India: The Way Towards Energy and resource efficient buildings

1. India's building sector: how significant it is to the world?

With an economic growth rate of 8.9%, which is the second fastest in the world and a GDP that is the fourth largest in terms of PPP at US$3.6 Trillion[1], India is fast seen emerging as a major global business giant. With 35 cities with populations in excess of 1 million, and more cities joining the list, investments in urban infrastructure for the provision of services such as roads, water-supply and sewerage, urban transportation and the like are projected to be higher than ever before. This of course is besides the investments already coming into the economy via 'foreign direct investments' into urban real estate development. This is one sector of the Indian economy that has activities, which are directly or indirectly linked to every other economic sector. The gross built-up area added to commercial and residential spaces was about 40.8 million square meters in 2004-05, which is about 1% of annual average constructed floor area around the world and the trends show a sustained growth of 10% over the coming years[2].(source?) The need for construction is imminent with the globe's second largest population housed on a mere 2% of the global land share. Since 1990, India has emerged as one of the wealthiest economies in the developing world; during this period, the economy has grown constantly with only a few major setbacks. This has been accompanied by increases in life expectancy, literacy rates and food security[3].

The spurt of economic activity post liberalization has ensured abundant liquidity in the market at all times over the recent past. Consequently, the economic share of the construction industry has grown significantly owing not only to an increased demand for residential, commercial and institutional projects but also due to it being viewed as a stable source of long term investment with near guaranteed returns.

The current state of the economy, foreign direct investment opportunities and other factors[4] such as

- Relatively low real estate prices,
- Tax-relief against interest cost on housing finance for durations as long as thirty years and
- Improved highways and transport infrastructure shall ensure a consistency in demand

for housing and commercial construction projects.

India's current percentage of urban population is approximately 30%[5]. If studies from developed nations are to be believed India's urban population percentage is likely to stabilize at 60% of the total population (what is the current % of urban population?). It is projected that India's urban population would grow to about 473 million in 2021 and 820 million by 2051, as against only 285 million in 2001. This further highlights the kind of demand that is expected in the residential and commercial sectors in India.

As per the National Housing Bank (NHB) the shortage in supply of urban housing units is to the tune of 8.9 million. This gap is seeing a steady widening with the housing stock growth percentage pegged at 1.6% as against the population growth rate of 2.7%[6]. Thus, the opportunities within the housing sector itself are enough to sustain a high growth rate in the construction industry.

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1 https://www.cia.gov/cia/publications/factbook/geos/in.html

2 India-Country Report 2005-2006 - Construction Industry Development Council, India

3 http://en.wikipedia.org/wiki/Indian_Economy#_note-CIA

4 India-Country Report 2005-2006 - Construction Industry Development Council, India

5 **Draft National Urban Transport Policy,**

6 Chintala, G.R., Sahoo, Indumati. *'Rural Housing Finance in India – A Status report'*, Basin – South Asia Quarterly Newsletter / 2006/ No.6, pg.03

2. Drivers of Indian government's increasing concern over energy efficiency

India's energy intensity in comparison to the world average is very low. At 0.16 kgoe/$GDP (PPP) it is lower that that of China's and the United States of America's, which are at 0.23 kgoe/$GDP (PPP) and 0.22 kgoe/$GDP (PPP) respectively, but fares higher than the intensities of the United Kingdom's at 0.14 kgoe/$GDP (PPP) and Brazil & Japan's at 0.15 kgoe/$GDP (PPP). But to a great extent this low figure is a result of India's large population. In other words, the urban population's energy consumption and expenditure on energy are markedly higher than that of rural India's, where the energy costs are cross subsidized by the commercial and industrial sectors of the country.

One of the main reasons for that is access to electricity is still very uneven. Even though 85 percent of villages are considered electrified, around 57 percent of the rural households and 12 percent of the urban households i.e. 84 million households (over 44.2% of total) in the country did not have electricity in 2000.

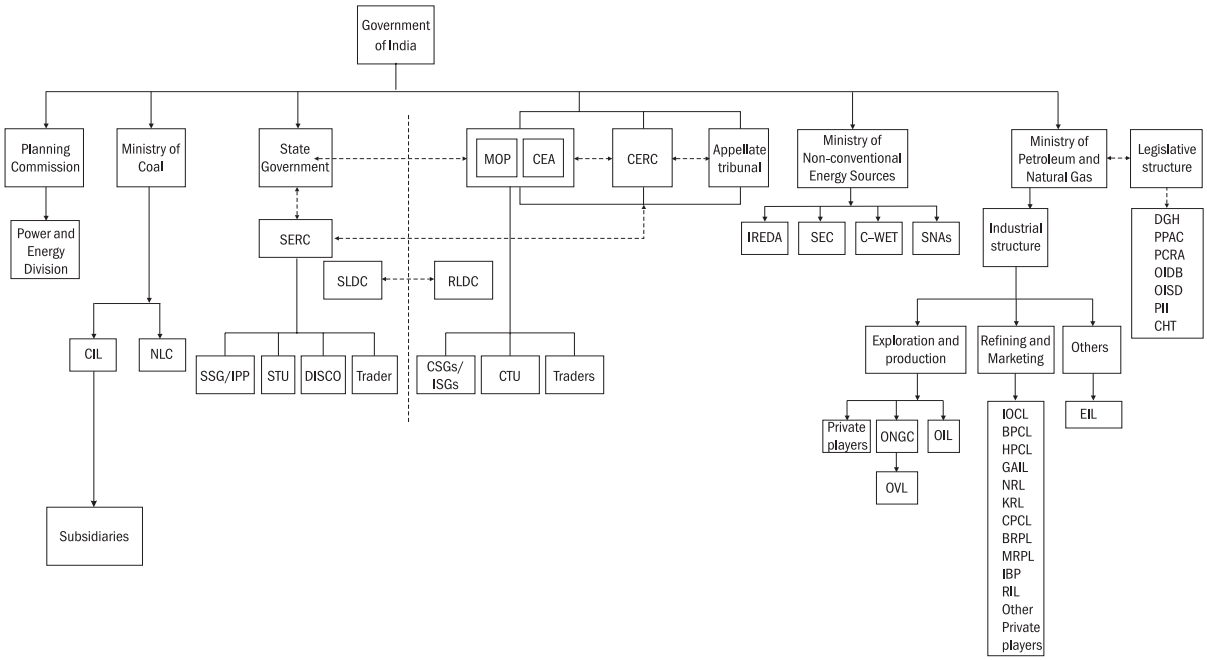
With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase from a low 14% in the 1970s to nearly 33% in 2004-2005. Nearly all the questions raised towards energy efficiency and energy security in the Integrated Energy Policy (which need to be addressed in the near future) are in the same league as those of China's concerns towards the same.

If we look at the consumption of electricity - one of the most convenient forms of energy - we see that per capita consumption in India is far below that in other countries. Added to this is the fact that in the period 2004-05 the peak 'shortage', i.e. time period for which electricity is not available to a consumer, varied between 0 - 25.4% and the average shortage was around 11.7%, this is in addition to the fact that access to electricity is very uneven. The average energy shortage for the same period varied from 0 to 20.1% with an all India average of 7.3%. (Not sure what this means – does this refer to the amount of time that electricity is not available e.g. outages?)

The Government is well aware that in order to sustain its GDP growth rate at the projected average of around 7-8%, one needs to ensure a sustained energy supply and increased energy security. As of date, problems such as shortages of fuels, an increasing dependency on imported oil and poor health of the power sector, discourages growth in a country where the need for energy for growth and improved human welfare are a necessity.

