is about 6% of India's fiscal deficit in 2010-11 (World Bank 2005)

Groundwater irrigation:

Groundwater now accounts for 70% of the irrigated area in India that grew by 8% yearly from 1970-2007, while agricultural electricity use grew by 22 times. Tube wells with pump sets are the primary means for groundwater access and millions of private tube wells have come into use over the last 40 years (IEI 2010).

- ▶ India has the largest number of pump sets in the world, where irrigation pumps alone account for 25% of electricity consumption in India.

Agrarian states like Karnataka, Haryana and Gujarat account for more than 40% of pump set instalments (Singh 2009, CEA 2008)

- ▶ 16 million electric pump sets are in operation in India, an estimated one million tube wells/borewells are added every year. Figure 19 shows the projected growth of pumps/farm machinery are likely to cause rapid increase in energy use (LBNL 2009)

⁷⁴ DNAIndia.2010.No power tariff hike for agriculture consumers, http://www.dnaindia.com/mumbai/report_no-power-tariff-hike-for-agriculture-consumers_1439034 T Accessed on 09-Feb-2011

⁷⁵ Example of states which provided free electricity to farmers – Maharashtra, Tamil Nadu, Punjab and Andhra Pradesh

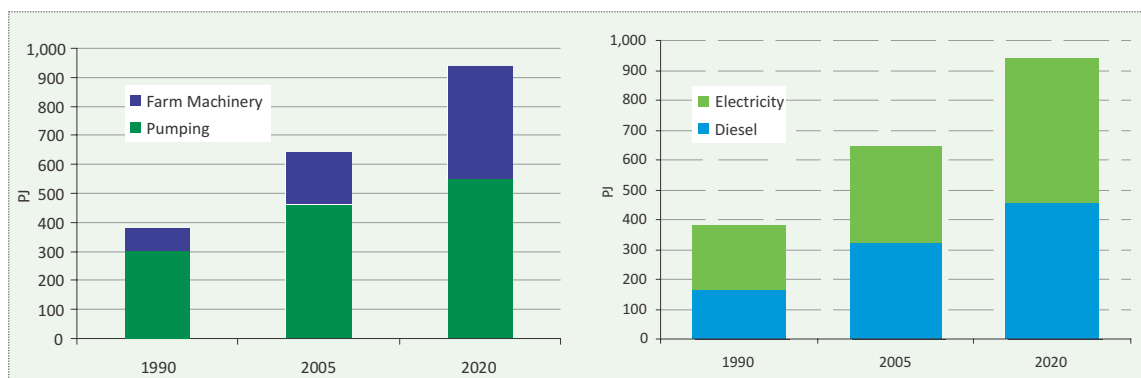


Figure 19: Projected final energy consumption in agriculture sector by end-uses and by fuel (in PJ) (LBNL 2009)

Unreliable Electricity Access:

Revenue losses from the agriculture sector to State Electricity Boards (SEB) have led utilities to reduce investments in additional capacity, transmission and distribution improvements and system maintenance, thus leading to poor quality of power supply.

- ▶ Utilities use the rostering method where power is rotated among farmers in two blocks of 4-8 hours per day, but ad-hoc changes in the rostering schedules have led farmers to leave motor switches turned on so that water is pumped whenever electricity is available
- ▶ Besides excessive water discharge, a large number of pumps get activated at the same time, driving the load demand and often burning out the transformers
- ▶ Driven by poor power qualities, farmers also tend to use oversized pump sets to obtain the

required water discharge

- ▶ Agriculture intense areas in India face severe groundwater stress and India is projected to be critically challenged by groundwater shortages in the coming decades (ADB 2007)

World Bank warns that the current rate of water consumption will put all aquifers in India in a perilous state by 2030 driven by uncontrolled pumping of water. Out of 5,723 water stress assessment units (Blocks/Mandals/Talukas) across the nation, 839 units are categorised as 'over exploited', 226 as 'critical', and 550 as 'semi-critical' units. Andhra Pradesh, Tamil Nadu and Karnataka in peninsular India and Rajasthan, Punjab, Gujarat, and Haryana in western India, account for 80% of these threatened areas (World Bank 2005; ADB 2007; IEI 2010).

2. Policy Initiatives for Energy Conservation in the Agriculture Sector

Policy impetus for electricity reforms came in the 1990s during the economic liberalisation that encouraged private participation. The Energy Conservation Act (2001) discussed earlier, set forth numerous energy efficiency programmes including appliance standards and labelling, energy audits and the creation of an Energy Conservation Fund which positively affected agriculture energy conservation programmes. This was empowered by the Electricity Act in 2003 which had provisions for:

- ▶ Open access provisions which eliminate licensing requirements for many generators and rural distribution
- ▶ Commitment to reduce and eventually phase out cross-subsidies between rate classes
- ▶ Strict new provisions dealing with electricity theft by consumers and corruption by utility employees, including the mandatory use of meters for all customers within two years
- ▶ Specific goals for stemming fiscal drain and reducing the operating costs of the SEBs
- ▶ Creation of an independent regulator **Central**

Electricity Regulatory Commission (CERC) with national tariff setting authority

- ▶ The requirement for new policies to deal with stand-alone systems for rural areas based on renewable and non-conventional energy sources
- ▶ To develop a five-year plan for rural electrification (World Bank 2005)

More significantly the Electricity Act 2003 provided a strong legal framework for pursuing Demand Side Management activities in the agriculture and municipal sectors. India took up the Accelerated Power Development Programme (APDP) in 2000-01 (soon reformed as APDRP⁷⁶) to provide investment assistance to create overall improvement in utilities and Distribution Companies (DisComs), to enable

reliable power supply for customers, by addressing transmission and distribution losses and hence improving utility revenues as well by addressing cross-subsidy issues. ToD metering and differential tariff for peak and off-peak hours were recommended to be implemented with suitable mass awareness and extension efforts (World Bank 2005). These reforms led to various current initiatives for separating agriculture feeders from domestic and industrial feeders.

Several energy regulatory commissions have adopted various measures like the ToD tariff. For example, the Maharashtra Electricity Regulatory Commission (MERC) has significantly enhanced the differential in peak and off-peak energy charges.

3. Energy Efficiency in Agriculture

EE in the agricultural sector can:

- ▶ Reduce the load on the country's power grid
- ▶ Cut back on carbon emissions in the process
- ▶ Reduce dependency on subsidies
- ▶ Reduce overuse of groundwater
- ▶ Result in savings for farmers

It is estimated that by 2011-12, India will have 20 million pumps where many are estimated to be of non-standard quality and unbranded. BEE estimates significant savings by replacement of 45-50% of the pumps which can create 62.1 billion units savings annually⁷⁷. There have been a few initiatives in India aimed at improving energy efficiency in agriculture through implementation of various programmes. Some of these are discussed in the following sections.

3.1. Agriculture Pump Replacement Programmes

Electricity consumption of pumps are driven by:

- ▶ Efficiency of the pumping system
- ▶ Standards for induction motors and agriculture pump sets

Improving the efficiency of agricultural pumps has been identified as critical and various pilot programmes were carried out in India. Many of these programmes were done through utility driven DSM initiatives by replacing inefficient pumps in bulk. Various international pilots enabled propagation of such programmes and Table 9 provides a short overview of such pilot pump replacement programmes.

⁷⁶ APDP was revised in 2002-03 and became the Accelerated Power Development Reform Programme (APDRP) and Revised-APDRP (R-APDRP)

⁷⁷ BEE.2011. Energy Efficiency Standards & Labelling programme, EMT http://www.emt-india.net/ppt_main.htm Accessed on 20-Jul-2011

Pilot Project/State	Year	No. of Pumps	Implementing Agency	Funding Agency
Adoption of efficient mono-block pumps (Gujarat)	1988-93	521	Institute of Cooperative Management, Ahmedabad	Ministry of Energy (now MoP), Farmers
Replacement of pump sets (Warrangal, AP)	1993-96	NA	NEDCAP & APSEB ⁷⁸	JBIC
Replacement of pipe & foot valve (Chittoor, AP)	1987-90	6,000	NEDCAP & APSEB	DFID
Single-phase HVDS and pumps (Nalgonda, AP)	1998-2000	1,641	APTRANSCO ⁷⁹	DFID
DSM pump replacement project (Madhya Pradesh)	2002-03	50	Kirloskar	CIDA
Pump replacement in five talukas (Gujarat)	2007-08	NA	GEDA	GEDA (50% subsidy)

Table 9: International agriculture pilots for pump set EE programmes in India (IEI 2010; Singh 2009)

Gujarat initiated pump replacement and retrofits as early as 1978-85, where 1,108 component retrofits (piping, foot-valves and pumps) reduced energy wastage by 21.7%. Replacement activities resulted in about 51% energy conservation (IEI 2010).

- ▶ In the 1980s, various state programmes, besides the Rural Electrification Corporation, undertook pump rectification programmes
- ▶ By the 1990s, state programmes were conducted as part of utility/DisCom DSM programmes,

sponsored by the Ministry of Power and supported by state agencies

- ▶ Over the past two decades, Gujarat alone replaced or rectified more than 50,000 pumps

Across projects, water discharge improved by more than 50% while energy use fell by 15-60%. Organisations like National Productivity Council, besides vendor organisations, have been involved in verifying the achievements (IEI 2010).

Pump Replacement DSM Programmes in Madhya Pradesh (MP) West DisCom

Implementing agencies: Kirloskar Brothers Ltd and KBL Econoler International

Financing: Canadian Climate Change Development Fund (CCCDF), Canadian International Development Agency (CIDA)

Duration: 2002-04

- ▶ Econoler performed a feasibility study for the replacement of inefficient pumps
- ▶ Econoler and KBL implemented a pilot project during 2003-04 in the area served by MP West DisCom like Indore, Ujjain and Dewas districts
- ▶ KBL conducted energy audits and then replaced 50 pumps and wells of less than 70 feet depth, with more efficient Kirloskar pumps
- ▶ Most 5 HP pumps were replaced with 3 HP pumps of almost equivalent discharge

Energy savings: 33.8-43%. The total connected load reduced from 213 kW to 117 kW

Cost savings: INR 0.6 million (96 kW saved)

Payback period : 27 months estimated, with an energy saving of 45% per hour of use

The project proved that financial participation from farmers (even a small share) is essential to secure their involvement and ownership.

- ▶ Scaling up: KBL estimated that 1,000 MW demand could be avoided through the replacement of 0.62 million pump sets at a cost of INR 4.50 billion (subtracting farmers' contribution of about 25% and scrap value of existing pumps) (IEI 2010)

⁷⁸ NEDCAP Non – Conventional Energy Development Corporation of Andhra Pradesh, APSEB Andhra Pradesh State Electricity Board

⁷⁹ APTRANSCO – Transmission Corporation Andhra Pradesh, GEDA – Gujarat Energy Development Agency

a) The Standards and Labelling Programme for Pumps and Motors

The Standards and Labelling Programme by the BEE in 2006 provides a voluntary scheme for induction motors and agriculture pump sets (S & L detailed in Chapter III, Sec 4.2). Under this programme:

- ▶ Pumps are Star-rated from 1-5, with pumps rated with 5 stars being the most efficient. A 5-star rated pump is expected to be 1.2 times as efficient as one designed to BIS standards
- ▶ An increase in efficiency by 2% can reduce yearly losses by up to 12% in 5 HP irrigation pump sets
- ▶ Since the introduction of labelling of pumps, various state governments now mandate star-rated pumps in their pump replacement programme.
- ▶ In 2010, Tamil Nadu announced that 0.2 million new pump sets would be distributed to farmers who have applications pending for the last 10 years and mandated that all new pump sets supplied would be at least 4-star rated as per the BEE Star rating (TNEB 2010)
- ▶ Haryana has a density of over 10 tube wells per sq. km (the highest in India) and nearly 0.45 million installed irrigation pump sets. Since December 2010, the state has mandated that all new tube well connections should use pump sets with minimum 4-star rating (DHBVN 2010)
- ▶ Gujarat replaced 6,000 submersible electric pumps across the state with more efficient 5 HP BEE star-rated pumps in 2007-09 (Singh 2009)

b) Feeder Separation Programmes for Agriculture EE: Jyotigram Yojana

The Jyotigram Yojana was conceived and launched in 2003 to provide 24 hours of uninterrupted rural power supply in the state of Gujarat. With decoupled feeders for agriculture and non-agriculture activities the programme provides:

- ▶ Eight hours of uninterrupted high quality power supply, pre-scheduled for agricultural use
- ▶ Uninterrupted power supply for 24 hours for domestic, industrial and commercial purposes in 18,065 villages and 9,681 hamlet-suburbs
- ▶ 18,724 new transformer centres and 78,453 km of new lines were laid down. The total expenditure incurred for the programme was INR 12.9 billion
- ▶ With the scheme executed, Gujarat achieved 100% electrification in some of the villages.
- ▶ Fixed annual payments (INR 850/HP/year) was

Madhya Pradesh EE Investment Programme

On the lines of Jyotigram Yojana, the Madhya Pradesh Government (GoMP) aims to provide 24-hour quality power supply in every household in the state while ensuring 8-hour supply of power to water pumps by the end of 2012.

