

# Implementation of Energy Efficiency Improvement Initiatives in India

V. S. Verma & K.K. Chakarvarti

## INTRODUCTION

India went through a fast pace of industrialization and economic self-reliance over the last few decades. Impressive progress has been made in the fields of industry, agriculture, communication, transport and other sectors necessitating growing consumption of energy for developmental and economic activities. If India is to achieve the targeted growth in GDP, it would need commensurate input of energy, mainly commercial energy in the form of coal, oil, gas and electricity.

Energy being an important element of the infrastructure sector has to be ensured its availability on sustainable basis. On the other hand, the demand for energy is growing manifold and the energy sources are becoming scarce and costlier. Among the various strategies to be evolved for meeting energy demand, efficient use of energy and its conservation emerges out to be the least cost option in any given strategies, apart from being environmentally benign.

The steps to create sustainable energy system begins with the wise and judicious use of resources, energy efficiency is the mantra that leads to sustainable energy management. Energy conservation, and energy efficiency is the part of the Government's strategy to decouple economic growth from growth in energy consumption.

## ENERGY DEMAND AND SUPPLY

On the energy demand and supply side, India is facing severe shortages. 70% of the total petroleum product demand

*Bureau of Energy Efficiency, Hall No. IV, 2nd Floor, NBCC Tower, 15 Bhikaji Cama Place, New Delhi - 110 066*

is being met by imports, imposing a heavy burden on foreign exchange. Country is also facing Peak power and energy shortages of about 12% and 8% respectively.

As per estimates made by Central Electricity Authority, an additional capacity of 100,000 MW would be need to be installed by 2012, requiring approximately Rs.8000 billion investment. Further, the per capita energy consumption in India is too low as compared to developed countries, which is just 4% of USA and 20% of the world average. The per capita consumption is targeted to grow to

about 1000 kWh per year by the year 2012, thus imposing extra demand on power system.

## IMPORTANCE OF ENERGY CONSERVATION

In a scenario where India tries to accelerate its development process and cope with increasing energy demands, conservation and energy efficiency measures are to play a central role in our energy policy. A national movement for energy conservation can significantly reduce the need for fresh investment in energy supply systems in coming years. It is imperative that

TABLE 1: ACTUAL POWER SUPPLY POSITION DURING 2005-06

Region	PEAK			
	Requirement (MW)	Availability (MW)	Surplus(+)/ Shortage (-) (MW)	Shortage/ Surplus (%)
Northern	28154	25200	-2954	-10.5
Western	31,772	25257	-6515	-20.5
Southern	24848	23372	-1476	-5.9
Eastern	10161	9677	-484	-4.8
North Eastern	1385	1192	-193	-13.9
All India	93214	81792	-11422	-12.3
Region	ENERGY			
	Requirement (MU)	Availability (MU)	Surplus(+)/ Shortage(-) (MU)	Shortage/ Surplus (%)
Northern	188418	168511	-19907	-10.6
Western	215983	186904	-29079	-13.5
Southern	156822	155582	-1240	-0.8
Eastern	62347	60706	-1641	-2.6
North- Eastern	7534	6888	-646	-8.6
All India	631024	578511	-52513	-8.3

Source: Central Electricity Authority

**TABLE 2: TARGET CAPACITY ADDITION FOR XI PLAN (Considering actual feasibility and contribution from Non-conventional/ Captive Plants)**

SECTOR	HYDRO	THERMAL	NUCLEAR	TOTAL
CENTRAL	10240	20340	3160	33740
STATE	2447	12788	0	15235
PRIVATE	2333	11167	0	13500
ALL-INDIA	15020	44295	3160	62475

Source: Central Electricity Authority

all-out efforts are made to realize this potential. Energy conservation is an objective to which all the citizen in the country can contribute. Whether a household or a factory, a small shop or a large commercial building, a farmer or a office worker, every user and producer of energy can and must make this effort for his own benefit, as well as that of the nation.