We now stand at a point where 72% of our crude consumption is met via imports; over 65% of our metallurgical coal demands are met via imports, and this in addition to our import dependence increasing alarmingly. Since the building sector is inextricably connected to nearly all our energy demands whether it be agricultural, transportation, industrial or residential & commercial, it is of prime importance that all possibilities towards energy efficiency and conservation in this sector be looked at in depth and put to use as soon as possible.

3. Key decision makers in India's energy sector



[7]The energy sector in India is under administration, regulation and ownership of government agencies and organizations. The basic institutional structure in energy sector comprises of central level nodal (key policy formulation and implementation) ministry, state level nodal (key policy formulation and implementation) agencies, public sector undertakings (PSUs), technical and research organizations. **There are five central government level ministries responsible for policy formulation in the energy sector:**

- **Ministry of Power,**
- **Ministry of Petroleum & Natural Gas,**
- **Ministry of Coal,**
- **Ministry of New and Renewable Energy Sources and the**
- **Department of Atomic Energy**

Coordination and integration is done with the Government of India through the Cabinet and the Planning Commission. In addition, the power and energy division of the Planning Commission plays a major role in plans, policies and formulation of 5-year plans for these sectors. The energy sector as a whole is looked at, only during formulation of these five-year plans. Even so, the plan approach resembles an aggregation of plans of individual sectors, rather than an integrated view of the entire sector.

The individual states government in India have been mainly involved in the electricity sector and promotion of new and renewable sources of energy. They have limited role in regulation, promotion or conservation of atomic, petroleum or coal based energy sources.

In view of the above, a clarity was sought regarding the direction we were to adopt in aspects such as energy security, research and development, addressing environmental concerns, energy conservation, etc. For this, the Prime Minister directed to the Planning Commission to constitute an expert committee to formulate an integrated energy policy. (who felt this need – was it a consensus in the government?)Additionally, The need to have an integrated policy arose because different fuels can substitute each other in both production and consumption. Alternative

[7] See list of abbreviations for expanded forms of the bodies included in the matrix.

technologies are available and there is substantial scope for exploiting synergy for energy system efficiency to meet requirement for energy services. There are several crosscutting issues that need to be addressed holistically in order to ensure energy efficiency in buildings. The current policy framework does not support the same. For example, enforcement of Energy Conservation Building Codes falls under the purview of Ministry of Power and designated state nodal agencies, while sanctioning power for building plans rests with local development authority or municipal corporations. This disparity needs to be eliminated in order to ensure optimized energy efficiency and use by minimizing any excesses leading to wastage of resources.

4. Investments on energy efficiency and DSM

In the 1990's several studies estimated the potential and cost effectiveness of energy efficiency and Demand Side Management (DSM) in India. The 8th five Year plan made a provision of Rs. 14 billion (USD 0.3 billion) for energy efficiency to provide targeted energy savings of 5000 MW & 6 million tonnes in electricity and petroleum sectors respectively. However, this money was not explicitly spent for this purpose[8] (is this a polite way of saying it was squandered or misdirected? – Open to reader discretion). A review of 8th plan performance does not quantify actual costs and savings. The 9th five-year plan proposed the passing of Energy Conservation act and setting up of Bureau of Energy Efficiency[9] The target for energy saving in 10th plan is 95,000 Million Units (Mu) (13% of estimated demand). However, there is no specific allocation of resources to meet the target. (can you describe the budget and staffing for the BEE?). The Bureau of Energy Efficiency (established under Ministry of power to implement Energy Conservation Act, 2001) has estimated a savings of 880 MW of power (is the % saving available?) by use of energy efficient Compact Fluorescent Lamps (CFLs) and Tubular Fluorescent Lamps (TFLs) during 2002-2005 with a corresponding increase in sale of CFL from 18 million in 2002 to 57 million in 2005.

Another study conducted by Asia Development bank in 2003, estimated an immediate market potential for energy saving of 54,500 MU and peak shaving of 9240 MW with an investment potential (in energy efficiency technologies, equipments and materials) of 140 billion INR (3.5 billion USD approximately) (I don't understand this – investment to realize the savings?). The aggregate saving potential varies from one source to other, it is evident that the potential is substantial (cost effective saving potential is at least 15% of total generation through DSM) and needs to be addressed effectively. The total volume of the energy efficiency consulting business as of now (audit, performance contracting, engineering, technical assistance and consultancy) is less than 1% of its potential (DSCL, 2004)[10] and a large market still remains untapped. It would be fair to say that DSM is viewed by the government as the primary strategy for energy conservation in residential buildings.

5. India's Energy efficiency policy and programs

The energy policies adopted since independence to serve the socio-economic priority of development have many deficiencies and have encouraged and sustained many inefficiencies in the use and production of energy. One of the outcomes is that India pays one of the highest prices for energy in purchasing power parity terms. The challenge is now to ensure adequate supply of energy at the least possible cost. Another major challenge is to provide clean and

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[8] Page 84, Draft report of the expert committee on the Integrated Energy Policy, Government of India, Planning Commission, New Delhi – December 2005

[9] The BEE comprises 5 permanent staff and a total of 23 members including consultants working exclusively on the building sector. There is additional staff working on other energy efficiency inititatives such as energy labeling, industrial energy efficiency etc.

[10] Datta Roy, G.C. *'DSCL (2004): Catalysing Markets Through Innovative Financing and Competitive Procurement for Energy Efficiency'*, Presentation available at http://www.bee-india.nic.in/sidelinks/Useful%20Downloads/Presentation%20seminars/Datta%20Roy%20Presentation%5B1%5D.ppt

convenient "lifeline" energy to the poor even when they cannot fully pay for it. With these primary objectives the planning commission has prepared an integrated energy policy linked with sustainable development that covers all sources of energy and addresses all aspects of energy use and supply including energy security, access and availability, affordability and pricing, as well as efficiency and environmental concerns.

India's conventional energy reserves are limited and a lot of stress has been laid under the Integrated Energy Policy on energy efficiency and conservation, with particular emphasis on efficiency of electricity generation, transmission, distribution and end-use. Over the next 25 years energy efficiency and conservation would be very critical to ensure energy security and economic growth. India cannot sustain a growth of 8% over the next 25 years without energy and water, and these two are poised to be the biggest constraints to India's growth. The energy intensity of our growth has been falling and is about half of what it used to be in the early seventies but there is significant room to improve. Studies show that implementation of Demand Side Management (DSM) options to reduce demand for electricity through energy efficient processes, equipment, lighting and buildings can help reduce the demand by an estimated 15% (Source cited in footnote) by 2031-32, a reduction of 152 Mtoe (381 Mt of Indian coal) in coal requirement can be effected[11]

While on one side we are striving towards energy security for all, we are also witnessing unprecedented urbanization with the growth of economy. The larger towns and metropolises serve as centers for higher education in India, as they do the world over. This has attracted an ever-increasing number of commercial and services sector enterprises (both national and international) to set up base in the cities. Resultantly, rapid urbanization has put added pressure on the energy infrastructure of the country's urban centers and incidents of power, water and other resource shortages are on the rise. With the AT&C losses[12] in the country at approximately 40-50% all possible means of reducing energy consumption need to be exercised forthwith, and among the foremost areas (as identified in the Integrated Energy Policy – 2006) where significant savings can make a substantial impact are[13]:

- Mining
- Electricity Generation, transmission and distribution
- Water Pumping
- Industrial production, processes, hauling
- Mass transport
- Building design
- Construction
- Heating, Ventilation and Air-Conditioning
- Lighting &
- Household Appliances

The Integrated Energy Policy also looks at finding solutions to questions that are likely to pose serious threats to India's Energy future if not looked at concertedly, in the short term and long-term perspectives. Henceforth, all decisions made in this direction shall be guided by keeping in view these key questions[14].