The programme will deploy feeder separation and installation of High Voltage Distribution Systems (HVDS) besides upgrading the distribution system. With the help of ADB, this programme will enhance the on-going MP Power Sector Investment Programme – working to reduce losses to DisComs. Three Madhya Pradesh DisComs will be the implementing agencies. The programme aims to:

- Improve the quality and reliability of power supply
- Prevent theft/direct hooking from Low Tension network catering to non-agricultural load

- Reduce technical and commercial losses in equipment/plant failures
- Implement flexible load management for DisComs

The project is seeking support worth USD 292.66 million where ADB will finance USD 200 million and the remaining financing will be from the GoMP and the DisComs.

Source: India: Madhya Pradesh Energy Efficiency Improvement Investment programme, 2011, ADB, www.adb.org/Documents/Environment/IND/43467/default.asp

imposed (except in the case of new connections)

- ▶ Highly subsidised unit tariff (INR 0.5/kWh, or INR 0.7/kWh for Tatkal connections)

Results:

- ▶ Uninterrupted power supply for rural households
- ▶ Reduced electricity used for tube wells by 37% from 2001-06
- ▶ Halved the farm power subsidy from USD 788

3.2. Agriculture DSM Programmes (Ag DSM)

Net economic gain in agriculture DSM is achieved if the savings are sustained and the cost of the electricity saved exceeds the cost of the new pump-set over its useful life. BEE projects that **replacement of 1 million pump sets can save an estimated 3 billion units annually, i.e. about 30-40% of electricity consumption in this sector.**

Bhatiani and Goyal (2010) show that these savings can be almost doubled by:

- ▶ Supplementing pump replacement programmes by electronic metering of all agricultural connections/ feeders, modernisation of existing low tension networks with HVDS and separation of rural feeders, using drip irrigation for water

conservation (see Table 10)

million to USD 388 million and has resulted in optimum use of water

- ▶ The programme achieved a tangible reduction in T&D losses by 3.74% in 2005-06
- ▶ Transformer failure rate also reduced by 1.17%
- ▶ The level of average employment and reduction in migration from rural areas by 33%. (Shaah et al 2008; Jyotigram Yojana 2010)

conservation (see Table 10)

The willingness of farmers to participate is central to the success of Ag DSM and accurate data is necessary to set baselines and proper M&V to measure and document savings.

Measure	Power Savings Potential
Efficient pump sets	25-40%
Suction pipes and foot-valves	05-15%
Efficient irrigation methods	15-25%
Total savings potential	45-80%

Table 10: Power savings potential in the agriculture sector (Bhatiani & Goyal 2010)

WENEXA Agriculture DSM Programme

The Water and Energy Nexus Project (WENEXA) is a USAID-financed technical assistance programme (2004-11).

Project: Utility-ESCO collaboration for Ag DSM (Dodaballapur region, Karnataka)

Objective: To improve co-management of energy and water resources in the agriculture, urban and industrial sectors through enhanced power distribution and end-use efficiency coupled with sound management practices

Implementing Agencies: USAID/WENEXA, Bangalore Electric Supply Company (BESCOM) and Enzen Global Solutions Pvt Ltd

BESCOM-WENEXA launched the pilot Ag DSM project based on a public-private partnership model. After analysing the depth of groundwater,

irrigated area, average size of holdings, number and types of pumps used:

- ▶ BESCOM-WENEXA installed a HVDS, the necessary distribution transformers and conducted awareness programmes for farmers
- ▶ High quality power and metering devices on the LT side of all distribution transformers supplying to agricultural installations
- ▶ Baseline establishment for evaluation of the project – data on pump and pump efficiency made available
- ▶ Replacement of 663 pumps in the region

Implementation and Financing (WENEXA):

- ▶ ESCO Financing: Enzen Global Solutions Pvt. Ltd. from Bangalore won the bid
- ▶ EGS dismantles and disposes the old pumps, finances the investment required for replacing pumps
- ▶ Provides on-going support to farmers, and implements an M&V protocol for meter reading
- ▶ BESCOM will make payments on a monthly basis to the ESCO based on the shared savings

Investment: INR 18.03 million

Annual Savings in Power Purchase: INR 1.87 million

Savings: 45% reduction in the electricity used for pumping (from 9.71 to 4.41 million units/year)

Return on Capital Investment: 4.4%

Source: (DRUM 2010; WENEXA 2007; WENEXA-II 2009)

BEE Agricultural DSM

BEE Agricultural Demand Side Management (Ag DSM) proposes to create appropriate framework for market based interventions in agricultural pumping sector through Public Private Partnership (PPP) mode. BEE Ag DSM aims to:

- ▶ Reduce the total amount of electricity consumed by the end-user in the agriculture sector, primarily by replacing inefficient pumps with high efficiency pumps
- ▶ Improve groundwater extraction efficiencies and reduce the subsidy burden on the government without sacrificing its service obligation to the sector
- ▶ BEE aims to replace inefficient agriculture pump sets with high efficiency, star-rated pump sets at zero cost to the farmers
- ▶ Ag DSM project funding has to be from ESCO mode with repayment over time from the stream of project benefits

BEE Pilot Ag DSM

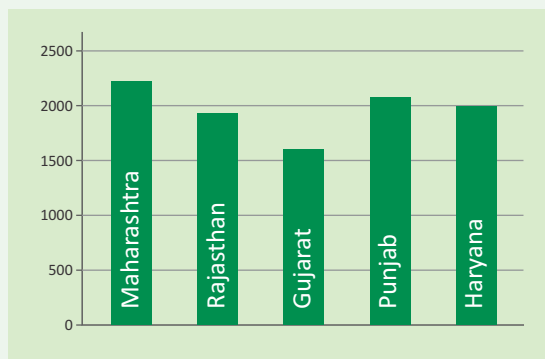
BEE launched its pilot Ag DSM project in Feb 2009 in Sholapur, Maharashtra. It was implemented by Maharashtra State Electricity Distribution Company Ltd. Following Sholapur, a few other states initiated pump replacement Ag DSM programmes.

- ▶ The project aims to replace 3,530 old/inefficient agricultural pumps with energy efficient 5-star rated pumps
- ▶ ESCO to implement the findings of the detailed project report
- ▶ Initial investment: INR 60 million, with an Internal Rate of Return (IRR) of 19%

Energy savings targeted:

- ▶ Annual savings of 8.12 million units targeted
- ▶ Cumulative savings of 36% over 5 years

- ▶ The savings accrued through this programme will be used to pay back the pump supplier
- ▶ CDM benefits are expected to increase the rate of return by 23%



Targeted Pumps Replacement in BEE Ag DSM Programmes (cited in: Singh 2010)

4. Financing of Agriculture Energy Efficiency Programmes

Financing EE programmes have remained muddled with many issues. Though various interventions have been made for agriculture EE improvement through pilot demonstration projects, only a few have been replicated or scaled up beyond the pilot initiatives. Most pilot initiatives in India have been implemented with the support of international funds and grants. Scalability of such projects may not be economically viable or the revenue model identified was not feasible. Other interventions identified were:

- ▶ The possibility of utilities implementing pump-replacement and financing it through the revenue from alternative sales of saved electricity to other (higher-tariff) sectors was evaluated.
- ▶ WENEXA proposed (i) self-financing (ii) financing through women's self-help groups and (iii) financing through the utility under a performance contract with a water/energy service company in conjunction with a corresponding pump set replacement programme (IEI 2010); it found that ESCO performance contracting had better advantages
- ▶ Energy efficient irrigation financing by Yes Bank (through REEEP)

BEE's Agenda: Despite various such initiatives, a success mantra for EE in agriculture was not identified. To enable its Ag DSM projects, BEE developed funding through three different modes: DisCom, ESCO and the hybrid mode. In its pilot

project in Maharashtra, the DisCom collected approximately INR 0.4 billion through the levy of Load Management Charge (LMC) and proposed the following:

- (i) In the DisCom mode, the utility (i.e. the DisCom) makes use of a part of the LMC Fund collected under a tariff regulation for replacement of inefficient pumps and contracts out repair and maintenance of pumps and certain aspects of project works to a project contractor
- (ii) In the ESCO mode, the ESCO which has a contract with the utility finances and implements the project:
 - ▶ ESCO would borrow the project debt and repay it from project revenues and the energy savings would be shared between the ESCO and the DisCom
 - ▶ If the implementation is via the vendor ESCO, an IRR of 19.21% for a project cycle of 10 years is

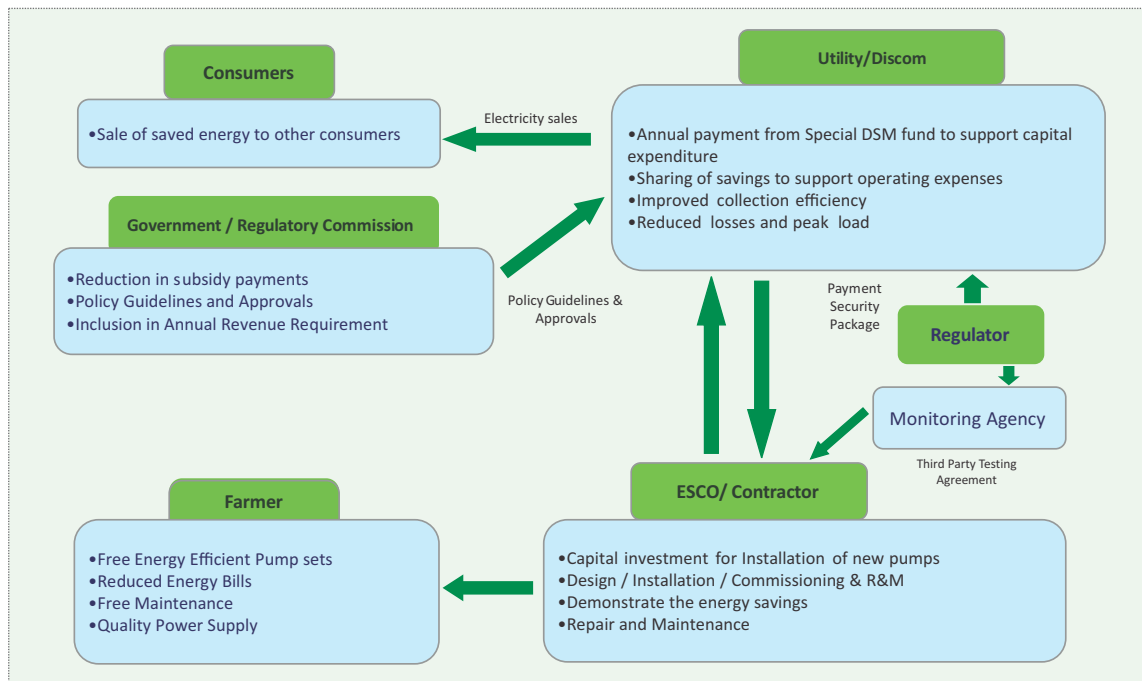


Figure 20: BEE Ag DSM hybrid business model (Sood, 2010)

expected (simple payback period of 5 years)

- ▶ If CDM benefits are considered the project IRR is expected to improve to 22.8%

(iii) In the Hybrid Mode (see Figure 20), the ESCO provides part of the project funds through debt and equity and signs a contract with the utility, whereas part of the project fund would be contributed by the DisCom through the LMC fund.