### PROGRESS MADE IN ENERGY CONSERVATION IN INDIA

The progress made by India in energy conservation can be seen in the following three areas:

- A. POLICY AND INSTITUTIONAL
- B. END-USERS
- C. TECHNOLOGY

#### POLICY AND INSTITUTIONAL

Recognizing the fact that efficient use of energy and its conservation is the least-cost option to mitigate the gap between demand and supply, Government of India has enacted the Energy Conservation Act – 2001 and established Bureau of Energy Efficiency.

The Act provides for institutionalizing and strengthening delivery mechanism for energy efficiency services in the country and provides the much-needed coordination between the various entities.

Important features of Energy Conservation Act include:

#### a) STANDARDS AND LABELING

- ❖ Evolve minimum energy consumption standards for notified equipment and appliances.

- ❖ Prohibit manufacture, sale and import of equipment and appliances not conforming to standards.
- ❖ Introduce mandatory labeling to enable consumers to make informed choice

#### b) DESIGNATED CONSUMERS

- ❖ Schedule to EC Act provides list of 15 energy intensive industries and other establishments to be notified as designated consumers (DC). DCs to appoint or designate energy managers.
- ❖ Get energy audits conducted by accredited energy auditors and Implement techno-economic viable recommendations.
- ❖ Comply with norms of specific energy consumption fixed, and
- ❖ Submit report on steps taken

#### c) ENERGY CONSERVATION BUILDING CODES

- ❖ Central Government to prepare guidelines on ECBC
- ❖ ECBC sets minimum energy efficiency standards for design and construction
- ❖ Mandatory Scope Covers commercial buildings
  - Connected load in excess of 500 kW
  - or
  - Contract demand in excess of 600 kVA
- ❖ Applies to New Construction only

### PROMOTIONAL PROVISIONS TO SUPPORT EC ACT

Various promotional provisions in support of the EC Act have been initiated by the Bureau of Energy Efficiency, which are briefly explained below:

#### 1. Indian Industry Program for Energy Conservation (IIEPEC)

This voluntary program of sharing of best practices, undertaking and specific energy consumption targets has full acceptance in the 7 sectors of industry including aluminium, cement, chlor-alkali, fertilizer, pulp & paper, petrochemicals & refinery and textile sector. Best practices have been recorded and published through CDs and also incorporated in BEE's website which is being updated periodically for use of designated consumers.

Task force workshops for Cement (January, 2005 at New Delhi), Pulp & paper (February, 2005) Petrochemical and Refinery Sectors ( 19th 20th May, 2005 at Vadodara ), Aluminium ( 19th August, 2005) and Pulp & paper ( 30th January , 2006) were organized by BEE under National campaign on Energy Conservation 2005 & 2006. In total 389 energy professionals from industry, and other organizations participated in these four workshops in which information on Best Practices and energy efficient technologies were shared.

#### 2. Voluntary EC Policy Declaration by Indian Industry

Industries have been approached to declare their top management commitments on energy conservation. Industries like Shree Cement, Reliance, INDAL, Rashtriya Ispat Nigam Limited, Moral Overseas Ltd, BK BIRLA Group of Companies, and many industrial units of Aditya Birla Group have committed to reduce their specific energy consumption levels. Under National Campaign on Energy Conservation 2005, 44 industrial and commercial establishments declared their energy management policy.

#### 3. Development of dedicated energy manager website

To support the capacity building of

Energy Managers and Energy Auditors, an interactive dedicated website, www.energymanagertraining.com has been launched in March 2003. Currently, website has recorded more than 7,68,000 hits as on 19<sup>th</sup> June, 2006.