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[11] Page 49, Integrated Energy Policy – Report of the Expert Committee, Government of India, Planning Commission, New Delhi – August 2006.

[12] Which include theft, non-billing, incorrect billing, T&D losses, inefficiency in collection etc.

[13] Page XXI, Integrated Energy Policy – Report of the Expert Committee, Government of India, Planning Commission, New Delhi – August 2006.

[14] **According to the Integrated Energy Policy, from a long-term perspective a number of issues need to be addressed:**
(a) How much energy do we need over the long run? Given our resources, what should be our strategy to meet the growing demand?

6. India's Building energy efficiency policy

6.1 Evolution of building EE policy in India

India's building and construction sector has seen unprecedented growth post liberalization circa 1991. Print and motion media explosions around the same time exposed the entire population to western lifestyles and trends including those of architecture and design. A resulting spurt in commercial and residential building types constructed in a distinct western style with an absolute disregard to context and climatic conditions led to a steady increase in building energy consumptions. The building trends ever since, have involved the use of high embodied energy materials such as aluminum and steel, extensive external glazing systems, leading to increased heat gains and (consequently) use of extensive refrigeration based space-conditioning systems, electrical appliances etc. To cater to the increased demand for such equipments in the increasing urban settlements, more industries were set up to manufacture and provide such appliances etc. Increasing travel times due to increased fringe development and satellite towns led to a sudden explosion in the transport sector as well, with unparalleled growth in the automobile sector and increased demand for petroleum and diesel. The current state of an overburdened energy infrastructure may be traced using the same route.

The need for energy efficiency in building was felt around the same time but the efforts, mostly due to inadequate awareness, were mostly made at an individual (private) level. TERI was (and has been since) involved with auditing many five-star hotels and other institutional and commercial buildings to understand their energy consumption and suggest energy efficiency measures via possible retrofit measures. However, the first government initiative towards energy efficiency was when the Indian parliament passed the Energy Conservation

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(b) How do we promote the efficient allocation of various fuels and energy forms to different uses? What should be their relative prices?
(c) How do we address the legitimate concerns of States rich in energy resources such as coal and hydro?
(d) What institutional reforms are needed to generate competitive efficiency? How do we leverage the strength of public sector units that dominate energy sectors? How do we obtain credible, independent, transparent and consistent regulatory oversight in the energy sector?
(e) What is the role of renewables in our energy supply? How do we promote their development?
(f) How should we increase India's known energy resources? What new technologies are relevant for India's future? How do we promote their development? What should be our R&D strategy?
(g) What is the scope for increasing the energy efficiency of the system? What policies can lead to higher efficiency? How do we encourage energy conservation and energy efficiency? In particular, how do we reduce the use of petroleum fuels for transport? What policies are needed to promote fuel efficiency and alternatives in transport?
(h) How do we ensure energy security? What is the role of obtaining equity energy abroad? How do we reduce dependence on imported energy?
(i) How do we encourage an energy system that keeps air pollution within acceptable limits? The growing global concern over the threat of climate change requires that India continues to increase its energy supply in a responsible manner without compromising its economic growth imperative. India's long-term energy strategy must take this into account.

In the short-term, our pressing problems are:

(a) How do we deal with persistent power shortages? How do we expand capacities for generation, transmission and distribution? How to generate investible surpluses with SEBs? How do we improve the financial health of SEBs? How do we reduce AT&C losses?
(b) How do we reduce the cost of power and improve its quality? How should we do away with cost plus regime? How do we introduce competition? How can we encourage private sector participation in the power sector? How can we provide open access in a level playing field?
(c) How do we ensure fuel supply for power generation? How should we expand coal supply in a cost effective way? How can we promote investment in coal production? How do we expand production by captive mines? How do we facilitate import of coal to meet shortfalls in domestic supply and wherever imports are cost effective?
(d) How should we allocate and price domestic gas?
(e) How do we deal with the rising cost of oil in the world market? How to minimise its adverse impact on the economy?
(f) How do we provide clean cooking energy to all? How can we develop an energy system that is poverty and gender sensitive?
(g) How do we provide access to electricity for all households? Considering some consumption of electricity as a merit good that we want all to consume, how should it be financed?
(h) How do we provide subsidy for electricity and clean cooking fuels to certain consumers e.g. poor households or agricultural pumps, in ways that do not encourage wasteful use of electricity?

Act, 2001 that led to the establishment of the Bureau of Energy Efficiency and kick started

Bureau of Energy efficiency: Functions and activities

The regulatory and promotional functions assigned to BEE under the Energy Conservation Act are given below.

Regulatory:

- Develop minimum energy consumption standards and labelling design for equipment and appliances.
- Develop energy conservation building codes.

Activities focussing on designated consumers include:

- Develop specific energy consumption norms.
- Certify energy managers and auditors
- Define the manner and periodicity of mandatory audits.

Promotional:

Some key functions are:

- Create awareness, organise training , educational curriculum on related subjects
- Promote R&D and strengthen consultancy
- Develop testing/certification protocols.
- Promote innovative financing and give financial assistance
- Implement international coooprationprogrammes on energy efficiency and conservation

In order to execute the functions, it is empowered to BEE has formulated an action plan for carrying out its activities. The thrust areas identified are:

1. Indian industry programme
2. Demand side management
3. Standards and labelling programmes
4. Energy efficiency in buildings and establishments
5. Energy conservation building code
6. Professional certification and accreditation
7. Manuals and codes
8. Energy efficiency policy research programme.
9. Energy efficiency and conservation in school education.
10. Delivery mechanisms for energy efficiency services.

Activities so far:

BEE has formulated energy labeling regulations . Energy labelling on voluntary basis for refrigerators and tubular fluorescent lighting has been launched in 2006. Labelled products are expected to be in market by 2006.

BEE formed a consortium of energy audit consultants to carry out energy audit in several important government buildings (the audits have been completed). BEE and the Central Public Works Department (CPWD) are in the process of implementing energy efficiency performance contracting projects in nine government buildings with an estimated annual savings of approx. 30 GWh with a simple payback of less than two years.

BEE has developed model documents such as Performance contract, Bid evaluation, Request for Proposal, and Payment Security Mechanisms for facilitation of project implementation through ESCOs.

BEE is carrying out accreditation of energy auditors in India

Under its statutory authority, BEE is developing an Energy Conservation Building Code in India (which is currently under review by state governments).

Energy conservation awards schemes have been constituted and implemented

Several awareness generation and training related activities are being carried out.

the formulation of the Energy Conservation Building Codes (ECBC) as India's first effort towards energy efficiency in buildings. The BEE is the primary body responsible for implementing the ECBC and works towards policy formulation as well as technical developments such as codes and standards. However, extraneous bodies (such as the IIEC) under the expert technical guidance of the BEE have helped develop the codes.

Subsequently, the Electricity Act 2003 (EA2003), enacted in June 2003 to consolidate the laws relating to generation, transmission, distribution, trading and use of electricity. It also called for rationalization of electricity tariff, and promotion of efficient and environmentally benign policies. As a result, the electricity utility system is being unbundled[15] and regulatory commissions are playing active role in enforcement of bill collection and promotion of DSM programs in some larger states. (what does "unbundled" mean? In compliance with the provisions of the above act, the National Electricity Policy was notified in 2005 by the

[15] Unbundling refers to the separation of the processes of generation, transmission and distribution, through privatization/corporatization for improved efficiency, management and reduced losses

central government. The prime objectives of the National Electricity Policy are to provide access to electricity for all households by next five years, meet full demand by 2012, increase per capita availability of electricity to over 1000 units by 2012, to ensure financial turnaround and commercial viability of electricity sector and protection of consumers' interest. Energy conservation and utilization of alternative forms of energy form two core issues that are to be addressed in order to achieve the desired objectives of the national electricity policy and plan. Thus the provisions of Energy conservation and Electricity Act complement each other is moving towards energy security in which conservation and efficiency hold a key role.