- ▶ The ESCO invests 33% of the total investment

and retains 55% of net savings, the project IRR is 27.27% for the ESCO

- ▶ For the DisCom, the project IRR will be 12.83% for a project cycle of 5 years (simple payback period of 4 years)
- ▶ With CDM benefits, the project economics shall improve with an IRR of 29% for the ESCO and 15% for the utility

5. Barriers to Implementation of Energy Efficiency in Agriculture

Diffusion of energy efficient technologies is slow in developing countries. There are, however, a few factors in the Indian agricultural sector which may be retarding this phenomenon further:

- ▶ Heavy subsidy on agricultural electricity prices prevents replacement of inefficient pumps and deliberate use of pumps that are not cost efficient, and hence neither of these are an area of concern for the farmer
- ▶ Also free distribution of pump sets as pilot initiative alone may not be sufficient to ensure long-term results
- ▶ Lack of awareness among farmers about the pressing need to avoid overuse of groundwater and electricity
- ▶ Continued pump efficiency is dependent on a number of factors including maintenance; farmers are not educated adequately about the necessity of proper and optimal operating conditions and maintenance
- ▶ The large rural population involved in agriculture makes awareness dissemination a slow process
- ▶ Reluctance among many in the rural areas to accept modern means of agriculture, either due to high comfort levels in following old practices or because of the costs involved
- ▶ Lack of policy or legislation mandating strict rules and levels of efficiency; installing star-rated pumps (efficient pumps) alone is not sufficient to claim energy savings over a long period of time
- ▶ Lack of skilled work force for maintenance services – the current repair and maintenance practice in rural areas is carried out by local, unskilled technicians and most of them lack awareness and training on energy efficiency
- ▶ Vested interests that promote cheap sub-standard pumps that often need regular maintenance, resulting in inefficient performance

There seems to be a lack of concerted effort to spread awareness about the need for agricultural energy efficiency and the regulated use of groundwater. Removal of subsidies on electricity to farmers appears to be a distant dream in most parts of the country. Lack of policy, however, is being partly rectified in many states by making the installation of energy rated pumps compulsory along with BEE making the rating of pumps mandatory.



Municipal Energy Efficiency

Overview

This chapter discusses

- ▶ Overview of Municipal Energy Efficiency Initiatives
- ▶ Water Supply, Sewerage, Public Buildings and Street Lighting EE Programmes
- ▶ National Municipal DSM Programme
- ▶ Financing of Municipal EE Projects and Capacity Building of Municipal Staff

“Municipalities spend a significant percentage of their budgets in providing basic services like water supply and street lighting to the local communities. In India, these two energy-intensive services often represent over 80% of a municipality’s total energy expenditures. The Municipal Energy Efficiency sector in India has come a long way now and is attracting increased attention from central and state government agencies including the urban local bodies. There has been relatively more interest and participation from project implementers and financial institutions. Yet much has to be done to create implementing opportunities ‘at scale’ to make municipal EE a priority investment opportunity. State and municipalities need to include EE in specific policies and regulations governing infrastructure development programmes. Similarly, financial institutions are yet to actively participate in EE lending as a business strategy and adopt cash-flow based project evaluation rather than asset based lending for larger municipal EE projects.”

Pradeep Kumar

Director,
Alliance to Save Energy, India



“Energy Efficiency in municipal systems is a win-win situation with quick paybacks in energy and cost savings, improved public service and reduced greenhouse gas emissions. But the time lag (due to procedural delays and other reasons) between the energy audit and implementation hamper scaling up of the projects.”

Sudha Setty

Municipal Energy Efficiency Expert
Former Director, Alliance to Save Energy, India

With rapid urbanisation in India, **Urban Local Bodies (ULBs)** (municipal corporations, municipalities, city councils) struggle to cater to the demands for civic amenities, shelters and public health and social security services. While the capital requirement is large for such infrastructure development, the planned investments of operation and maintenance of existing “core urban services” is found to be severely inadequate⁸⁰. Municipalities often operate on a negative budget. Though the total revenue of the municipalities grew from INR 115.2 billion in 1998-99 to INR 151.5 billion in 2001-02 at CAGR 9.6%, the total expenditure grew faster at 9.8%. During this period, the public works expenditure of ULBs for energy and lighting activities saw the fastest growth at 42.65%, while water supply expenditure grew by 9.38%⁸¹.

Municipalities have the second largest opportunity for energy conservation, accounting for 23% of energy use inefficiency in the country. Public water supply systems and lighting, together account for 4% of the total electricity consumption in the country (PwC 2010). On an average, the utility spends over 60% of its budget on energy costs for water pumping, while street lighting alone accounts for 10-15% of the municipal budget. Thus, energy conservation projects can create monetary and electricity resource conservation that can be freed up for health and infrastructure development. Also, municipal EE improves the quality of services delivered and reduces greenhouse gas emissions.

1. Municipal Energy Efficiency

Various studies indicate substantial energy conservation opportunities in ULBs through water supply systems (water supply and sewerage), street lighting and public buildings⁸²:

- ▶ 15-40% in water supply systems
- ▶ 25-30% in street lighting
- ▶ 23-46% in public buildings

Municipal EE projects were first initiated in the late 1990s’ by individual municipalities, after being exposed to the concept of **Watergy**⁸³ which highlighted the link between water and energy

usage. Watergy pointed out that globally 2-3% of the world’s energy consumption is used for pumping and treating water for urban and industrial requirements. EE in the municipal sector was then included in the National Energy Conservation Awards (NECA) to encourage various agencies to successfully implement such programmes (BEE 2008).

1.1. Energy Efficiency in Water Supply Systems

A third of India’s urban population has no direct access to clean, affordable and reliable water services. Inefficiencies in water utilities are largely due to aging infrastructure and over designing of systems. Also, there is inefficiency of equipment, which means more energy is needed to deliver water to end-users.

The Watergy programme found that, energy is among the top three cost items to water utilities. In India, energy cost is 40-60% of the operating cost of supplying water. Fortunately, EE can yield cost and energy savings of between 15-40%.

EE in Water Supply Systems via

- Pumps, Motors
- Right-sizing of Impellers
- Capacitors
- Variable Speed Drives
- Automation System: Electrical Panels
- Metering and Monitoring Systems: flow meters, electricity meters, sub-meters

⁸⁰ RBI. *Municipal Finance in India: An Assessment* www.rbi.org.in/scripts/bs_viewcontent.aspx?Id=1158# Accessed on 18-Jan-2011

⁸¹ RBI. *Trends in Municipal Finances* http://www.rbi.org.in/scripts/bs_viewcontent.aspx?Id=1161# Accessed on 18-Jan-2011

⁸² Cited in Sood (2010) (Source: ADEE, Econoler, IREDA and TERI, DSM from a sustainable development perspective, 2003)

⁸³ Alliance to Save Energy, ‘Watergy Programme’ <http://ase.org/programs/watergy> Accessed on 19-Jan-2011

Water distribution can be increased much more effectively and inexpensively through efficiency improvements than by adding new infrastructure, thereby deferring the need for additional investment in infrastructure. Energy efficiency opportunities in water supply systems can be no or low cost measures

or capital-intensive measures. The no cost and low cost measures have short payback periods of 1-2 years. Efficiency opportunities are typically found in inefficient pumps and motors, inadequate pipe sizing, mismatch in head and flow, system over-design and excess contract demand.

a) Pioneers in Watergy Projects

Ahmedabad, Indore and Pune Municipal Corporation were the first municipalities in the country to initiate water and energy efficiency pilots via Watergy projects in the late 1990s which showcased the potential energy efficiency opportunities that existed in municipal systems in India. This led to municipal corporations of Vishakhapatnam, Greater Mumbai, Nasik and Thane and water utilities such as the Delhi Jal Board to undertake water and energy efficiency projects. Watergy pilot and dissemination was adopted at the state level in Karnataka, Andhra Pradesh and Maharashtra and paved the way for bundled municipal energy efficiency projects in Tamil Nadu and Gujarat.

i. Andhra Pradesh Urban Services for the Poor implemented municipal energy efficiency in 24

towns and accrued cumulative savings to the tune of INR 117.9.92 million in March 2007⁸⁴.

ii. Nagpur is one of the mission cities under the **Jawaharlal Nehru National Urban Renewal Mission (JNNURM)** that initiated a comprehensive programme to improve the efficiency of the water supply system⁸⁵.

iii. Among the other initiatives, Water and Energy Audit has been considered to be one of the first steps of the reform process. Similarly, most pilot energy efficiency projects in water supply systems have been supported by bilateral agencies such as USAID and implementation has been supported by DFID, World Bank and Asian Development Bank.

iv. The first pilot water pumping energy efficiency project was structured for carbon credits through

Watergy: Pune Municipal Corporation, Maharashtra (2004)

Technical Assistance: ASE with funding support from USAID

Energy audits on Pune Municipal Corporation's (PMC) bulk water supply systems were conducted along with hands-on training for 45 PMC engineers in order to build technical and managerial capacity at PMC. They implemented a number of capital-intensive efficiency measures as per the recommendations of the energy audit reports.

PMC capital contribution: INR 8.5 million (USD 189,000)

Energy savings: 3.78 million kWh annually

Cost savings: INR 14.8 million (USD 336,000)

Other benefits:

- ▶ 70% of the energy efficiency measures had payback periods of less than 1 year

- ▶ 10% increase in water supply to the community
- ▶ The utility also saved money by qualifying for a rebate programme offered by the Maharashtra State Electricity Board for maintaining a good power factor and reducing usage during peak hours

Dissemination: Owing to the success of PMC's programme, other ULBs in Maharashtra – Thane, Nagpur and Municipal Corporation of Greater Mumbai (MCGM) undertook the Watergy programme. A Roadmap on Energy Efficiency was also prepared for Maharashtra ULBs.

Source: (ASE 2007)

⁸⁴ ASE. 2005. India Watergy Case Study, Vizianagaram www.watergy.org/resources/casestudies/vizianagaram_india.pdf Accessed on 15-Feb-2011

⁸⁵ JNNURM. Nagpur City Development Plan www.jnnurm.nic.in/jnnurmudweb/nagpur/ExecutiveSummary.pdf Accessed on 9-Mar-2011

CDM. It was a Karnataka-based project in which 5 municipalities had been bundled together. **Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC)** has been authorised by the Government of Karnataka to be the state

nodal agency for carbon trading. The World Bank is buying the carbon credits and has signed the Emission Reduction Purchase Agreement (ERPA) with KUIDFC.

Watergy: Municipal Corporation of Greater Mumbai (MCGM), Maharashtra

- One of the largest water supply systems in India: 11.9 million people
- Electricity consumption in 2005: 06-250 million kWh
- Electricity cost for supplying water: INR 815 million
- Projected annual savings from EE: Over 197 million kWh

MCGM created a line item in the annual operating budget and allocated funds for EE in order to sustain the initiatives.

Source: (ASE 2007)

b) Bundling of EE Projects

States like Tamil Nadu and Gujarat opted for bundled municipal projects through Energy Service Companies (ESCOs).

- ▶ In Tamil Nadu, 29 municipalities are bundled together and these ULBs have been divided into three zones. Two ESCOs won the bid. Investment grade energy audits have been completed and energy performance contracts will shortly be signed.
 - ✦ Water supply and street lighting are combined and treated as one project (Setty 2010)
- ▶ Gujarat is implementing bundled municipal water and EE projects across seven municipal corporations. All 159 ULBs (including seven municipal corporations) in the state have been bundled together for municipal water and energy efficiency projects
 - ✦ Water supply and street lighting are treated as separate projects (based on lessons from Tamil Nadu)
- ✦ Financing through ESCO performance contracts on shared savings mechanism
- ✦ Owing to the large size of the project, it's being implemented in phases; the large size makes the projects attractive to ESCOs
- ✦ Phase-I with pilots in 10 urban local bodies; investment grade energy audits in water supply completed and energy performance contracts are to be signed shortly; in Phase-II, the remaining ULBs are divided into 4 zones

Financing municipal EE Projects

- ▶ Effectively utilising a portion of operations and maintenance funds
- ▶ Borrowing from financial institutions
- ▶ ESCOs are implementing agencies with technical expertise and financial investment

1.2. Energy Efficient Street Lighting

Inefficient and inadequate lighting wastes significant amount of energy and financial resources and creates unsafe conditions for driving and for pedestrians. Well-designed street lighting enhances the appearance of the local environment and improves both personal and perceived safety. Street lighting alone can account for 10-38% of the total energy bills in most cities worldwide. In 2007-08, total energy consumption for public lighting in India was estimated to be 6,131 million kWh (ECO-III 2010).

A large number of India's ULBs have either inadequate or poor street lighting and incur high maintenance costs, often amounting to 10-15 % of a typical municipal budget.

Overall, street lighting EE can dramatically create 25-60% savings using EE technologies and design practices:

- ▶ Light Emitting Diode (LED), a fast evolving

Initiatives in Street Lighting

- ▶ Energy efficiency initiatives in the street lighting sector began in the early 90s. The **Vadodara Municipal Corporation (VMC)**, in 1992-93, was one of the first municipalities to implement energy conservation measures in street lighting (through energy efficiency procurement):
 - ✦ Replaced 40W Fluorescent Tube Lights (FTLs) with 36W FTLs; created 10% energy savings
 - ✦ By 2008, 1,691 km of EE street lighting resulted in a 45% reduction in VMC's energy consumption⁸⁶
 - ✦ Through a capacity building programme, **International Council for Local Environmental Initiatives (ICLEI)** facilitated a sharing of best practices and experiences between VMC and the Municipal Corporation Jabalpur. Municipalities from other states also learnt from the best practices at VMC
- ▶ In 2002-05, the **Madhya Pradesh State Electricity Board (MPSEB)** enlisted the services of an ESCO in Indore and Ujjain where demonstration projects were successfully implemented:
 - ✦ Investments were recovered and continued savings of 39% were expected
 - ✦ MPSEB engaged an ESCO to design a business model which facilitated street lighting projects bundled with CDM, which resulted in eight cities entering into shared savings
 - ✦ Many municipal corporations across the country have since followed the Vadodara, Indore and Ujjain models
- ▶ The success of these municipal-level schemes encouraged the scale-up of EE initiatives to the state level in Andhra Pradesh, Tamil Nadu and Gujarat. The municipal DSM programme launched by BEE were as well adopted:

Energy Efficient Street Lighting: Akola, Maharashtra (Retrofit completed in 2007)

Replacement of more than 11,500 standard fluorescent, mercury-vapour and sodium-vapour street lights with efficient T5 fluorescent tube lamps.