#### 4. Small Group Activities on Energy Conservation

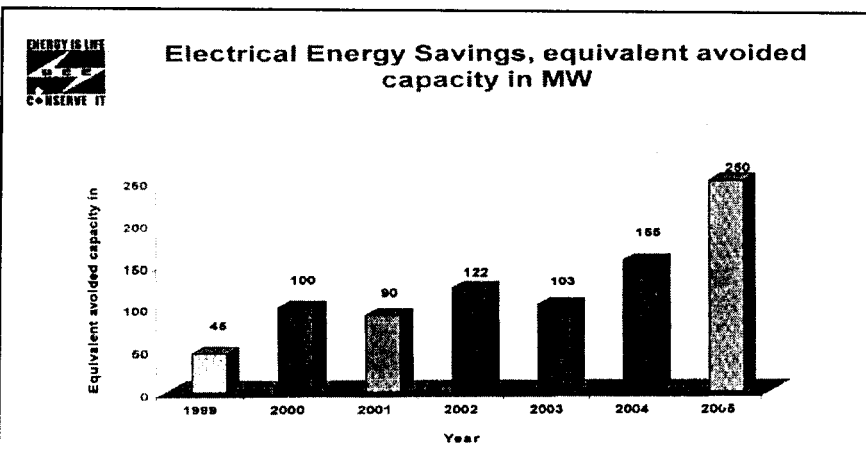
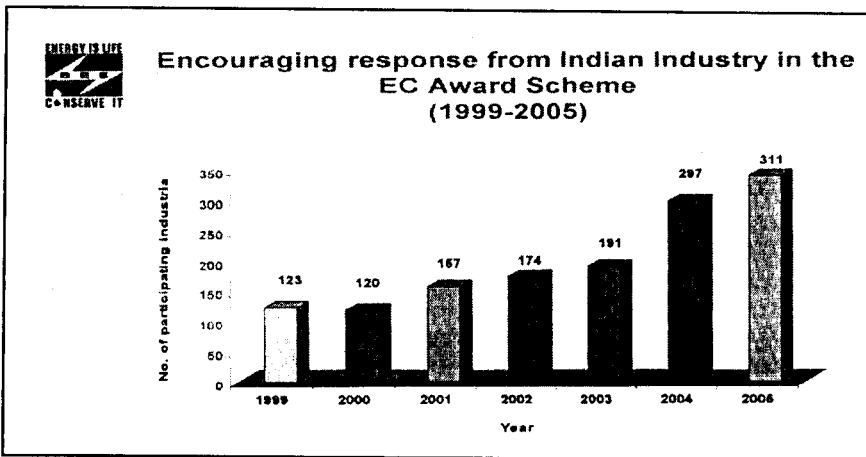
BEE supports designated consumers in improving their energy efficiency

through launch of voluntary programs. BEE launched Small Group Activity focused on energy conservation in 5 industrial units in textile, automobile and cement sector. Feed back received from the units indicate that about 5 % savings through housekeeping and no cost measures is possible through this concept. Small group activity is planned to be expanded to cover more sectors.

#### 5. National Energy Conservation Awards

Industrial units have been motivated through National Energy Conservation Award scheme. Due to consistent efforts put in by BEE, scheme has become very popular among industrial units, as is evident from increasing participation level (from 120 in 2000 to 311 in 2005). Award scheme includes 33 sub-sectors from large and medium scale industries and 3 sub-sectors from small scale industries. From the year 2005 two new awards for Government Buildings and Commercial Buildings (Private Sector) have been introduced.

In EC Award 2005, 311 participating industrial units saved Rs. 9890 millions per year against an investment of Rs. 13160 millions, on account of implementation of various energy conservation projects. Electricity savings achieved by the participating industrial units resulted in saving in avoided capacity equivalent to 250 MW.



#### 6. National Campaign on Energy Conservation 2005

On 14th December, 2004, the Hon'ble Prime Minister of India, Dr. Manmohan Singh launched the National Campaign on Energy Conservation, under which various measures, activities were undertaken during 2005 by Bureau of Energy Efficiency, industries, Schools, State Governments and Designated Agencies, Public Sector units of Ministry of Power, etc.

The Hon'ble Prime Minister as a part of the national campaign also released a postal stamp on energy conservation.