6.2 Current Building EE strategies

The current strategies for energy efficiency in buildings can all be attributed to the initiatives enlisted under the purview of the

- **Ministry of Power - Bureau of Energy Efficiency**: Around September 2002, DSM cells were set-up in utilities in five states and pilot projects had been designed for Karnataka and Mahrashtra. Through 2002-03, capacity building exercises were initiated and completed in MEDA (Maharashtra Energy Development Agency) and BESCOM (Bangalore Electricity Supply Company). Ever since, additional capacity building exercises for the electric utility regulators as well as the preparation of investment grade feasibility reports for implementing DSM projects have been under way[16].

- **Ministry of New and Renewable Energy Sources (MN&RE)** – Have initiated several programs focusing on utilization of renewable energy sources in buildings. The MN&RE has a solar buildings programme, which provides assistance for several dissemination related activities and provides financial support for the design and construction of energy efficient and solar passive buildings (is that financial support or technical support). Solar buildings are constructed based on the techniques of solar passive design with a view to provide comfortable living and working conditions, both in winter and in summer. Such energy efficient buildings can save significant amount of conventional energy that is used for lighting, cooling or heating. The buildings have been tried out in a few States as a result of the initiatives taken by the Ministry. Govt. of Himachal Pradesh has made it mandatory to construct all its future buildings using passive design features.
    - IREDA (Indian Renewable Energy Development Agency) is the promotional, developmental, and financing arm of the MN&RE. It provides concession based finance and technical consultation for the promotion and development of NRSE (non renewable sources of energy).
    - India's renewable energy programme derives strength from technical support provided by the SEC (Solar Energy Centre) and the C-WET (Centre for Wind Energy Technology).
    - Additionally, SDAs (state designated agencies), also known as energy development agencies, are responsible for propagating RETs (Renewable Energy Technologies), in tandem with the MN&RE, in their respective states. These agencies chalk out state level programmes and plans for RETs. Subsidies and other support provided by the MN&RE are also channeled through SDAs. In addition to their own schemes, SDAs also facilitate implementation of various schemes of the MN&RE. Many state SDAs have now been designated as implementation arm of the provisions of Energy conservation Act 2001, including adaptation and implementation of the energy conservation building codes. The SDAs also have the responsibility of modifying the ECBC according to regional requirements and constraints. This requires a certain level of technical

[16] Action taken Report, Bureau of Energy Efficiency, 2004

expertise, which does not exist at the moment but is being developed alongside the code development. (do these organizations have the necessary skills sets or does that need still to be built?)

6.3 National building energy standards/codes

The first 'stand-alone' national building energy standard/code was developed after the implementation of the Energy Conservation Act, 2001. Under which the formation of the Bureau of Energy Efficiency and its thrust areas covered most aspects of energy efficiency dealing with new and existing buildings.

The ECBC program's objective is to reduce the baseline energy consumption by supporting adoption and implementation of building energy codes. These codes take into account location and occupancy of the buildings and provide minimum standards to be followed to reduce energy demand of the buildings through design and construction practices while enhancing occupant comfort.

As per the EC act, to effectively implement the ECBC, the act has defined the powers and functions of the central government to take suitable steps to prescribe guidelines to facilitate and efficient use of energy and its conservation; to prescribe ECBC for efficient use of energy and its conservation in the building or building complexes; to amend ECBC to suite the local climatic conditions; and to direct every owner or occupier of the building or building complexes, being a designated consumer to comply with the provisions of the ECBC[17].

For the purpose of the ECBC, the definition of a building is as mentioned in the Energy Conservation Act, 2001, i.e. any structure with a connected load of 500kW or contract demand of 600kVA and intended to be used for commercial purposes The code is also applicable to all buildings with a conditioned floor area of 1,000 m^2 (10,000 ft^2) or greater. The code is recommended for all other buildings. (Other DSM programs target residential buildings with lower connected loads). Does that translate in the code only being applicable to commercial buildings?

The Bureau of Indian standards (national body for development of codes and standards) has developed the National building Code as a guiding code to be followed by municipalities and development authorities in formulation and adoption of building bye lawsThis was the first national building code that covered nearly all aspects of building design and construction exhaustively. (was this the first national building code?) Later you mention that includes some EE elements – what are they?) Building byelaws in India iare under the purview of state governments and vary with administrative regions within the state. However, the central government realized the need to develop a unified building code to reflect latest trends in construction. It must be understood that it is not a mandatory code but becomes so, if the local bodies (in part or whole) adopted it within their respective building byelaws. The code is meant to be a guide to all governmental and private agencies controlling building activities.

The National building code has recently (2005) been revised. In the latest edition of the code, aspects of energy conservation and sustainable development have been consistently dealt with in various parts and sections through appropriate design, usage and practices with regard to building materials, construction technologies, and building and plumbing services. The document focuses on energy efficiency in aspects such as

- Use of pozzolanas (such as fly-ash, rice husk ash, metakaoline, silica fume, ground granulated blast furnace slag, etc.) in concrete production

[17] Adapted from - Action Taken Report, Bureau of Energy Efficiency, 2004

- Daylight integration, (indoor lighting levels to be met via day lighting),
- Artificial lighting requirements (levels) for indoor spaces
- Ventilation standards (natural and mechanical) for optimal human health and well being
- Electrical standards (minimum power factor, allowances for diversity, etc.)
- Select HVAC design norms

(What is the scope of EE measures covered (eg. Envelop, air con, lighting, electrical, etc)?) It would be relevant to mention that there is no integration effort so far of the National building code with the Energy conservation building code.

A preliminary assessment of building codes/standards in India

India has many central and local authorities and bodies that help compile building codes and standards that are applicable at local and national levels. A of now, there are different codes that have been developed by bodies such as:

- The Bureau of Indian Standards – National Building Code
- The Bureau of Energy Efficiency – (Draft) Energy Conservation Building Codes
- Ministry of Environment and Forests – Environmental Impact Assessment and clearance

The code that is expected to have the most significant impact on energy efficiency in buildings is the ECBC, which has a prescriptive and performance based part. The prescriptive route calls for adoption of minimum standards and efficiencies for building envelope and systems (lighting, HVAC, service water heating and electrical). The performance based approach requires whole building simulation approach to prove efficiency over base building as defined by the code (What is scope and approach of the ECBC?) This leaves the code inherently flexible and easy to adopt. However, the degree of technical know-how required to understand and implement the code is high and may lead to some teething trouble (lack of technical capacity to understand and implement) during its initial implementation.

To ensure the success of the Code and its adoption we need to ensure tat activities such as strengthening of institutional frameworks, inter-departmental linkages, capacity building of Urban Local Bodies are undertaken urgently.

Based on reviews and interviews with experts / developers the following assessment of building codes can be made:

1. Building energy codes have just been formulated and are still in draft stage, proposed to be finalized by the year-end (2006)
2. The national building code has been released in 2005 and as per expert's recommendations the ECBC should be integrated with national building code. This would lead to uniformity and larger adoption of energy code (as NBC is mostly adopted by State governments in their building byelaws).
3. Most of the large developers are still unaware of ECBC and need to be educated on the same. According to Mr. Sunil Koul, Chief Architect with DLF, one of the largest real estate developers in India, " A developer does not get any benefit out of designing energy efficient buildings and their power running costs. Lack of adequate infrastructural support from the state government to provide reliable power and gas forces us to invest a lot on providing 100% power back up. If the state provides reliable power for 100% time, we can divert this money to incorporate energy efficient measures."