Type of project: Through performance contracting Asia Electronics Limited (AEL), the ESCO, financed all investment costs, implemented the project, maintained newly-installed lamps, and received a portion of the energy savings to recover its investment. Under the energy savings performance contract, compensation to AEL was based on a shared savings approach under which Akola Municipal Corporation (AMC) paid AEL 95% of the energy bill savings over the contract's 6-year duration. AEL was also paid an annual fixed fee for maintaining the lamps and fixtures.

Capital cost/initial investment: INR 5.7 million (USD 120,000) (estimated)

Energy reduction: 2.1 million kWh (56% in annual energy savings)

Cost savings: INR 6.4 million (USD 133,000)

Payback period: less than 11 months

Benefits: Akola Municipal Corporation was able to improve the service level of street lighting at low capital cost and lower electricity bills

Source: ESMAP – EECL. 2009. 'Akola Municipal Corporation, India - Performance Contracting for Street Lighting Energy Efficiency'

⁸⁶ Hindu.2010.Solar street-lighting for Jakkampudi Township www.hindu.com/2010/05/28/stories/2010052859990300.htm Accessed on 25-Jan-2011

- ✦ **Andhra Pradesh Urban Finance Infrastructure Development Corporation (APUFIDC)** hired Pricewaterhouse Coopers to develop street lighting projects in 50 ULBs across the state under a public-private partnership model (PwC 2010)

Most municipal street lighting initiatives have been

supported by international organisations with funding from bilateral agencies as a technical assistance programme. These establishments have been assisting local authorities in the tendering process, financing, monitoring and evaluation, and training and capacity building for the projects.

2. National Municipal Demand Side Management (MuDSM) Programme

DSM initiatives offer significant cost savings to municipal corporations while reducing specific energy consumption and addressing the supply shortages. BEE initiated nation-wide Municipal DSM (MuDSM) programmes in 2007 to address EE in water pumping, sewage pumping, street lighting and public buildings across ULBs in the country. ESCOs are being encouraged to take up implementation of the programme with financing from institutions like banks, etc.

A Situation Analysis Survey across 23 states and 171 ULBs was done to form the basis of preliminary energy audits of the MuDSM Programme. The situation analysis survey report⁸⁷ identified the potential for 9,820 possible projects across all four

major segments – water supply, sewerage, buildings and street lights. The study indicated that ULBs had low prioritisation in energy conservation:

- Only 13 states allocated budgets for energy conservation in 2007-08
- 38 cities have separate budgetary allocations for energy efficiency initiatives
- Only 9 out of 171 ULBs have dedicated 'energy cells'
- Energy conservation budgetary allocations were only 1.06% of the total ULB budget in 2006-07, even reducing to 0.88% in 2007-08 (TUV 2008)

Investment Grade Energy Audit (IGEA) under MuDSM at Greater Vishakhapatnam Municipal Corporation

Project: IGEA of water supply and treatment, sewage, street lighting and public buildings by PCRA.

IGEA was done for 35 pumping stations, 6 water treatment plants, 2 sewage pumping stations, 1 sewage treatment plant, 60,000 lights and 20 municipal buildings.

Observations: ULB's total power consumption is approximately 32.6 million kWh of which water supply and treatment consumes 26%; about 8% is consumed by sewage pumping and treatment; 63% is consumed by street lighting and 3% by municipal buildings.

Estimated Energy Savings, Investment & Payback Period

Description	Annual Savings kWh	Savings INR (million)	Investment INR (million)	Simple Payback Period (months)
Pumping	25,14,337	12.4	17.0	16
Sewage	21,900	0.10	-	immediate
Street lighting	4,60,937	3.10	6.40	25
Buildings	87,91,574	35.3	120.4	41

Source: (PCRA 2010)

⁸⁷ Report on Situational Survey for MuDSM Project, 2008, submitted for Bureau of Energy Efficiency, TÜV SÜD South Asia

States such as Karnataka, Gujarat, Rajasthan and Tamil Nadu led the MuDSM initiatives, with Karnataka allocating approximately INR 740 million, Gujarat INR 240 million and Rajasthan INR 220 million in 2007-08. Haryana, Punjab, Madhya Pradesh, Chhattisgarh, Uttarakhand and Andhra Pradesh were

identified for BEE's first phase of Investment Grade Energy Audits (IGEA). It is anticipated that IGEAs will be completed and Detailed Project Reports⁸⁸ (DPRs) for all 171 ULBs be finalised in a phase by phase manner.

2.1. Public Buildings (also see Chapter III, EE in Buildings)

Improving the energy efficiency of the existing buildings not only generates energy savings with attractive pay back periods, it also improves a nation's energy security and makes buildings more liveable. Various studies indicate that energy usage in public buildings alone can be cost-effectively reduced by 15-20%. BEE's national level programme for energy efficiency in government buildings sought to convert prominent buildings around the capital into energy efficient premises and set a precedent. Similar efforts by State Designated Agencies (SDAs) in Haryana, Kerala and Punjab, with assistance from BEE, have initiated EE programmes for public buildings.

Haryana Renewable Energy Development Agency, an SDA has carried out energy audits of 35 government buildings including Haryana Raj Bhawan and the

Chief Minister's residence.

- ▶ Of the 35 buildings, 25 along with five large markets (mandis) have had IGEAs (BEE 2010)
- ▶ Recommendations for CFLs and low wattage tube lights have been implemented in 10 of these buildings
- ▶ Haryana is the first state to have introduced an initiative in 2009-10 to promote IGEAs in private, government, quasi-government and industrial buildings (HAREDA 2008)

In Kerala, the Energy Management Centre, another SDA, carried out IGEAs of 22 government buildings and a survey and analysis of buildings of designated consumers (under the EC Act 2001) with the aim of better implementation and compliance check of the ECBC in 30 buildings (Limaye *et al*, 2008).

3. Challenges facing Municipal Energy Efficiency Projects

As discussed in earlier sections, various pilot municipal energy efficiency projects have been implemented or are underway. However, scaling up has been a challenging and daunting task. Even though energy efficiency initiatives are cost-effective and political/administrative will exists, funding, inexperience with energy efficiency and delivery mechanisms, procurement difficulties and lack of understanding of financial and legal risks for project partners can be prohibitive obstacles for carrying out energy efficiency programmes in the municipal sector.

3.1. Financing for EE Projects

Financing for municipal EE investments is difficult to secure through a bank loan/FIs since banks tend to consider both municipalities and ESCOs to be a financial risk. Until recently, large municipal corporations and utilities funded energy conservation projects through their operation and maintenance budgets or loans from multilateral institutions (for example, Delhi Jal Board). Since

most municipal budgets often lack funds for investment in EE improvements, ULBs are interested in innovative ways of financing energy efficiency projects.

Financing municipal energy efficiency projects using ESCOs can also face significant challenges. ESCOs typically do not have large assets to bank upon. Therefore while they have the technical capability to

⁸⁸ Besides project description, planning and implementation of the project, DPRs include examination of technological parameters, description of the technology to be used, broad technical specification, evaluation of the existing resources, schedule plan, general layout, and specifications.

identify and design EE projects, they are often unable to convince water utilities/municipalities, investors and bankers about the certainty of energy savings.

- ▶ Tamil Nadu and Gujarat have bundled municipal EE projects and are trying to address some of

these challenges by setting up Trust & Retention Account (TRA) with escrow of electricity bill payment and using the International Performance Measurement and Verification Protocol (IPMVP) for measurement and verification

3.2. Capacity Building

Apart from financial constraints, municipal EE initiatives tend to be hindered by a dearth of technical and managerial capacity, lack of awareness and inadequate technological resources. Therefore, capacity building is an integral part for sustaining municipal energy efficiency. Interventions in this regard include institutional development, training workshops, awareness campaigns, manuals/guide and hands-on technical assistance.

a) Training

As institutional intervention, Energy Management Cells (EMCs) comprising of cross-functional teams in municipal corporations and at a few state levels were established to oversee execution and implementation of energy efficiency projects. Responsibilities of the EMCs also included staff training in various aspects of data management and also to act as an information clearing house and resource centre for energy efficiency in the state (BEE 2008a).

b) Technical Resources

Manuals and guidelines have been developed for municipalities and other stakeholders involved in municipal energy efficiency programmes with the aim of assisting them in developing municipal EE programmes and adopting energy efficiency initiatives.

The *Manual for the Development of Municipal Energy Efficiency Projects* was released by BEE as a reference guide for developing and implementing municipal energy efficiency projects. This manual is a step-by-step

guide for developing, financing and/or implementing a municipal energy efficiency project using a performance contract⁸⁹. JNNURM has instructed all urban development departments in India to refer to this manual for municipal energy efficiency projects. As part of the USAID ECO-III Project, guidelines on energy efficient street lighting have been developed. The document is aimed at providing practical guidance on energy efficient street lighting best practices. In addition, the guidelines contribute to the development of future standards (ECO-III 2010).

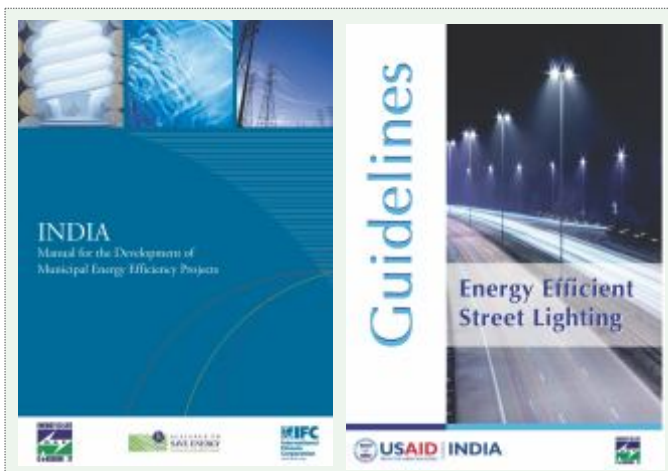


Figure 21: BEE-ASE Manual for Municipal Energy Efficiency Projects

Figure 22: BEE-USAID Guidelines for Energy Efficient Street Lighting

⁸⁹ INDIA Manual for the Development of Municipal Energy Efficiency Projects, 2008, BEE, ASE and IFC

Market Transformation towards Energy Efficiency in India

Overview

This chapter examines key areas in EE market transformation in India, using excerpts from discussions with thought leaders and industry specialists like, Dr. Ajay Mathur, Director General, Bureau of Energy Efficiency, Mr. Shishir Joshipura, MD, SKF India Ltd, Dr. Datta Roy, CEO, Dalkia Energy Services Ltd, and Dr. Prem Jain, Chairman, Indian Green Building Council. The discussions focus on areas mentioned below and are complemented with inputs from a few other EE stakeholders.

- ▶ Policy Impact
- ▶ ESCO Initiatives
- ▶ Demand Side Management
- ▶ EE of Buildings and Smart Grids

“A process of change management, both at equipment manufacturers and industrial end-users, is necessary through technological intervention for moving industries towards EE. In the energy conservation space, a lot is getting done on the generation side; however, industries/manufacturers or industrial end-user issues need concentrated efforts. The Perform, Achieve and Trade scheme for industries is coming into place, but more initiatives are necessary to push the cause of energy efficiency as an agenda for the industries. This process can happen only when standards, benchmarks and incentives are in place.

Manufacturers have no incentive to invest in EE unless it gives a competitive positioning in the market, especially if the equipment manufacturer's market positioning is based on low cost or the availability of the product. Because of this decision that the market puts on the supplier, the end-user is forced to make a trade-off. Often energy use inefficiencies get built into the system at the design stage of the product/system and these designers are not the users of the system. More so, industries often lack knowledge or availability of benchmark for energy use on specific sectors. A lack of reliable benchmarks makes the organisation dependent on internal benchmarks, resulting in a situation where sub-optimal improvement is targeted by the plant.”