A painting competition was conducted for schoolchildren for 4th and 5th standards, at School, State and National level as a part of the Campaign which has not only made aware the children about the need of conserving energy but at the same time educated and involved their parents as well in the above cause.

The completed activity is one of the measures, which helped in creating awareness in the unorganized sector, particularly, in the domestic sector.

The painting competition was

**SUMMARY OF ENERGY SAVINGS ACHIEVED BY INDUSTRIAL UNITS PARTICIPATING IN MINISTRY OF POWER'S ENERGY CONSERVATION AWARD SCHEME (1999, 2000, 2001, 2002, 2003, 2004 & 2005)**

Year	No. of participating units	Savings in Rs. Crores	Investment in Rs. Crores	Electrical Energy Saving		Furnace Oil Savings in Lakhs KL	Coal Savings in Lakh Metric tonnes	Gas savings in Lakh Cubic Metres
				Million kWh	Equivalent Avoided Capacity in MW			
2005	311	989	1316	1316	250	2.40	7.68	13122
2004	297	763	1364	814	155	2.49	5.37	18685
2003	191	539	1071	642	103	2.21	12.65	73181
2002	174	594	691	641	122	1.7	7.4	36588
2001	157	687	659	485	90	2.21	4.79	3929
2000	120	366	630	524	100	1.327	0.54	707
1999	123	205	940	205	46	1.62	2.16	2444
<b>Total 7 years</b>		<b>4,043</b>	<b>6,671</b>	<b>4,627</b>	<b>866</b>	<b>13.967</b>	<b>40.68</b>	<b>1478,56</b>

conducted at three levels - School, State and National level. The activity was implemented with the support of all the CPSUs and BEE under Ministry of Power

**Milestones Achieved (January – December , 2005)**

- New Award Scheme for Government Buildings and Commercial Buildings implemented
- Secured the support of more than 75 industrial and commercial units 117 Seminars, Workshops and Training Programmes on Energy Conservation organized (2700 participants)
- Opportunity provided to 8400 students to visit industry and make them aware about the Energy Conservation practices and methods adopted by the Indian Industry;
- 17560 number of Schools and 3.43 lakhs students of 4th & 5th standard participated in the School Level Painting Competition on Energy Conservation in 35 States/ UTs
- 44 Industrial units and hotels declared their Energy Policies bringing in the top management commitment

**7. National Campaign on Energy Conservation - 2006**


Encouraged by the response received National Campaign for the year 2006 has been initiated

**Mandatory provisions of the EC Act**

**1. Strengthening energy management and energy auditing capabilities of energy professionals:**

To strengthen the energy management and energy auditing capabilities in the country, First, Second and Third National Certification examinations for Energy Managers and Energy Auditors have been successfully conducted in 2004,2005 and 2006 in 23 centers all over the country.

512 Certified Energy Managers and 1156 Certified Energy Auditors are in place from the first and second certification examinations



**Actual candidates appeared in examination**

22-23 April 2006

Exam	2004	2005	2006
<b>Paper 1</b>	<b>3431</b>	<b>2878</b>	<b>83.88</b>
<b>Paper 2</b>	<b>3656</b>	<b>2980</b>	<b>81.51</b>
<b>Paper 3</b>	<b>3274</b>	<b>2696</b>	<b>82.35</b>
<b>Paper 4</b>	<b>3199</b>	<b>2645</b>	<b>82.68</b>
<b>Overall</b>	<b>13560</b>	<b>11199</b>	<b>83</b>

<b>Feedback received 2006</b>	<b>529</b>
<b>Feedback received 2005</b>	<b>584</b>
<b>Feedback received 2004</b>	<b>654</b>

**2. Accreditation of energy auditors:**

Process for temporary accreditation of energy auditors for a limited period ( 3 years ) has been initiated in order to gain experience. In total 104 applications from ESCOs and individuals were received for temporary accreditation. Two separate high-level committees were constituted for evaluating the above applications based on their energy auditing capabilities and institutional set up. Condition of the availability of certified energy auditors with energy auditing agencies was not considered at this stage as the certification system is under developmental phase. 64 energy-auditing agencies have qualified for temporary accreditation. Accredited Energy Auditors have carried out about 2000 energy audits on voluntary basis in the last two financial years (2003-05).