4. Large-scale availability of appropriate materials and equipment to meet requirement of ECBC is urgently needed. The Energy codes are relatively new in India and the products (insulation, efficient glass, efficient HVAC systems etc) and services required by buildings to comply with the code requirements are not readily and abundantly available or competitively priced . (Does that mean that many of the materials need to be imported? Can you give some examples of the most basic requirements?) Market monopoly of a handful of manufacturers of EE products has resulted in a non-competitive market for products like insulations, chillers etc. Testing facilities for certifying products are also lacking and according to Dr Mathur, DG, BEE, " We have to rely on international testing, till we have the facilities developed in the country"
5. The architects who are aware of the ECBC are very apprehensive of increased initial cost vis-à-vis life cycle cost of some high cost measures recommended by the code e.g. insulation (which is still largely imported and the technical expertise for installation is with a handful of companies) and efficient glazing (low 'U' glass for windows is increasing in demand in India but the supply is largely met via imports). This leads to increased initial costs varying between 10% to 40% depending on the technologies/materials/equipments adopted and the skill set (technical and labor related) required to deliver the same. (I thought insulation was really cheap! Is the issue that the materials need to be imported? Does glazing refer to window treatment? Are there any estimates of the increased cost of compliance?
6. There is lack of knowledge among designers to analyze designs based on code requirements due to the novelty of the concept of energy efficiency. (Because the whole concept of a building code is new?. Energy simulation capability to quantify savings based on energy efficiency parameters as defined by the code is very limited. The building construction industry (contractors, services providers) is not geared to apply these measures practically on site.
7. The energy conservation act empowers the state government to amend the energy conservation building codes to suit the regional and local climatic conditions. This provision may in longer run lead to large deviations from the ECBC that has been developed by the BEE. This may lead to confusion among builders/developers /designers
8. As initial boost on promotion of energy efficient products and services is required in form of import duty relaxation, reduced tax, excise duty. The government could play a major role in realizing the same. There is no concrete plan for implementation of the code, or monitoring and verification.
9. The BEE would introduce the code on a voluntary level and slowly make it mandatory with adequate data to justify the benefits of doing so. The code may be made mandatory in larger cities logically(where the savings potential is significant in comparison to smaller towns) followed by smaller ones. Is this speculation or their stated plan?
10. The builders and developers who have to get environmental clearance from the Ministry of Environment and Forests feel that it leads to additional delays as the clearance process is very time and resource consuming. Also due to absence of normative guidelines for the same they are often left unsure of the options that they have to adopt in their projects to make the projects environmentally sensitive.

6.4 Voluntary green building standard and certification system

Indian industry associations have played an important role in promoting energy efficiency. The Confederation of Indian Industry (CII) and Federation of Indian Chambers of Commerce and Industry (FICCI) are two such bodies. The Indian Green Business Centre is an example of an institution created by an industry association; CII jointly with the Andhra Pradesh government and with technical support from USAID set it up as a public-private partnership. In the year 2001, The US-GBC's internationally accepted and renowned rating system – LEED was introduced in the Indian building sector. The Indian Green Building Centre building in Hyderabad was the first platinum

rated building to be built outside of the USA. The IGBC is facilitating the LEED rating of the United States Green Building Council. There are about 5 buildings that have been rated and 25 projects are registered for rating under the LEED system. As per Mr S Srinivas, Senior Counsellor, IGBC, the Indian corporates see tremendous opportunity in the development of energy efficient products and services. The total potential for Green Building materials and equipments is estimated at about 400 million US$ by the year 2010 (for LEED rated buildings). This could be 8-10 fold higher, considering buildings incorporating green but not going for a formal rating. Typical Products and equipment are Roof paints, Variable frequency drives, High efficiency chillers, BMS, Efficient lighting etc. According to IGBC, after the introduction of the LEED rating system in India, several new energy efficient equipments have been introduced in the country and are being produced locally? It would be accurate to say the introduction of the system has stimulated some innovation within the building materials supply industry. To name a few – High albedo roofing materials, High performance glass, waterless urinals, Fly ash bricks for walls, Roof insulation Materials, High COP chillers. Besides this, a market has been created to offer energy simulation services.

However, the bulk of Indian buildings are distinctly different in design approach than the buildings in developed countries. There is a need felt by designers and builders to have a rating system tuned to Indian environmental conditions and addressing need of the Indian building stock. For instance, the international rating systems are developed around the premise that the buildings are air conditioned, whereas in India, a large number of buildings built to date are non-air-conditioned or partially air-conditioned. To bridge the demand for a rating system for non-air conditioned buildings and one that took into account the possibility of a partially air conditioned building as well, TERI developed its own system known as GRIHA (Green Rating for Integrated Habitat Assessment). This system responded specifically to India's prioritized national concerns such as extreme resource crunches in the Power and water sectors and a fast eroding biodiversity. It attempted to stress on solar passive techniques for optimizing indoor visual and thermal comfort and relying on refrigeration based air-conditioning systems only in cases of extreme discomfort. There are 8 registered projects under GRIHA that are under construction.

However, this system has only been developed for the largest upcoming energy consuming segment, i.e. commercial, institutional and residential buildings (new construction), and is in the course of developing a similar standard to address the needs of other building typologies such as existing buildings, industrial buildings, etc. (Did you mention that this rating system is being considered by the government to make a regulatory requirement?

Now, in consultation with the experts from various related fields in India, the MN&RE is planning developing a national rating system for green buildings. This shall be a voluntary system to be adopted by builders and individuals alike. The MN&RE is trying to develop an incentive mechanism for the same as well.

6.6 Appliance labeling and standard

Due to a multiplicity of manufacturers of electrical equipment all over the country, there is significant variation in the energy consumption and resultantly, efficiency of household electrical equipments. To make the situation worse, information pertaining to a piece of equipment's energy consumption is either not known or difficult to understand. The Bureau of Energy Efficiency's standards and labeling (S&L) program aims to ensure the availability of only energy efficient equipment and appliances to the people.

Initially, the program shall aim to help the people in taking informed decisions towards purchasing an appliance based on its energy consumption and efficiency. This will help identify appliances that perform poorly with respect to energy consumption. After the initial stage, the program shall help establish a minimum energy performance standard to ensure that all the appliances available to the purchasers necessarily conform to a prescribed standard. This will provide the necessary pull in the market to enable the transition from the current.

The first few equipments and appliances that have been short-listed for the program are as follows:

- Refrigerators with or without a low temperature compartment
- Room air conditioners (unitary)
- Stationary storage type electric water heaters
- Electric motors up to 100kW
- Agricultural pump sets up to 10kW
- Fluorescent tube lights
- Ballasts
- Compact Fluorescent lamps
- Distribution Transformers
- Industrial Fans and Blowers up to 100kW
- Air compressors up to 100 kW

The first labeled appliance will be introduced in the market shortly for which the date shall be announced on the BEE website. As of now it is a voluntary scheme and offers no direct financial incentive for industry to participate. Has the BEE a budget/plan for promotion re the labeling?

6.5 Financial /fiscal incentives

Energy efficiency is still not largely incentivized in India. However, there are several incentives offered of renewable energy technologies by the central as well as some progressive state governments.