Shishir Joshipura

Managing Director,
SKF India Ltd



1. On Market-Based Policies like NMEEE, PAT and DSM

“While reduction in energy intensity is taking place, the full potential of EE is not being exploited due to a range of market failures. The impact of energy performance of equipment on the bottom line is not known. High risk associated with new technologies is another problem. Finally, the first cost could also be a barrier. Therefore, public policy moves are designed to address these market failures.”

Dr. Ajay Mathur
Director General,
Bureau of Energy Efficiency



BEE programmes like Lighting DSM, Standards & Labelling, Energy Conservation Building Code (ECBC) & EE in Existing Buildings, Investment Grade Energy Audits in buildings, Star-rating of buildings and, Municipal and Agricultural DSM have targeted influencing end-user energy efficiency through large scale programmes. BEE, which is carrying out various EE measures and objectives of the Energy Conservation Act 2001, considers the National

Mission for Enhanced Energy Efficiency (NMEEE) to be the primary vehicle for implementing these initiatives. Through various specific programmes in NMEEE, BEE seeks to reduce the energy intensity of India's GDP (at present 0.14 kgoe is consumed for every USD of GDP). Perform, Achieve & Trade (PAT) envisaged under NMEEE targets specific energy consumption in designated industries which are largely energy intensive.

1.1. PAT Mechanism incentivising EE in Industries

PAT scheme sets a target for a sector as a whole while energy use reduction targets are for specific installations. While least efficient ones are persuaded to achieve more ambitious targets, most efficient ones are given reasonable targets. These targets are spread across the units on the basis of relative efficiency. Hence, theoretically, PAT will take the industry benchmarks to optimal standards to improve EE.

The PAT mechanism has been a step in the right direction, so far, says Dr. Datta Roy. Historically, the cement industry is a fine example where co-operative effort and information sharing drove EE in the sector. Technology risk assessment was done collectively, including the ownership of risk and responsibility. Hence, critical technology areas were easily identified, like the milling systems, fans and heat recovery from clinker, while technology development in variable speed drives and other specific areas helped. The cement industry's success did not repeat in other segments like textile, steel or paper because of wide diversities. But the sugar industry is an area where a similar possibility exists, where the steam consumption can be brought down by as much as 50%.

Dr. Roy cautions that designing the right level of incentives is critical to the success of PAT. Very low incentives affect consumer motivation adversely, while high incentives can create tendencies to *short-change the government* – a critical challenge in the PAT mechanism. Also, associated with the PAT scheme and other programmes is the need for strong Measurement and Verification (M&V) processes. M&V requires a significant amount of capacity building as energy and cost savings require independent verifiers to certify the savings for EE programmes. M&V is still taking shape and the markets will determine what sort of verification/verifier is necessary and suitable.

1.2. Incentivising EE Appliances' Markets

“India's Standards and Labelling Programme is considered successful. EE appliances penetration is much faster in India, though China launched the programme ahead of India. When compared to the USA, since the time of the introduction of labels, the percentage of labelled products sold is much higher in India. The ECBC programme has added to this success in India.”

Dr. Datta Roy

CEO,
Dalkia Energy Services Ltd

The Standards and Labelling programme has the potential of triggering extensive changes in various appliances and equipment. Dr. Mathur emphasises that the efficiency of appliances and equipment is bound to increase. To enable a healthy market competition, numerous incentives for EE appliances are made available towards encouraging manufacturers to invest in R&D for EE. Various appliances are now required to abide by mandatory labelling and consumers are ready to pay more for such appliances. Energy efficient pumps and motors are integral to agriculture DSM. Through the rating of appliances, BEE targets EE of air conditioners as air conditioning systems will play an important part in the EE of future buildings. To accelerate this process, BEE is introducing the Super-Efficient Equipment Programme (SEEP) to induct 20-40 times more efficient equipment. Ceiling fans, the most widely sold appliance in India, will be the first in this series.

“Motors are the single largest cause of energy consumption as they drive most activities in the industrial environment. A small gain in motor EE will go a long way in energy conservation. Labelling of motors should soon mandate that 1-2 star-rated motors be phased out. Besides incentivising manufactures, it is necessary for incentivising customers to demand energy efficient solutions. This shall force manufacturers to deliver; this is a crucial policy necessity. To create such a conducive environment, incentivising both users and OEMs is necessary, thereby creating a successful market transition.”

Shishir Joshipura

MD, SKF India

1.3. The DSM Agenda

“BEE is depending on utilities to implement vigorous DSM programmes to keep energy requirements to a reasonable level. In Mumbai, Tata Power has a DSM initiative for replacing old fans with 5-star rated fans. Utilities like those in Haryana have also started DSM for better capacity factor and transformer efficiency.”

Dr. Ajay Mathur

DG, BEE

Though BEE is the nodal agency for all SDAs (implementing various EE measures), it is yet to have an authority over public buildings that are under other ministries. So by joining arms with the Forum of Regulators, through utilities, DSM can be mandated across sectors like buildings, industry,

agriculture or municipalities. However, the challenge is to enhance the capacity of SDAs to get them interested in energy saving initiatives. Industry will be important in providing support and partnership for this effort.

► Dr. Roy points out that the DSM project design

requires establishing an equation between private and public benefit for the ESCO participation. Currently, the DSM logic benefits the public good and unless there is private benefit it is not possible to attract the public. However, the private benefit is not easily understood and will require public policy research and support to form a mandate.

- ▶ It is necessary that the consumers begin to understand the benefits that shall result from

three different situations: (i) a dominant private benefit which is understood by everyone; the market will emerge (ii) a mixture of private and public benefit where market drivers are necessary and (iii) only public benefits; the need for government investment.

Technologies and solutions will fall in place if these dynamics are understood and hence research and analysis is necessary.

Large scale deployment, like the DSM programmes, need critical prioritisation of EE procurement:

Currently, there are no policy guidelines for EE public procurement. A BEE stakeholder dialogue⁹⁰ in 2010 saw strong recommendations to incorporate Standards and Labelling, utility rebates, tax incentives and “green purchasing” in public procurement processes. The procurement agencies lack awareness of EE and there are no guidelines to facilitate them. This contradicts the General Finance Rule 160 that mandate public procurement to be carried out “to secure the best value for money”.

- ▶ The total public procurement in India was around INR 4900 billion⁹¹ in 2002, which represents 13% of the national budget, about 20% of the national GDP
- ▶ About 20-30% energy cost can be reduced through purchasing EE products and efficient management of facilities in sectors like NTPC, oil companies, iron & steel, fertilisers and railways (PwC 2010)
- ▶ Procurement processes lack Life Cycling Costing, one of the biggest roadblocks to effective EE procurement

2. Future of EE in Buildings

“ECBC, GRIHA and IGBC are meant for large buildings. While there is a critical issue in reaching out to millions who are yet to be converted, how do these initiatives percolate down to the next level of the general construction industry? ECBC is considered elitist by many in the field, so it is necessary to take measures to impact the municipal byelaws. Green concept penetration will be much deeper through municipal byelaws because local byelaws are supreme and adhered to, for all construction in the jurisdiction of these municipalities.”



Dr. Prem C Jain
Chairman,
Indian Green Building Council

The National Building Code (NBC) revised in 2005 is “too fat” at 1200 pages and makes it difficult to access the information required, says Dr. Prem Jain. Hence there is a hectic and urgent objective to bring

an addendum to NBC by October 2011. This code can give necessary impetus to EE in buildings by bringing out an optimum envelope design for each climatic zone. The building code is faithfully followed across

⁹⁰ BEE-PwC energy efficient procurement workshop, 28-Jun-2010, Delhi

⁹¹ Converted from USD 100 Billion (2002 USD value) http://www.data360.org/dsg.aspx?Data_Set_Group_Id=69 Accessed on 13-Feb-2011

the country even though it is not mandatory. While metros are reluctant to follow NBC, Tier II and Tier III cities, townships and districts largely follow the code. Ensuring 100% compliance is not necessarily relevant

as all buildings will not adopt EE, says Dr. Jain. Instead, larger problems need to be minimised while smaller issues that come in the way of adoption of the code can be addressed.

2.1. Pathways for EE in Buildings

BEE has focused on buildings in recent years and adopted the ECBC for new buildings. For the success of EE in buildings, there is the need to engage municipal and state level officials because this subject falls in their purview (like the NBC). Capacity building for architects, builders and equipment suppliers is very much the need of the hour and some efforts are already underway to train architects who will ensure the EE of buildings. Dr. Ajay Mathur shares some of the concerns and opportunities:

The increased demand for HVAC shall clearly be a challenge. The demand for appliances is set to grow rapidly as there is indication that by 2030, 70% of buildings will be newly built, thus implying EE has to be prioritised in this vast infrastructure growth. BEE intends to revise air conditioner EE standards in the beginning of 2012 and re-revise it in 2016, such that, at the end of the decade, since the introduction of Standards and Labelling Programme in India, air conditioner EE would be higher by 50%.

In commercial buildings, achieving EE in those owned by corporates is relatively easy and various companies like **Johnson Controls** and **Honeywell** are doing it. However, in the case of buildings managed

by property managing agencies, energy bill is a pass-through item. They will be interested only if they benefit from the process. BEE plans to develop a business model in reaching out to such property managing agencies.

For existing buildings, BEE is promoting ESCOs and performance contracting as they seem to be the only way to bring about visible change. However, qualifying ESCOs for various kinds of projects and establishing a competitive bidding procedure that leads to a meaningful performance contracting model is essential. For instance, in public buildings, the acceptability of investment grade audit carried out by another entity is often a challenge.

2.2. Drivers of Energy Efficient Buildings and Barriers

Green certifications of buildings are driven primarily by inherent marketing and brand mileage, available to all stakeholders. However, for Indian clients, the initial cost is at the core of all decision-making and the payback should be attractive, say stakeholders.

- ▶ Most users are keen to have energy and water conservation without extra cost
- ▶ Few customers are interested *because EE is a good thing*
- ▶ In comparison, multinational organisations are usually more receptive to measures for “greening” the buildings; yet the necessary visibility is still a challenge as they form very small percentages
- ▶ Large Indian companies and banks which occupy large spaces are yet to be proactive in resource conservation measures; thus, there is need for creating more awareness

“The success of star labelling of appliances needs to be achieved in star-rating of buildings or by GRIHA and other such green certification so that such measures result in reduced energy consumption. This coupled with data and subsequently benchmarks of various types of buildings such as hospitals, commercial buildings or schools will go a long way in convincing the client.”

Ganapthy S
Director,
Ecofirst Services Pvt Ltd

- ▶ On the other hand, quite often, clients do not see the promised services or payback, thus leading to a sense of mistrust of the system

R&D for India specific building solutions, rewards, incentives and recognition for EE buildings and a favourable environment for businesses to venture out for opportunities shall be enabling factors. Financial incentives to mitigate the higher capital

cost of EE buildings are a great attraction. However, Dr. Prem Jain warns that incentives should not be confused with subsidies *as subsidies are often misused*. On the other hand, the rapid growth of green building floor-spaces in India has been purely market driven. But for quick transitions, buildings that are deploying more sustainable practices must be suitably incentivised.

3. Enabling the ESCO Model

There is a formidable challenge in EE financing because ESCOs prefer that the building owner borrows on the basis of his credit worthiness, says Dr. Ajay Mathur. For public buildings, if public bodies or state agencies have to resort to borrowing then they themselves can carry out the work. The government cannot borrow on behalf of their buildings, which implies that the ESCO will have to take on the risk. The key issue is that either the ESCOs will have to take the risk or a third party invests. Hence such a scenario needs a business model where,

- ▶ The ESCO and financial institutions have a back-to-back arrangement
- ▶ The business model that has a financial institution as the front-end would be an ideal
- ▶ Various stakeholders interact successfully, namely, the government, the regulator, BEE, Ministry of Urban Development, the building owners, Public Works Department with the ESCO and the financial institutions (FI) at the other end
- ▶ Appropriate support policies are necessary to define if ESCO or FI will require to do the investments (debt or equity)

3.1. BEE funds for EE

BEE is launching two funds as a part of NMEEE – the **Partial Risk Guarantee (PRG) fund** and the **Venture Capital fund**:

- ▶ The PRG fund will address the debt part of the EE investment, so that if a financial institution is not comfortable, the PRG will do a back-to-back arrangement i.e up to 50% of the non-repayment is met by the PRG fund. This would enhance the comfort of the FIs to invest in EE
- ▶ For increasing the borrowing capacity by enhancing the equity, BEE is setting up the Risk Capital Venture fund whether for manufacturing EE equipment or to provide EE services such as ESCOs. BEE hopes that such financial instruments can be replicated and attract private investments in the ESCO industry

3.2. The State of the ESCO Business in India

ESCOs are yet to succeed in India, says Dr. Datta Roy. It is not as much a business model or lack of it that has inhibited growth of the business, it is the information asymmetry that has been the main hurdle. The baseline and M&V methodologies are complex issues encompassing technical, accounting and information management processes. Very few ESCOs possess the capacity to understand these issues for a building/facility and then develop a transparent methodology for communicating it to the facility managers, their accounts and finance personnel (of the clients). The entire process is time and resource intensive as well. That raises the project development cost immensely. Dr. Roy points out that this issue can only be tackled by a sustainable capacity development programme, particularly for the managers in the government and PSU facilities, which can benefit the highest from ESCO performance contracts. That would automatically help the ESCO market development faster.