**3. Fixation of norms for different industrial sectors**

To start with, Cement and Pulp & Paper sectors have been selected for fixation of specific energy consumption norms. The Draft norms for these sectors are now under discussions with the concerned sectors.

**4. Manuals and Codes for standardizing the process of energy auditing**

Draft code on 7 Technologies (Equipment) Lighting Systems; Dryers;

Cogeneration Plants; Electric Motors; Electric Transformers; Fluid piping systems (network), insulation and Air Conditioners/Chillers (HVAC) have been prepared. These draft codes are posted on the Bureau's website.

The comments were reviewed and incorporated in the revised draft codes, which were discussed with energy auditors/managers and other experts in a workshop organized from 6 to 10th June, 2005 at Vadodara.

Final draft version of the code incorporating the comments in the workshop was prepared and each code was tested in the field by selected BEE certified energy auditors, which has been completed in March, 2006

**5. Notification of Designated Agencies**

28 States Governments and union Territories have notified State level Designated Agencies for the prose of implementing EC Act within the state and detailed list is available at BEE.

**6. Standards & Labeling**

Energy labeling Rating plans for Agricultural pump sets, Motors, Distribution Transformers, Fluorescent tube lights, Refrigerators and Air conditioners have been prepared after detailed interaction with manufactures and other stakeholders.

Identified equipments have been tested

for energy performance and engineering economic studies were carried out for arriving at Minimum Energy Performance Standards (MEPS) for motors, agriculture pump sets, distribution transformers and refrigerators.

Testing parameters and procedures have been drawn mainly from Indian Standards finalized.

- Lighting (Indoor and Outdoor)
- Heating Ventilation and Air Conditioning (HVAC) System
- Service Water Heating and Pumping
- Electrical Systems

The draft ECBC is now being circulated to state governments for their comments. Impact of ECBC: -

**B. END-USERS**

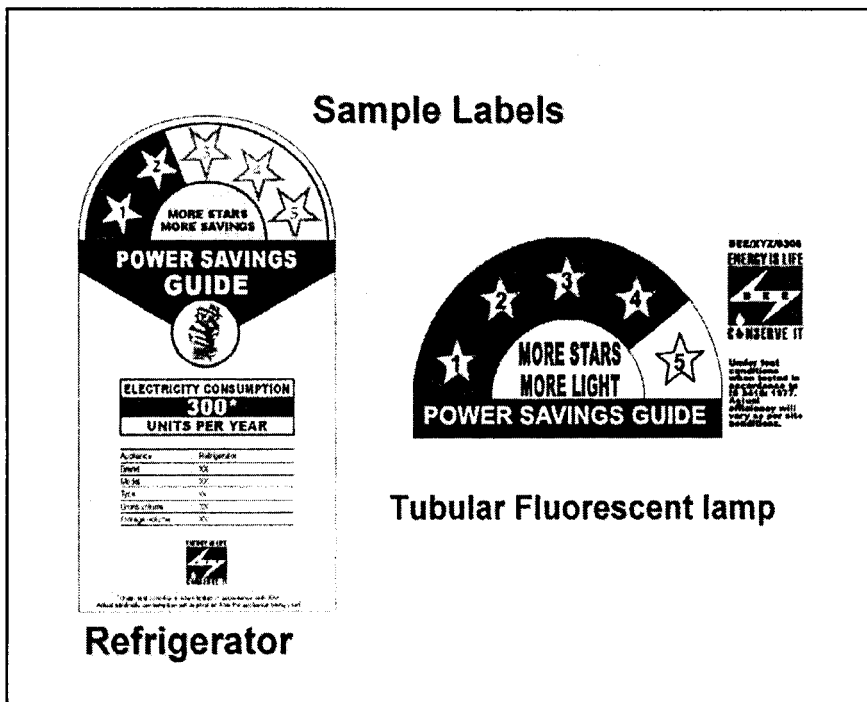
**1. Energy Efficiency In Indian Industry**