The following table gives an overview of the kind of incentives made available under the Ministry of New and Renewable Energy Sources' schemes:

S.No.	Programme	Item/Activity	Incentive/Support

1	Solar Water Heating System	• Domestic • Institutional • Industrial & Commercial • Service charges to FIs/Banks • Incentive to Motivators • Performance Monitoring by SNAs • Incentive to Municipalities& Municipal Corporations • Other activities	• Loans @ 2% interest rate • Loans @ 3% interest rate • Loans @ 5% interest rate • Rs. 200 per loan disbursed • Rs. 100/- per sq.m. of collector area installed • Rs. 50/- per sq. m.of collector area visited • Rs. 5.00 lakhs & Rs. 10.0 lakh[18] (??) respectively on notifying amendment in Building Byelaws. • Financial support for Seminars / symposia / workshops/Business Meet/Exhibition etc; Training Programmes; Publicity & Awareness Technology Upgradation & Exposure Visits abroad; and studies/surveys on case-by-case basis.
2.	Solar Air Heating/ Steam Generating System	• Solar Steam generating System • Flat Plate Collector based Solar Air Heating System • Service charges to Implementing Agencies • Other Activities	• 50% of cost limited to a maximum of Rs. 5000/- per sq.m of dish area for non-profit making organizations • 35% of cost limited to a maximum of Rs. 3500/- per sq.m of dish area for profit making organization • 50% of cost limited to a maximum of Rs. 2500/- per sq.m of collector area for non-profit making organization • 35% of cost limited to a maximum of Rs. 1750/- per sq.m of FPC area for profit making organization • 3% of MN&RE support • Financial support for publicity & awareness; seminars /workshops/ symposia / Business Meet; Training Programme; Technology Upgradation; and studies/surveys etc. on case by case basis
3.	Solar Buildings	• Preparation of Detailed Project Reports (DPRs) • Demonstration solar Buildings • Other Activities	• 50% of the cost of DPR to a maximum of Rs. 2.00 lakhs • 10% of the cost of construction to a maximum of Rs. 50.00 lakhs • Financial support for workshops, seminars & publication of documents on case-by-case basis.

[18] One Lakh = One Hundred Thousand

4.	Akshay Urja (Solar Energy) Shops (what?)	• Soft Loan through public sector banks • Monthly recurring grant for 2 years • Monthly incentives for 2 years • Service Charges	• 7% interest rate to a maximum of 85% of cost of shop for establishment • Rs. 5000/- per month subject to certain conditions through SNAs • Rs. 5000/- per month subject to certain conditions through SNAs. • Rs. 50,000/- per shop to SNAs with 50% to be spent on publicity • @ 2% to IREDA on interest subsidy disbursed • @Rs. 5,000/- per loan disbursed to Banks
5.	Solar Photovoltaic Systems for renewable energy generation in Urban Area (what?)	• BIPV systems (max. 5 kWp module) • Solar power packs (max. 1 kWp module)	• 50% of cost subject to maximum Rs. 2.00 lakhs per kWp • 50% of cost subject to maximum Rs. 1.00 lakh per kWp

7. Implementation of building energy efficiency policies in India

7.1 Need of an effective management system/ implementation infrastructure for new buildings and for upgrades in existing buildings

As mentioned in the sections above, there is no integrated framework for management and implementation of energy efficiency. India is still in very early stages of energy code implementation. There is a strong need felt for an institutional framework with well-defined authority and responsibility. The capacity of the state level bodies, which would be responsible for the final adaptation and implementation of the energy code, should be strengthened. There is need to develop to a set of code official who would understand the energy code thoroughly along with its enforcement requirements. Demonstration projects are required at key geographical locations of the country to test the effectiveness code recommendations on real time projects. TERI GRIHA has adopted the ECBC within its framework and thus promises to deliver buildings in conformance to the ECBC.

In addition to new buildings, there is also a large chunk of existing buildings that need overhauling from an energy efficiency point of view. The BEE has planned to mandate energy audits (by early 2007) for all commercial buildings above a certain threshold of connected load and would develop mechanisms to ensure that the recommendations of the audit are implemented in a stipulated time. There would thus be a large demand for ESCOs and according to Dr Ajay Mathur, DG , BEE " An early bird would get the worm"- the Energy Service Companies (ESCOs) establishing themselves faster would reap maximum benefits of the mandate. However, management and monitoring would hold key to success of the mandate.

7.2 Barriers for owners/developers to implement energy efficient measures

There has been general lack of interest among builders to implement energy efficiency in their buildings because of the sheer dichotomy of the fact that "he who invests does not reap benefits of the investment". According to some leading builders in India the following are the main deterrents:

- There are planning constrains on the site, the indivisual plots are pre allocated by the state development authorities. Therefore, passive features like right orientation are difficult to achieve. The builders are not ready to sacrifice on maximum optimisation of the space and design in order to adopt energy efficiency features in the building design.

- In a colony developed by the builders, he only constructs 5-10%. Rest of the land is sold to different buyers and stakeholders in the market, and thus has no control on the energy efficiency of those buildings. In a colony the builder just builds public buildings, community halls, where they could implement the energy efficiency measures.

- Increase in initial building cost restricts the builders from not adopting energy efficiency measures in their buildings. The builders mostly look at the project from commercial aspects rather than from its efficiency aspect. Moreover the customer being mostly unaware of its advantages does not demand energy efficiency.

- However Mr. Sehgal, VP Ansal properties, pointed out that the Multi National Companies (MNCs) who are building in India, demand for energy efficient building materials and equipment, and thus the developers are fulfilling these demands on client specific requirements.

- Unavailability of efficient equipments in India is another major barrier. Equipments imported from abroad example from China, increases the cost of the equipment and also results into more time consumption for installation, which delays the project.
- No incentives from the government. Accordingly a senior official in DLF, a major developer in India, there should be tax rebate or duty rebates from the government to the developer; otherwise the developer has no reason to invest more capital in making the buildings energy efficient.
- Back up industry in terms of materials, equipments and technical expertise is not coming up as fast as the construction industry. (what specifically?)
- Lack of infrastructure to provide power and gas from the state government. Forces the developer to invest in 100% power backup. If the state provides reliable power supply, this chunk of money could be shifted to incorporate energy efficiency measures in the buildings.

9. Local Level Implementation Successful cases:

Initiative of local Municipal Corporation of Thane (TMC), Maharashtra

The municipal corporation of Thane, covering an area of 147 sq. km and population of nearly 1.7 million is one of the most progressive municipal corporations located in western India. The municipality has taken consistent actions over past years and has demonstrated energy savings by application of no-cost and cost effective energy conservation techniques. TMC has an energy conservation cell responsible for identifying energy conservation opportunities and implement projects to effect savings. TMC has been able to affect a savings of INR 32 million during last 3 financial years. (what ?% of savings?) The basic approach followed to ensure maximum outreach and benefits out of their efforts are:

1. Large-scale awareness generation among own employees and residents of the municipality. The awareness generation stresses use of no cost or low cost options. For e.g., avoid wastages by switching of gadgets when not required.
2. Implement Cost effective energy saving measures in municipal services and public buildings e.g. 33% energy saving was achieved in street lighting through introduction of energy efficient lamps and ballasts, municipal water pumping efficiency was enhanced through suitable retrofits.

3. Waste to energy projects have been commissioned with private participation.

TMC is also taking innovative initiatives and are likely to implement solar energy based A.C. systems on pilot scale for two public buildings.