In critical non-government building sectors like hotels and hospitals, performance contracting (PC) face a huge problem due to mistrust. For example, ESCOs face customer ire in hotel EE projects when air conditioners fail and these failures in hospitals are unacceptable. Such set-backs are viewed upon with little tolerance as in the case of an ESCO (as against when a similar problem occurs while maintained by the facility management). Also, the in-house facility management team is often confrontational when “an outsider” is allocated to do “a better job” in their facility. Alternatively, the ESCO should work along with the internal staff towards identifying EE

opportunities. Thus, ESCO services becomes relevant through two purposes:

i) The discovery process: EE opportunities in a daily run system is better discovered by an external agency (the facility manager might be inhibited to the discovery process)

ii) For verifying savings achieved, and sustaining it

However, if this can be done internally, ESCO service is often not required and for replacing equipment ESCOs are considered unnecessary. If the industry is investing in equipment, it does not rely on a service provider just because it is an ESCO.

3.3 ESCOs and the DSM Opportunities

DSM would be a very attractive market for ESCOs as it can be mandated across sectors like buildings, industry, agriculture and municipalities. But ESCOs are yet to explore the DSM market in the industry sector as utilities realise best energy tariffs from the industry and hence ESCO initiatives are diverted towards Agricultural DSM. This contradiction in perspective could be an inhibiting factor for ESCO development through DSM. Dr. Roy recommends that the Forum of Regulators should prioritise the role of ESCOs in utility DSM programmes. This requires utility capacity building in research, mobilising skilled work force supported by necessary training for meaningful DSM impacts.

Dr. Datta Roy points out that in the public sector, government agencies do not have sufficient know-how for buying a service, unlike the purchase of equipment. Equipment procuring is critical to mass replacement of EE appliances in the DSM programme. Thus, DSM project design requires establishing an equation between private benefit and public benefit – the logic of DSM is designed for larger public benefit, than that of private benefit. Designing a DSM project needs to economically justify the financial return and social benefits, such that there is an overwhelming case for public benefit. Eventually, the private benefits will become visible while technologies and solutions will fall in place as EE markets emerge.

4. Optimisation of Processes, Technologies and Materials

India's industry has increasingly seen a strong presence in technology areas like boilers, testing and control equipment (software companies), furnaces, electric motors, compressors, electrical and electronics systems, HVAC, refrigeration, cooling towers, fans and pumps, diesel generating systems, and insulation and refractories⁹².

BEE's efforts in promoting and strengthening market-oriented schemes like Standards and Labelling gives OEMs credibility and transparency, besides enabling them to be accountable to consumers. Promoting awareness, education and incentivising entrepreneurs to explore sustainable technologies remains crucial. In 2004, about 1,200 recognised R&D units in India spent more than INR 40 billion and there are about 35 foreign companies with global R&D centres in India while almost none of them exclusively focus on EE. EE has been only an incidental aspect of the research carried out in these centres. (A few important initiatives are listed in Appendix-1.)

⁹² Equipment Manufacturers, BEE. http://www.energymanagertraining.com/new_manufacturersmain.php Accessed on 16-Jan-2011

“Growing markets tend to be affected by efficiency issues. As manufacturers have to rely on the existing capability of workforce and technologies, inefficiency is reflected through inefficient processes and ultimately the quality. As the demand for goods and services are very high, the spike in the cost of goods from the energy cost is overshadowed by the demand. What will influence these trends? Regulatory mechanisms are necessary for utilities to achieve their conservation goals, which seem to call for command and control. Successful DSM programmes and energy efficient public procurement processes require stringent regulatory forces. On the other hand, industrial processes and appliances markets can achieve transitions towards EE, only if driven by markets.”

Balwant Joshi

Director,

ABPS Infrastructure Advisory Private Limited

4.1. Emergence of new EE Concepts and Technologies

The perceived high risk of new technology leads to slow adoption of new EE technologies, observes Dr. Jain. He points out that cooling technologies have increased emphasis owing to their energy demands.

District Cooling is a capital intensive technology at its initial stage in the country. As buildings in India get constructed in stages it is extremely difficult to make distribution arrangement in the first stage for all the subsequent buildings. Developers or builders invest proportionately for each phase, resulting in individual AC units which are not as efficient. There are also trust issues even though billing is done through BTU meters. However, some high-end builders are making it mandatory to accept centralised systems. But often the developers cannot invest upfront. This gap can be filled through big players emerging in this space, such that they will amortise the cost in 3-5 years. In Dubai and Qatar, district cooling technology is being deployed by utilities formed for this purpose like **Dubai Cool** or **Qatar Cool**, with government support to a small extent, while manufacturers supply equipment to the utilities. Government support may not be needed in India as opportunities are huge for such utilities.

Variable Primary Chilled Water Flow to replace secondary variable chilled water flow. This technique requires manufacturers to have a system which is amenable to variable flow in the chiller. Primary chilled water flow and variable condensed water flow result in substantial savings.

In the air conditioned space, a new development is the use of **Chilled Beams** which were not adopted earlier due to apprehensions of high humidity. Latent load is addressed by dehumidified fresh air coming from dedicated outdoor units. A further development of chilled beam is Chilled Slab as the pipes can be inserted in the slab itself. These pipes will not be super imposed but will be buried under the building structure.

Other major changes are in the Coefficient of Performance (COP) of chillers which can be improved from 6-8 and through Integrated Part Load Value (IPLV) to even 12. In fans, the use of plug fans with the motor directly mounted on the fan causes varying air flow and results in lower energy consumption.

4.2. Strengthening and Promoting Existing Technologies

Energy intense sectors like cement, iron and steel, among others, have their own in-house energy/environment management cells which work primarily on optimisation of processes for energy consumption and environmental degradation reduction. Technology innovation is also looked into. Some of these are listed in Appendix-2 (Technology Improvements in Industries).

Waste Heat Recovery (WHR) is one such technology that is widely used in energy intensive industries. WHR contributes to energy recycling efficiently, typically where the thermal energy from all waste gas coming out of a furnace in an industrial unit is utilised to generate steam, which is fed to a turbine to generate electricity. Now, large hospitals and

hotels deploy WHR systems from waste incineration.

- ▶ The energy generated thus avoids the use of an equivalent amount of electricity from the grid
- ▶ The negated greenhouse gases from avoided fossil fuels make them eligible for CDM credits

The need for enhanced visibility of WHR technology

The National Workshop on WHR⁹³ held in Delhi, 2011, found that awareness, policy level support and incentives were necessary to promote the technology:

- ▶ Need state-specific WHR policies based on regional industrial and energy scenario, pilot projects and sharing of successful case studies between states and to take discussions on WHR to regional-level, with focus on specific industry segments like sugar, cement, steel, sponge iron and healthcare and hospitality sectors
- ▶ Creating awareness among building owners, facility managers, data centre operators and addressing issues such as split-incentives

while implementing WHR projects in the building sector

- ▶ Prioritising gas allocation to those entities which have effective WHR systems in place, to promote energy efficiency and lower specific energy use
- ▶ Tax rebates/incentives to WHR equipment at par with other EE equipment and systems.
- ▶ To engage the practitioners, equipment suppliers and end-user industries at a regional level in order to identify potential and establish the market for WHR

4.3. Need for Indigenous Solutions

“India’s warm climate demands external insulation as against colder countries which require indoor insulation. BEE is yet to take an EE initiative in building materials – there is a need for technology up-gradation in building materials, particularly for wall, roof and window insulations.”

Dr. Prem Jain
Chairman, IGBC

The optimal building envelope is yet to receive adequate attention. In the country, in the past 30-40 years, western practices influenced building envelopes and India is still making glass boxes, unmindful of the orientation, climate or weather conditions in the area and disregarding energy efficiency. For a proper building envelope organisations like IGBC, TERI – GRIHA and BEE are stressing on simulation. For example, any large building of 10,000 sq. m or above must go through a process of simulation so that the architect can work on orientation to minimise heat gain and maximise visible light, suggests Dr. Jain. As more than 1,000 buildings are vying for green certification it is expected that in such buildings envelopes can be optimised and EE buildings

⁹³The first National Workshop on WHR was organised jointly by BEE and Alliance for an Energy Efficient Economy (AEEE) in 2011. It provided a platform for WHR equipment manufacturers, service providers and industry users to convene and engage in dialogue with policy makers.

will be built. To catch the tide, the building sector in India needs to focus on the following:

- ▶ External insulation is exposed to weather and the material elements need to withstand seasonal variations, rain and dust, apart from heat
- ▶ Except for roofing materials there is a lack of insulation material, especially for walls
- ▶ **Du Pont** and **Corning** are exploring the huge requirements in India and other West Asian countries
- ▶ Coating material necessary to act as a barrier to heat transmission
- ▶ Similarly, water proofing materials should not allow heat nor water to go through, which is a challenge
- ▶ Also, there is an urgency that recyclable materials be used in construction

5. The Smart Grids: Future of India's Utilities

The Ministry of Power launched the Smart Grid Forum in India in 2010, towards creating a comprehensive power infrastructure. Smart Grids are expected to enable customer participation in their energy use decision making, besides making generation and storage options available, providing premium power quality, optimising asset utilisation and operating efficiently, automation of prevention, containment and restoration of disturbances and finally, operating resiliently against all hazards⁹⁴.

5.1. Building up to Smart Grids

A multi-stakeholder Smart Grid Workshop⁹⁵, in 2011, saw participants share consensus that DSM measures like the Time of Day tariff for industrial consumers have already been piloted in India. Under India's Re-structured Accelerated Power Development and Reform Programme (R-APDRP) metering of Distribution Transformers and Feeders, Automatic Data Logging for all Distribution Transformers and Feeders and SCADA⁹⁶, Feeder Separation, Load Balancing, among others, are already being deployed. Lessons from these efforts and integration of such initiatives have to be prioritised to build

pathways for Smart Grid's goals in India. There are various technological and other logistical requirements that will call for cost commensuration which has to be justified. Each utility has a unique position because of its customer profiles (the customer groups can be extremely diverse) profiled by their power requirements. Thus, segmentation of consumers, the granularity of customer requirements, price elasticity, and data about customers will be very critical. Finally, the viability of the consumer groups to pay for such refined services for energy access will be the ultimate objective.

⁹⁴ Smart Grid White Paper, Rahul Tongia, WH-1:14.8.2009, Center for Study of Science, Technology and Policy (CSTEP) http://www.cstep.in/docs/Smart_Grid_Whitepaper_CSTEP.pdf Accessed on 11-Feb-2011

⁹⁵ Smart Grid Multi-Stakeholder Workshop by Centre for Science, Technology and Policy (CSTEP) on 13th May, 2011, Bangalore

⁹⁶ Supervisory Control and Data Acquisition (SCADA) industrial control systems: computer systems that monitor and control industrial, infrastructure, or facility-based processes

Smart Grid Pilots in India

India's Smart Grid pilot programmes are being tested under two utilities in Karnataka⁹⁷. The **Mangalore Electricity Supply Company (MESCOM)** conducted a trial run of a Smart Grid pilot in 2010, for 100 consumers of mixed profiles, using modified existing static meters by adding smart nodes⁹⁸ for giving consumers prior information, energy monitoring and help utilities control aggregate consumer loads. In the pilot test, during peak hours, domestic consumers are required to reduce the consumption to a pre-

determined value for running essentials. After the pre-set time, normal loads were restored remotely. The pilot saw avoided load shedding, continuous energy audits and control from remote locations. Similarly, the **Bangalore Electricity Supply Company (BESCOM)** aims to conduct a pilot for 19,441 consumers where 86% are in the domestic category. To enable Smart Grid pilot, BESCOM implemented SCADA and is now implementing Distribution Automation System (DAS) and remote monitoring units.

6. Capacity Building, Awareness Creation and Information Dissemination

Tamil Nadu made water harvesting mandatory for municipalities and since then the critical peak demand for water-tankers reduced gradually. For EE policy frameworks to achieve such results there is a need for promoting awareness and education and incentivising entrepreneurs to explore sustainability with development.