Industry is the major energy consumer utilizing about 50% of the total commercial energy use in India. The six key industries – namely aluminium, cement, fertilizers, pulp & paper, petrochemicals and steel - consumes about 65% of the total energy use in India. The energy intensity in some of these industries is reported to be higher than the industries in developed countries. One of the main reasons for higher energy use is the presence of obsolete and energy inefficient processes in some of these sectors. To promote adoption of energy efficient processes, they are planned to be notified as designated consumers under the Energy Conservation Act. By complying with various provisions of EC Act, as applicable to designated consumers- namely meeting specific energy consumption norms, conduct of regular energy audits and implementation of techno economic viable recommendations and establishment of energy management system through appointment of certified energy manager -is expected to boost adoption of energy efficient processes and technologies.

**2. Energy Efficiency in Government Buildings**

Bureau of Energy Efficiency has undertaken Energy audit studies in 8 Government buildings to set up an example for private buildings to pursue similar efforts. The buildings included - Rashtrapati Bhawan, Prime Minister's Office, Rail Bhawan, Sanchar Bhawan, Shram Shakti Bhawan, Transport Bhawan, R&R Hospital, Terminal I, Terminal II and Cargo Sections of Delhi Airport, and AIIMS. Energy savings potential between 25 to 46 % has been identified in the above buildings.

Implementation of the recommendations of the Energy Audit studies have been completed through ESCO mode in Rashtrapati Bhawan, Shram Shakti Bhawan & Transport Bhawan. 17 more central buildings are being undertaken for conduct of energy audit in Delhi.



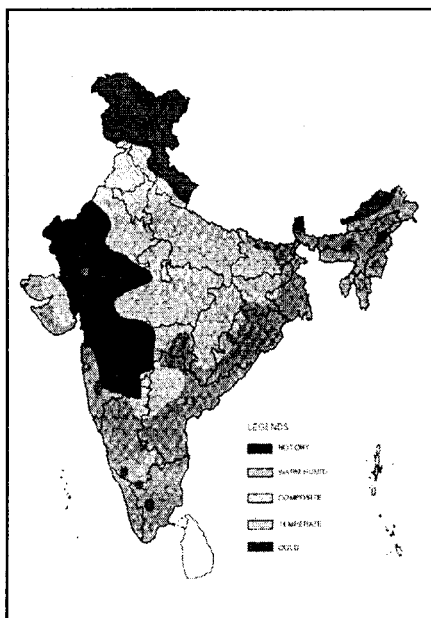
The Hon'ble Union Minister of Power has launched the National Energy labeling scheme on May 18, 2006 at New Delhi. To begin with the scheme is being implemented on voluntary basis for Refrigerator (No-Frost) and Tubular Fluorescent Lamp. Other equipments would be introduced in phased manner.

**7. Energy Conservation Building Codes (Implementation Status)**

Committee of experts was constituted to guide preparation of Energy Conservation Building Codes (ECBC) to cover 5 climatic zones.

Draft ECBC covering the following components has been prepared:

- Building Envelope (Walls, Roofs, Windows)



## Energy Audit Results (Government Buildings)

Building particulars	Annual Energy Consumption (Million kWh)	Annual Energy Savings (Million kWh)	Percentage Savings (kWh)	Annual Energy Savings (Million Rupees)	Investment (Million Rupees)	Payback period (Years)
Rashtrapati Bhawan	3.4	0.8	23	5.0	5.1	1
Prime Minister Office	0.8	0.3	32	1.7	5.0	3
Sanchar Bhawan	2.6	1.2	46	7.6	14.7	1.9
Shram Shakti & Transport Bhawan	2.0	0.8	39	4.3	15.8	3.7
R R Hospital	10.0	2.9	28	8.8	4.5	0.5
Air Port	71.3	1.5	20	5.9	18.0	1.5
Rail Bhawan	2.4	0.6	25	4.0	16.3	4.2
AIIMS	36.9	9.3	29	7.1	107.0	1.5