TMC has also modified the development control rule (building bye law) to mandate use of solar water heating system in certain building typologies. In order to promote use of SWH, TMC also offer property tax incentives to residential users. Having realized that implementation of most of the projects based on non-conventional power sources do not offer attractive returns instantly, TMC is exploring CDM route and availing benefits there from. The CDM (Clean Development Mechanism) route can generate opportunities for carbon credit trading in the international market and help avail the financial benefits accrued from that, not to mention the mitigation of Green House Gases released into the atmosphere due to use of conventional technologies. (do not understand this point.)

TMC is one of the most revered municipalities in the country, which has also received several state level and national awards for in energy conservation activities.

Initiative by a private developer in Bangalore , T ZED homes

T- ZED homes have been promoted by one of India's largest 'sustainably built environment' [SBE] enterprise, BCIL. A cluster of 95 homes built over an area of 5 acres in the city of Bangalore, the T ZED homes aims to set new standards for residential housing. The basic features and highlights of the complex are:

- Energy efficient homes built using materials and technologies that have low embodied energy.
- Ergonomically designed.
- T-Zed Homes come with built-in energy efficient lights, solar hybrid fans in each of the washrooms, intelligently switched lighting systems for corridors and other areas, master controller operable through mobile, offsite green power generation using is a biomass-gasifier that uses wood chip as fuel, grown or procured in a sustainable way, customized environment-friendly (brine–based), zero electricity refrigerator cum freezer and home air–conditioning that is fully controlled, and is based 100 per cent on fresh air .
- The campus will also have a 24-hour DG backup made up of two 125 KVA genset modules that will be powered by biodiesel or diesel.
- Extensive water conservation measures coupled with rain water harvesting and reuse
- T ZED homes do not cost higher than conventional homes and yet promises attractive returns on investment through power and water savings
- The T ZED homeowners have been involved in the entire design and construction process and have made valuable additions to the design.
- The project is considering applying for carbon credits under CDM.
- The project demonstrates that it is possible to deliver sustainable homes at no added costs with help of a dedicated team of intelligent professionals and a well-informed clientele. Is there a business case? I did a bit of searching and found that the sit holds 95 homes but under "normal" building circumstances would accommodate ~300 homes. Low density is a very high cost from a developers perspective unless the houses sold for 3X more? We have no information on this, but considering that it is the first such attempt in India, it is likely to face some teething trouble before it becomes a lucrative option for developers/builders.
- However, according to Harsha Sridhar, Architect, BCIL, too much interference of the customers in the design process leads to unnecessary delays and thus upsets the project cycle. Client interface should be allowed in a much controlled way . Also, he feels that in Southern India (Bangalore is in South India), major governing factor of construction is

the entire science of *Vastu Shastra*[19] , which at times may conflict with some energy efficiency principles

- **10. Recommendations:**

In India, there are several central level ministries administering the energy sector. The respective ministries carry out co-ordination and integration with the state governments, with the National Development Council providing a forum for co-ordination at the highest level of the government. This arrangement obviously has the inherent weakness of lack of co-ordinated vision and sustained action. The energy sector as a whole is looked at, only during formulation of five-year plans. Even so, the plan approach resembles an aggregation of plans of individual sectors, rather than an integrated view of the entire sector. The integrated energy policy 2006 holds a lot of promise to integrate these efforts and should be implemented effectively.

There are several cross-cutting issues that need to be addressed holistically in order to ensure energy efficiency in building. The current policy framework does not support the same. For example, enforcement of energy conservation building codes under the purview of Ministry of Power and designated state nodal agencies, while sanctioning power for building plans rests with local development authority or municipal corporations. There is no worked out modality for integration of energy conservation building code with local building bye-laws. The energy conservation act empowers the state government to amend the energy conservation building codes to amend the energy conservation building codes to suit the regional and local climatic conditions. This provision may in longer run lead to large deviations from the ECBC that has been developed by the BEE. The renewable energy programs and incentives are not integrated with policies and programs of the Ministry of Power.

To promote energy efficiency and conservation, we need to create an appropriate set of incentives through pricing and other policy measures. Barrier removal and encouragement to develop and deploy more efficient technologies has to be enabled. An enabling institutional framework is essential to achieve these objectives effectively.

Appendix 1, A list of building energy codes/standards/policies programs in India

Policy or Program	India
Energy Efficiency Plan/Policy	The Electricity Act of 2003: Sets up central and state-level independent regulatory commissions, can mandate and finance DSM programs http://www.bee-india.nic.in/sidelinks/Electricity_Act_2003.html Energy Conservation Act of 2001: Established the Bureau of Energy Efficiency (BEE), under Ministry of Power. Energy

[19] Vaastu Shastra deals with various aspects of designing and building living environments that are in harmony with the physical and metaphysical forces/ energies of the cosmos such as the gravitational, electromagnetic and supernatural. Building practices based on limited interpretations of these principles are still sustained in specific areas of India.Though Vastu is conceptually similar to Feng Shui in that it also tries to harmonize the flow of energy (Also called Life-force, and Prana in Sanskrit, similar to Chi in Chinese) through the house, it differs in the details, such as the exact directions in which various objects, rooms, materials etc are to be placed.(Source: http://en.wikipedia.org/wiki/Vaastu_Shastra Access date: 22.10.06

	conservation Building Codes, ECBC , under implementation http://powermin.nic.in/acts_notification/energy_conservation_act/index.htm The Ministry of Environment and Forestry notification issued on July 2004 required any construction project above a certain threshold, to get clearance from the ministry. This notification has been amended and now the states are empowered to give environmental clearance. The threshold criteria has also been modified. Petroleum Conservation Research Association: Mission is Efficient energy utilization and environment protection leading to Improvement in Quality of Life. http://www.pcra.org/English/aboutus/default.htm Government of India (GoI) has set a goal - Mission 2012: Power for All:
Renewable Energy Plan/Policy	Ministry of Non-Conventional Energy Sources: Provides incentives for solar buildings and incentivises RE adoption in buildings http://mnes.nic.in/frame.htm?majorprog.htm
State Designated Agencies (Energy Efficiency and Renewable Energy)	Bureau of Energy Efficiency web site lists Designated Agencies to coordinate, regulate and enforce the provisions of Energy Conservation Act 2001 http://www.bee-india.nic.in/Designated%20Agencies/designated_agencies.html
Appliance testing & (comparison) labeling	The Bureau of Indian Standards (BIS) covers product quality certification, consumer affairs and development of technical standards: http://www.bis.org.in/ LBNL has been collaborating with the GOI, USG, and NGOs in India to support labeling and standards: http://www.dc.lbl.gov/india/asl/index.html
Voluntary (V) or Mandatory (M)	Minister of Power Shri Sushikumar Shinde officially launched the National Energy Labeling Programme in May 2006. The first element of this program is a categorical (1 to 5 stars) label applied to frost-free refrigerators and fluorescent tube lights. The label will initially be voluntary, but the GOI plans to move to a mandatory label and mandatory minimum energy efficiency standards for these products over time. The refrigerator label announcement includes three sets of increasingly stringent specifications, coming into force respectively in 2006, 2009 and 2012. Voluntary labeling with Minimum Energy Performance Standards (MEPS) on Freezers, Refrigerators, Room Air Conditioners: http://www.clasponline.org/countryinfosummary.php?country=India#National Test Standard