"We need more architects, engineers and planners to imbibe conservation at all levels of education. Today, with the advent of green buildings, again it is time to look back into our roots and innovate to come up with materials and products that are green, sustainable and the very essence of who we are. We should be looking inward to innovate and manufacture various green materials instead of importing them from the West. This will ensure that our own economy grows while we try to minimise our carbon footprint. Educational systems have to be utilised extensively for integrating the concept of sustainability into the social systems."

Deepa Sathiaran

*Executive Director,
En3 Sustainability Solutions Pvt Ltd*

6.1. Indian Industry Associations Promoting EE

Trade bodies have taken up energy conservation with a larger mandate. The following are a few who have an active presence in the area of energy conservation:

- ▶ Alliance for an Energy Efficient Economy (AEEE)
- ▶ Association of Energy Conservation and Environment Protection (AECEP)
- ▶ Cement Manufacturers Association (CMA)
- ▶ The Confederation of Indian Industries (CII)
- ▶ Electric Lamp and Components Manufacturers Association (ELCOMA)
- ▶ Federation of Indian Chambers of Commerce & Industry (FICCI)
- ▶ Indian Semi-Conductor Association (ISA)
- ▶ Indian Green Building Council (IGBC)
- ▶ Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE)
- ▶ Society of Energy Engineers and Energy Managers (SEEM)

AEEE was formed to promote energy efficiency through policy research, market transformation, technology innovations, capacity building of energy

⁹⁷ Power-Line.2011.MESCOM and BESCOM on Utility Pilot Projects, April edition

⁹⁸ Smart Nodes had features like memory, logic, communications and connect/disconnect switch

professionals and stimulating financial investments for EE and for supporting the implementation of the EC Act 2001 and the NMEEE. AEEE was the first to identify the need for Measurement and Verification (M&V) professionals to drive energy conservation in India and is actively engaged in M&V capacity building. CII's Energy Management Cell conducted about 450 detailed energy audits in various industrial sectors that have reported a recurring

annual savings of over INR 1.1 billion. Sector specific associations like the Fertiliser Association of India, Indian Agro and Recycled Paper Mills Association, Cement Manufacturers' Association and All India Steel Re-rollers' Association have spearheaded energy efficiency and energy conservation and thereby production cost reduction within their own sectors. Appendix-3 lists out various examples of energy conservation initiatives in specific industries.

6.2. EE Capacity Building

Over the past two decades various multilateral and bilateral organisations have collaborated for tech-transfer and capacity building programmes to promote EE in India. The MSME sector especially received great emphasis in technical assistance owing to its share in the Indian industry and its poor state of energy conservation. Subsequently, the EC Act 2001 reinforced various energy conservation programmes in the nation and these organisations continue to collaborate with BEE and other stakeholders in India. USAID, GTZ (now GIZ), ADEME and JICA are some of those who have actively engaged in international co-operation for tech-transfer and assistance (see Appendix-4 for an overview of their programmes).

The demand for EE services and solutions are increasing and there is increased need for skilled manpower, trained in various aspects of EE, both from a technical aspect as well as in services. Many national and state level initiatives are in place towards this effort. Wide cooperation of industry trade bodies make this possible. Engineering and management institutes in India have started to

cater to the demand for skilled professionals. Appendix-5 shares a list of various capacity building and awareness programmes catering to this demand.

Developing Measurement and Verification (M&V) capacity building in India

M&V is the corner stone for energy efficiency projects. Energy savings and hence cost savings can be determined only when there are clear M&V methodologies and standards available. For successful performance contracting, transparent M&V guidelines are necessary.

Alliance for an Energy Efficient Economy (AEEE) has been actively promoting capacity building programmes in International Performance Measurement and Verification Protocol (IPMVP), a worldwide M&V standard, in India⁹⁹. AEEE M&V training programmes have reached out to more than 250 Professionals since 2008, and 65 have been certified eligible to apply IPMVP standards. Globally there are 1,075 certified IPMVP professionals.

⁹⁹ AEEE is the India affiliate of Efficiency Valuation Organization (EVO) a non-profit that works on M&V tools and is the chief developing body of the International Performance Measurement and Verification Protocol (IPMVP). AEEE-EVO with support from USAID/ECO-III Project kick-started IPVMP capacity building programmes in India

The Way Forward

1. Energy Efficiency is Integral to India's Climate Change Responsibilities

India's per capita energy consumption of 0.5 MTOE is small compared to the minimum average 4.0 MTOE of countries with a high Human Development Index (HDI above 0.9). For developed economies such as the UK and the USA, the per capita energy use figure is in the range of 12-20 MTOE. It is possible that India may achieve the requisite HDI for a reasonable quality of life with just 3.0 MTOE. However, this shall also drive India's CO₂ emissions. In the larger scheme of things, global emissions of the 10 billion world population (by 2100) has to be restricted to 3 tonnes per capita to avoid perilous climate changes. This means, while India's energy supply has to increase by 6 times, CO₂ emissions can grow only sparingly from its current 1-1.2 tonnes CO₂ per capita to less than thrice this figure. **To achieve such low carbon objectives, India will need to have every new service in lighting, cooling or mobility to be more energy efficient.** This requires:

- ▶ Identification of areas where EE initiatives can create major savings at the national level through massive replication of reductions
- ▶ Technological interventions in various segments where energy efficiency has a role to play towards significant savings
- ▶ Organisations targeting ambitious goals in their respective fields to reach a level of energy conservation not envisaged so far
- ▶ Scrutinising expensive energy consuming areas for substitution by cheaper or renewable energy
- ▶ Emphasise the role of equipment and service providers
- ▶ Contribution from general public through communication and increased awareness
- ▶ Effect of global developments in EE at the national level

2. Future of ESCOs: Lessons from Predecessors

- ▶ In USA, super Energy Saving Performance Contracting (ESPC) as a means of ESCO has been done with a kind of mandate. The US has accredited 10-20 super ESCOs through a simple process where they have a fiat that all federal facilities have to get EE jobs done by these companies through a standard ESPC approved by U.S. Department of Energy. The only competition that remains is through the highest percentage of savings offered by the companies. This simplifies the contracting process.
- ▶ In China, the government places complete reliance on technology standardisation. For instance, air conditioners are pre-set to work at 26°C in summer and 20°C in winter. Similarly, chillers installed are of COP 6 and above. The Performance Contracting Business in China is equipment-centric while usage efficiency remains poor. Hence energy efficiency markets exist only in buildings and there are no mandates for industry, resulting in poor energy performance in the country.

3. Need Strong Inclusive Policies for Promoting EE Markets

- ▶ Holistic policy environments (driven by BEE) which can mandate standards, create awareness of technologies and incentivise EE in industries will continue to be necessary. The EE sector should focus on getting the kind of support that renewable energies like wind and solar have been receiving. Such incentives for EE will have double the effect on the generation side, thereby leading to efficient fossil fuel conservation
- ▶ Industries will be forced to improve EE, driven by the market forces, such that cost and the availability factor of goods and services do not overrun the EE criteria. DSM for industries will be

important to drive technological intervention at equipment manufacturers and within the operational level of plants (that is changing processes that have been running for a long time, reliably). DSM in its present form targets the domestic mass consumers; for example, Standards and Labelling should be extended to industrial intermediates also. Today, though the industry benefits from energy conservation, EE is

yet to appeal to a large number of industries where energy cost may not be relevant for facing the market competition. The absence of benchmarks for various industries is a major handicap which does not encourage the industry to look seriously at EE in its area and hence they tend to remain content with sporadic improvements.

4. Sustainability and Reliability will be the Way for the Future

- ▶ Sustainability has to be integral to industry infrastructure development across diverse projects from green buildings to water conservation in municipalities. Today, green buildings that use 100% recycled materials, often ship them from western countries, and thereby undermine the larger objective of reducing the carbon foot print. On the other hand, recycled products can be manufactured in India at one-tenth of the cost of the goods imported.
- ▶ Reliable quality power supply still continues to be the crux of the issues in promoting EE. Despite various initiatives in the power sector, India's Transmission and Distribution (T&D) losses are in the magnitude of 22-45%. These figures are also not from metered calculations; estimated figures

indicate a fiscal loss of about INR 20 billion. The utilities are wary about the challenges in convincing the regulators and the consumers of the value and benefits of smart grids. Smart Grids can be integral in such a scenario through automating existing electricity networks and improved communication with consumers. Distribution utilities can optimise power distribution and hence increase efficiency and reduce losses. Besides logistics, data security and privacy become key issues. Utilities and regulators need to realise the project's investment value, develop sustainable business models and enable decision makers to make use of Smart Grids successfully.



R&D Initiatives for Achieving Energy Efficiency

Institutions	Activity Areas
Petroleum Conservation Research Association (PCRA)	• PCRA supports and facilitates substitution of petroleum products with alternate and renewable fuels • R&D projects – eg: efficient equipment for glass industry with an expected reduction in gas consumption of 8-15% • Energy audits and awards for various institutions, industrial units, energy auditors and ESCOs for achievements in energy savings • Development of energy efficient oil expeller for Jatropha seeds • Improving efficiency of LPG stoves, solar powered ceiling fans
Central Paper and Pulp Research Institute (CPPRI)	• R&D and implementation of energy and water conservation, for the past 18 years • Research in chemical recovery and energy management is a thrust area for research, as is environmental management
National Thermal Power Corporation (NTPC)	• All coal-based power plants consume 10% of the power generated for running their boiler auxiliaries and other support equipments • The efficiency of any power plant is the figure of the Aux Power Consumption (APC) and Plant Load Factor (PLF) • NTPC in India is considered the role model for other power plants for lowest possible APC and highest PLF • Transformation is achieved through Super Critical Steam Generation in these plants
The Energy and Resources Institute (TERI)	• TERI is involved in researching a variety of environment-related topics, including energy efficiency and management
Indian Institute of Technology, Delhi (IITD)	IIT Delhi Centre for Energy Studies is an interdisciplinary centre deriving its strength from pure sciences and engineering subjects: • Research and consultancy in various aspects of energy systems as well as energy conservation and planning • In 2010, IBM tied up with IITD for research focused on energy efficient computing • Supports start-ups working in the clean technologies sector, including renewable energy, energy management and agriculture
International Institute of Information Technology (IIIT), Hyderabad	IIIT Hyderabad has a Centre for Building Science which focuses, among other areas on energy efficient buildings: • Research on various IT tools like simulation and modelling for optimisation automation and intelligent buildings • Supports start-ups working in the clean technologies sector, including renewable energy, energy management and agriculture

Technology Improvements in Industries (source: BEE 2004)

Institutions	Activity Areas
Aluminium	• Multiple pre-baked anodes used in Hall-Heroult Process • Improved anode design and increasing anode area by redesigning the existing cell • Improved techniques in cathode lining and cell design • Efficient gas cleaning system and recovery of fluorides for dry gas-scrubbing system • Complete automation • Trials to improve existing process operations, development of new processes, quality improvement, and environment management
Cement	• Gyratory crushers and mobile crushers • VRM (Vertical Roller Mills), external recirculation systems in VRMs • Adoption of roller press technology and high efficiency separators in grinding circuits • Static V separators along with dynamic separators • Installation of pre-calcinators and 5/6 stage pre-heaters with low pressure drop cyclones • Short kilns having lower L/D ratio; new generation coolers having better heat recovery potential
Fertilisers	• Internal heat recovery systems • Reformer tubes of superior material • Adiabatic pre-reformer • Low steam/carbon ratio • Purge gas recovery unit • Make up gas chillers at suction; urea hydrolyses stripper • Trays inside the reactor • Coils to feed the reactants from the top of the reactor • Vacuum pre-concentrator • Basic Oxygen Furnaces (BOFs) instead of Open Hearth (OH) furnaces
Iron and Steel	• Continuous casting • Improvements in sinter quality • Waste heat recovery • Improvements in blast furnace practices like coal dust injection • Increased blast pressure and temperatures • Direct charging of hot slabs, automation, rolling to strict tolerances, controlled cooling and automatic gauge control

Examples of Energy Conservation Initiatives in Specific Industries

Name of Company	Intervention	Energy Savings
Apollo Tyres	Heat recovery from hot water system	50% reduction in steam consumption and fuel consumption reduction by 4000 litres/day
Bajaj Auto Ltd	Replacement of electricity with LPG	Annual energy savings of INR. 0.15 million
Century Rayons Ltd	Heat recovery from DG set jacket cooling water	Daily steam savings of 58 tonnes
Calcutta Electric Supply Corporation(CESC)	Combined modulation of ID fan suction vane and scoop (variable speed hydraulic coupling)	3.4 million kWh annually
GMR Sugars	Replacement of Eddy Current drive with VFD	97.2 MWh annually
Tamil Nadu Newsprint and Papers Ltd	Installation of Waste to Energy Plant	Daily savings of 9,000 litres of furnace oil
Asian Paints Ltd	Reduction in cooling water circulation pump power by siphoning effect	Energy savings of 75 kW/hr and INR 2.2 million per annum
Bharath Heavy Electricals Ltd (BHEL)	Polyurethane foam spray on roof for reducing AC load	10% savings on AC load power consumption
Century Pulp And Paper	Use of waste pith from bagasse as fuel in boiler	Annual savings of 42,896 MT of coal
Vestas	Technology R&D capabilities in India with the opening of a state-of-the-art test centre for wind turbine components in Chennai for improving reliability of Vestas products	NA
Ultratech Cement Ltd	HTVFD installation for cooler ESP fan	Annual energy saving of 0.4 million kWh