### Results achieved by BEE

The results achieved after implementation of various promotional and mandatory provisions in support of the EC Act are as follows:

- 64 Accredited Energy Auditing firms are in place, which have carried out around 2000 Energy Audits in 2003-05.
- 512 Certified Energy Managers and 1156 Certified Energy Auditors are in place. Certified Energy Auditors will be considered for accreditation whereas the designated consumers will consider Certified Energy Managers for appointment or designation as certified energy manager under the EC Act.
- 3rd National Certification Examination for Energy Managers and Energy Auditors successfully conducted.
- 4 Guidebooks prepared to assist energy professionals
- Two interactive Websites in place
- 7 Sector specific Task Forces for Aluminium, Cement, Chlor alkali, fertiliser, Pulp & paper, Petrochemical & Refinery and Textile constituted and regular workshops have been held.
- 7 Draft energy auditing codes for utility equipment in place
- Savings of 865 MW of electric power, as equivalent avoided capacity, achieved during 1999-2005 through National Energy Conservation Award Scheme
- Labeling plan for air conditioners, refrigerators, distribution transformers, fluorescent tube light, motors prepared
- 28 States Governments and union Territories have notified State level Designated Agencies for the purpose of implementing EC Act within the state
- ECBC structure draft prepared
- Energy audit studies completed in 9 Government buildings to set up an example for private buildings to pursue similar efforts. The buildings included - Rashtrapati Bhawan, Prime Minister's Office and Defence Ministry blocks in South Block, Rail Bhawan, Sanchar Bhawan, Shram Shakti Bhawan, Transport Bhawan, R&R Hospital, Terminal I, Terminal II and Cargo Sections of Delhi Airport, and AIIMS. Savings potential between 25 to 46 % identified in the above buildings
- Implementation of Energy Audit Studies in Rashtrapati Bhawan, Shram Shakti Bhawan & Transport Bhawan have been completed through ESCO route
- 16 more Government buildings are being taken up in second phase for energy auditing and its implementation through ESCO mode.

### C. TECHNOLOGY

The new generation industrial plants installed in India have excellent energy efficiency norms comparable with the

best and most energy efficient plants in the World. This shows the deep penetration of advanced energy efficient technologies in many of the Indian industrial plants. For example, in Indian cement plants, the technology penetration is very high and the energy efficiency norms are comparable to the best energy efficient plants in the World. Further, some of the Indian Steel plants are already undergoing a process of modernization and are adopting more energy efficient practices. Technology updating is also positive in the Indian Power and Pulp & paper sector. There has been commendable progress in energy efficient technologies employed in thermal and electric utilities. Use of fluidised bed boilers and furnaces, variable frequency drives, energy efficient pumps, fans, compressors and cooling towers are widely employed in Indian industries. Energy efficient compact fluorescent lamps and electronic ballasts are penetrating domestic, commercial and industrial sector at a very faster rate. Standard and labelling program of EC Act will further boost manufacturing and adoption of energy efficient technologies

### CONCLUSIONS

The increasing preference for commercial energy has led to a sharp increase in the demand for electricity and fossil fuels. Use of Fossil Fuels has resulted in emission of huge quantity of carbon dioxide causing serious environmental damages. There is still a considerable potential for reducing energy consumption by adopting energy efficiency measures at various sectors of our country. Energy efficiency will not only reduce the need to create new capacity requiring high investment, but also result in substantial environmental benefits. With the enactment of the Energy Conservation Act, 2001, a legal framework is now available for promoting energy efficiency in all sectors of the economy. Efficient use of energy and its conservation will succeed as a programme if opinion leaders and captains of industry take the lead in supporting the conservation programme