Overview of International Co-operation of Tech-Transfer and Assistance

International Agencies & EE Programmes	Programmes and Activities
United States Agency for International Development (USAID) projects: Energy Conservation and Commercialisation Programme (ECO) Distribution Reforms, Upgrades & Management (DRUM) Water Energy Nexus (WENEXA) Partnership to Advance Clean Energy (PACE)	• ECO-I launched in 2000, supported the formation of Demand Side Management (DSM) cell for integrated resource planning tool for utilities in India, training and capacity building for BEE's EE financing programmes that induced various Indian banks; Energy Service Companies (ESCOs) concept was revived through training and tools development⁹⁹ • ECO-II provided key assistance to BEE in the development of the Energy Conservation Building Code (ECBC) for five climatic regions of India, Energy Conservation Action Plan for the states, demonstration projects for DSM in state utilities (municipal water pumping projects, EE street lighting projects, EE in public buildings among others) • ECO-III supported BEE's focus areas in the eleventh Five Year Plan-framework and tools for implementation of ECBC (benchmarking of commercial buildings, building EE simulation technologies), R&D centre for EE appliances and equipment, EE in SMEs and promotion of Measurement and Verification of energy savings and continued effort to promote state level EE programmes • DRUM launched in 2004 was primarily "to test and demonstrate new technologies in the power distribution sector" for scaling up in later phases¹⁰⁰ • DRUM trained 35,000 professionals and engaged in capacity building of 20 training institutes to improve the quality of electricity services in India • Through India's Accelerated Power Development and Reform, the DRUM programme paved the way for a Smart Grid vision in India • WENEXA launched in 2005 focussed on energy and water conservation by supporting the Agriculture DSM and engaged in municipal water management programmes¹⁰¹ • The PACE programme, launched in 2009, brought various US and Indian government agencies together for Clean Energy Research and Deployment

⁹⁹ Model performance contracts, project financial analysis and screening software, model financial feasibility study format for lender approval, and introduction to Monitoring and Verification protocols

¹⁰⁰ Inaugural Speech by Ms. Erin Soto, USAID, Feb 28, 2011, http://www.usaid.gov/in/newsroom/speeches/feb28s_11.html Accessed on 1-Mar-2011

¹⁰¹ WENEXA <http://www.waterenergyxexus.com/> Accessed on 13-Feb-2011

International Agencies & EE Programmes	Programmes and Activities
The Indo-German Energy (IGEN) Programmes: Deutsche Gesellschaft für International eZusammenarbeit (GIZ) German Development Cooperation KfW Entwicklungsbank	- Indo-German Technical Cooperation for energy conservation (Phase 1) in 1995-2000 created the Energy Management Centre, a predecessor to BEE - The second phase launched in 2000, restructured in 2006 as IGEN, to support energy security, EE and renewable energy programmes and to develop capacity building for CDM projects in India - BEE partners with GIZ in IGEN programmes on demand-side EE projects - IGEN has been promoting Trigeneration technology since 1995 for combined cooling¹⁰², heat and power generation for energy production and waste heat recycling through heating and cooling. Besides industries, buildings are actively deploying Trigeneration in hotels, hospitals, airports, shopping malls, data-centres among others - KfW Entwicklungsbank is introducing a calculation model from the Fraunhofer Institute for Building Physics in India to evaluate the EE of residential buildings. The model that will be used on the subcontinent is established in Europe and has contributed to a standardisation of the energy balance for buildings in the EU. The basis is the German industrial standard V 18599, based on research results from the Fraunhofer Institute for Building Physics. The model is now being adapted to the conditions in India in cooperation with TERI, supported by KfW Entwicklungsbank
L' Agence De l'environnement Et De La Maitrise De l'énergie (ADEME) Environment and Energy Management Agency of France	- ADEME launched in 2006 established Energy-Info Centres (EIC) in Gurgaon and Chandigarh as sources of information on various EE and renewable energy technologies and solutions - Prime support to BEE to develop the DSM portal involving Ministry of Power, regulator agencies, the Central Electricity Authority, Financial Institutions among others - EE demonstrations in construction and SME sectors, implementing regional climate-energy plans in Punjab, Haryana and Himachal Pradesh and technical support for Sustainable City and District Operations¹⁰³ - ADEME facilitates partnership between the Indian Society of Energy Engineers and Managers (SEEM) and the French Energy and Environment Association, to foster technology transfer

¹⁰² Trigeneration "Future of clean & green energy generation", Dr. Anant Shukla, Technical Expert - TRIGEN

Indo-German Energy Programme (IGEN), trigenindia.com/files/Project%20Images/Anant%20Shukla%20TRIGEN.pdf 11-Jan-2011

¹⁰³ India Partners for the Planet <http://www.ademe.fr/htdocs/publications/international/14/p4.htm>

¹⁰⁴ Berkeley Lab lends expertise to India to promote Energy Efficiency <http://newscenter.lbl.gov/feature-stories/2009/11/18/berkeley-lab-lends-expertise-to-india-to-promote-energy-efficiency/> Accessed on 11-Jul-2011

International Agencies & EE Programmes	Programmes and Activities
The Berkeley-India Joint Leadership on Energy and the Environment (BIJLEE) Lawrence Berkeley Lab and University of California, other US and Indian universities, institutions	• BIJLEE signed in 2009 to develop EE and renewable energy technologies in partnership with the Indian government and industries towards developing innovative technologies and transforming the market and policy mechanisms for adopting these technologies¹⁰⁴ • The EE programmes include efficiency of buildings, lighting, windows, cool roofs, HVAC systems, integrated design and technology for super-efficient buildings and software for building design and simulation; under this initiative, research is also focused towards electricity systems, waste heat recovery and refrigeration, renewable energy and improving the reliability of transmission
Alliance to Save Energy (ASE)	• ASE has been partnering with India for over a decade providing technical assistance for municipalities extensively in water and energy efficiency programmes
International Council for Local Environmental Initiatives (ICLEI)	• ICLEI engages with Urban Local Bodies in adopting renewable energy and EE policies, supporting and developing model communities
Japan International Co-operation Agency (JICA)¹⁰⁵ New Energy and Industrial Technology Development Organisation (NEDO) Energy Conservation Centre, Japan (ECCJ)	• JICA activities were launched in 2008 • Model project for efficient coke-dry quenching system, converting a diesel generator to dual-fuel operation, highly efficient coal preparation technology • NEDO's energy conservation diagnosis programme in the cement and steel sectors • JICA training programme on thermal power technology, study on enhancing the efficiency of operating thermal power plants in India's NTPC Ltd. • ECCJ energy conservation management technology in the industrial sector, training Indian energy managers, Indo-Japanese technology forums

¹⁰⁵ Bilateral Documents, 2010, Ministry of External Affairs <http://meaindia.nic.in/mystart.php?id=530515762> Accessed on 11-Jul-2011

Capacity Building, Awareness Creation and Information Dissemination

Programmes and Organisations	Activities
Training and Capacity Building Programmes	
National Certification of Energy Auditors and Energy Managers (Ministry of Power) BEE's audit and assessment methodologies, conducted by National Productivity Council (NPC)	• BEE qualifies auditors for energy audits of equipment/systems • Energy managers to establish an energy conservation cell within a firm and initiate activities to improve monitoring and process control to reduce energy costs • For establishing methodologies to accurately calculate the specific energy consumption of various products/services • Develop and manage training programmes for EE at operating levels • Since 2004, BEE has certified more than 8,000 energy professionals
Dr. Ambedkar Institute of Productivity (AIP) and NPC (Ministry of Power)	• AIP-NPC conducts electrical and thermal energy systems services for all types of industries across private, public, SME and government sectors¹⁰⁶ • More than 2,000 audits have been completed in India and abroad • AIP-NPC provides post graduate training in energy management and audit • Prepares guidebooks for the national energy auditor and managers certification exam
CII-ITC Centre for Excellence for Sustainable Development Corporate Sustainability Management (CSM)	• Integrated framework for strategy and leadership, sustainability reporting, stakeholder engagement and research for integrating sustainability in decision making • Capacity building activities, training and technical assistance services • Mapping of stakeholders within a sustainable business context and increasing stakeholder inputs for strategic decisions • Improving business performance (supply chain relationships opportunities for innovation, resource optimisation)¹⁰⁷
TERI Industrial Energy Efficiency and Sustainable Technologies (IEEST)	• Capacity building and information dissemination programmes • Research, development and diffusion of advanced technologies solutions to enhance competitiveness of the Small Scale Industry Sector • TERI published the <i>Handbook on Energy Audit and Management</i> for enabling users to understand the operation of various appliances and systems, and to identify opportunities for energy saving in industrial units

¹⁰⁶ Energy, AIP-NPC <http://www.aipnpc.com/energy.html> Accessed on 15-Jul-2011

¹⁰⁷ CSM Stakeholder Engagement

sustainabledevelopment.in/services/corporate_substainability_management/activities/stakeholder_engagement.htm Accessed on 15-Jul-2011

Programmes and Organisations	Activities
Training and Capacity Building Programmes	
Capacity building for GRIHA	Association for Development & Research of Sustainable Habitats (ADaRSH) promotes GRIHA • ADaRSH conducts awareness workshops on GRIHA rating system • Training and Examination for GRIHA trainers and evaluators • Online training certification and tools • Awareness/training sessions for government and private organisations • Nation-wide capacity building exercise for Public Works Department
CII - Sohrabji Godrej Green Business Centre	• Indian Green Building Council Accredited Professional Examination (IGBC AP) • IGBC AP exam is conducted by MeritTrac Services Private Limited • LEED Accredited Professional (LEED AP) certification in India is awarded by the IGBC
Distance Learning Courses	• Energy management training programmes by the Maharashtra Institute of Technology and the TERI University • Power distribution management by IGNOU • The programme offers free on-line training for energy professionals
Awareness Workshops, Seminars and Resources	
BEE Workshops BEE has been partnering with various stakeholders from the public and private sector for conducting awareness workshops and training For wider outreach, workshops are often conducted in various places across the nation, e.g. NETP was conducted in 36 cities and trained 2179 professionals	• National Educational and Training Programme (NETP) on Standards and Labelling (refrigerators and air conditioners) • National ECBC Awareness Programme (Buildings/Hotels/ Hospitals/BPO) • Financing EE in Buildings • EE in Pumps and Motors and Standards & Labelling • EE process technologies & practices and implementation of EC Act in the Power Sector • EE process technologies and practices and implementation of EC Act in Fertiliser/ Chemical/ Chlor Alkali / Agrochemical Sectors • PAT consultation workshops • Waste Heat Recovery in industries • Demand Side Management • Municipal Energy Efficiency Projects in India • National/International training programmes for SDAs • Workshop on energy efficient procurement (Policy Guidelines)
USAID/ECO-III	• Building Physics & Energy Simulation Workshop • Benchmarking of Energy Consumption and Labelling of Commercial Buildings • Network for Energy Efficiency in the Building Sector – Standards, Education and Information Technology

Programmes and Organisations	Activities
Awareness Workshops, Seminars and Resources	
International Copper Promotion Council of India (ICPCI)	• ICPCI conducts workshops for developing skill sets in Motor EE by targeting rewinders, pump repairers and technical experts
Online Resources on EE BEE, CII, EMC Kerala, FICCI, TERI, LBNL, MERC	BEE DSM Best Practices: bee-dsm.in/BestPractices_3.aspx • BEE Energy Manager Training: energymanagertraining.com • ECO-III List of Publications www.eco3.org/publications/ • Efficiency Valuation Organisation: www.evo-world.or • CII-ITC www.sustainabledevelopment.in/publications/bookstore/featured_publications.htm • Energy Management Centre Kerala http://www.keralaenergy.gov.in/emc_energy_efficiency.html • Maharashtra Development Agency (MEDA) www.mahaurja.com/Events.html • TERI publications http://www.teriin.org/ • LBNL EE programmes in India: ies.lbl.gov/node/308 • Forum of Regulators http://forumofregulators.gov.in • Maharashtra Regulatory Commission http://www.mercindia.org.in/

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