	(V)CLASP-promotes the world's best practices in energy efficiency standards and labeling for residential, commercial and industrial equipment and lighting. In India has worked on refrigerators, CFLs, and other appliances. See: http://www.clasponline.org
Building sector voluntary agreements	U.S. Asia Environmental Partnership (USAEP) in partnership with local governments, builders, architects, and academic institutions on promotion of green building for the housing sector in the city of Pune in Maharashtra. See: www.ecohousingindia.org eeBuildings/India, a pilot program cosponsored by USEPA ,USAID/India, and the Bureau of Energy Efficiency (BEE) and the Maharashtra Energy Development Agency (MEDA) provides a voluntary, no-cost approach to improved energy efficiency: Pilot project was launched in Mumbai in 2005. See: http://www.epa.gov/eeBuildings/india/index.html Confederation of Indian Industries/Green Buildings Centre promotes the building of world class "Green Buildings". Several corporate buildings have been built to US Business Council's platinum and gold LEED ratings: See: http://greenbusinesscentre.com/ TERI Green Rating for Integrated Habitat Assessment: (TERI–GRIHA), voluntary program. Primary objective of the rating system is to help design green buildings and, in turn, help evaluate the 'greenness' of the buildings in India. The rating system follows best practices along with national/international codes that are applicable to achieving the intent of green design. See: http://www.teri.res.in/core/griha/
Utility or government rebates	The Central Electricity Regulatory Commission (CERC) was established in 1998 under the Electricity Regulatory Commissions Act, 1998. Out of 29 states about 18 states have also formed the State Electricity Regulatory Commissions (SERC).
	Maharashtra Electricity Regulatory Commission (MERC) instituted a public-benefits type of electricity charge on industry, funds from which can be used to finance renewable energy and energy efficiency programs in the state. MERC ordered utility companies in the state to begin CFL programs in the residential sector in Mumbai and in the Nasik District using these resources in late 2005. See: http: mercindia.org.in/Orders_2005.htm The Bangalore Electricity Supply Company (BESCOM) in Karnataka initiated a program, Bescom Efficient Lighting Program (**BELP**) to promote the use of CFLs. See: http://www.bescom.org/en/news/belp.asp
Energy audits (R) or (C)	BEE shall mandate audit for all buildings over a certain

	threshold of connected load by early 2007 Energy Audits for Buildings: http://www.bee-india.nic.in/Energy%20Auditor/Guidelines/Energy%20audit%20for%20buildings.pdf Federation of India Chambers of Commerce and Industry is conducting energy efficiency training and audits: http://www.ficci.com/services/energy.htm Petroleum Conservation Research Association (PCRA) provides energy audits, see: http://www.pcra.org/English/aboutus/default.htm Energy Audits for Buildings: http://www.bee-india.nic.in/Energy%20Auditor/Guidelines/Energy%20audit%20for%20buildings.pdf TERI conducts energy audits and training www. teriin.org
Boiler/HVAC inspections (V) or (M)	Under the Energy Conservation Act of 2001, development of energy performance codes has been initiated for Boilers, Compressors, Fans, Pumps and Cooling Towers. See: http://www.techno-preneur.net/new-timeis/ScienceTechMag/april04/energy.htm and http://www.bee-india.nic.in/aboutbee/Action%20Plan/11.ta7.html
Government buildings – special requirements or targets	
- New public buildings	In Haryana, all public building post June 2006 have to be mandatorily designed as energy efficient buildings
- Existing public buildings	Maharashtra Public Works Department (MPWD) has identified energy savings opportunities in government buildings. Two cost-effective pilot projects were implemented by MPWD. The Maharashtra State Electricity Board, in conjunction with LBNL, US EPA, and USAID are working to improve EE in public buildings in that state: http://www.mahaurja.com/PDF/MSEB%20Case%20Study.pdf and http://www.dc.lbl.gov/india/buildings/index.html BEE and the Central Public Works Department (CPWD) are in the process of implementing energy efficiency performance contracting projects in nine government buildings with an estimated annual savings of approx. 30 GWh (~US 3.5 million) with a simple payback of less than two years. See LBNL-60035 Report referenced above. Other state governments like Haryana has also initiated similar efforts
Government energy-efficient procurement	
Financing, including ESCOs	Private ESCOs have mobilized and recently set up the Indian Council for Energy Efficiency Business (ICPEEB) to

	network, provide input to policy makers, support business development, and disseminate information on energy efficiency. See: LBNL-60035 Report: Implementing End-use Efficiency Improvements in India: Drawing from Experience in the US and Other Countries, http://www.shrishakti.com/alternativeenergy/index.html ESCOs have worked with the Ahmadabad Electricity Company to implement efficient lighting & other measures to lower pehttp://www.usaid.gov/in/Pdfs/Draft_DSM%20Guidebook.pdf 3 Country Energy Efficiency Project: Initiated in 2001, by the WB, UNEP, to substantially increase investments in energy efficiency by the domestic financial sectors in Brazil, China and India. Five of India's largest banks have developed new energy efficiency lending programs. See: http://3countryee.org/ and http://3countryee.org/PressRelease.pdf Programme on Solar Water Heating: Regular interest rates are being subsidized by Ministry of Non-Conventional Energy Sources (MN&RE), typically the bank finances 85% of the project cost, for a loan period of five years. See: www.mnes.nic.in
Professional/technical training & certification	Energy Conservation Act 2001 called for training and certification of professionally qualified energy managers and auditors with expertise in energy management, project management, financing and implementation of energy efficiency projects, as well as policy analysis. http://www.energymanagertraining.com/new_index.php Federation of India Chambers of Commerce and Industry is conducting energy efficiency training and audits (as noted above): http://www.ficci.com/services/energy.htm
Public information campaigns	National Campaign on Energy Conservation 2006 http://www.bee-india.nic.in/NCEC2006/NCEC06.htm
[OTHERS…]	From the Ministry of Power: National Energy Conservation Award – 2005: Govt Bldg. and Commercial Bldg (Private Sector) http://www.energymanagertraining.com/eca2005/Award2005CD/list.htm
	GEF Energy Efficiency Project: http://www.gefonline.org/projectDetails.cfm?projID=404 [20]

[20] Reference: Draft action plan for buildings and appliances task force under APP partnership

Abbreviations used

BEE	Bureau of Energy Efficiency
BPCL	Bharat Petroleum Corporation Ltd.
BRPL	Bongaigon Refineries and Petrochemicals Corporation
BTU	British Thermal Unit
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
CFL	Compact Fluorescent Lamps
CHT	Centre for High Technology
CIL	Coal India Ltd
CPCL	Chennai Petroleum Corporation Ltd.
CTU	Central Transmission Utility
C-WET	Centre for Wind Energy Technology
DGH	Directorate General of Hydro Carbons
DISCOM	Distribution company
EIL	Engineers India Ltd
GAIL	GAIL India Ltd.
GBC	Green Building Centre
GDP	Gross Domestic Product
GRIHA	Green Rating for Integrated Habitat Assessment
HPCL	Hindustan Petroleum Corporation Ltd.
IBPL	Indo Burma Petroleum Company Ltd.
IOCL	Indian Oil Corporation Ltd.
IPP	Independent Power Producer
IREDA	Indian Renewable Energy Development Agency
KRL	Kochi Refineries Ltd.
KWh	Kilowatt Hour
LEED	Leadership in Energy and Environmental Design
MoEF	Ministry of Environment and Forests
MoP	Ministry of Power
MRPL	Mangalore Refineries and Petrochemicals Ltd.
MN&RE	Ministry of New and Renewable Energy
NLC	Neyveli Lignite Corporation
NRL	Numaligarh Refineries Ltd.
OIDB	Oil Industry Development Board
OISD	Oil Industry Safety Directorate
OVL	ONGC Videsh Ltd
PCRA	Petroleum Conservation research Association
PII	Petroleum India international

PPAC	Petroleum Planning and Analysis Cell
PPP	Purchasing Power Parity
RIL	Reliance Industries Ltd.
RLDC	Regional Load Dispatch Centre
SEC	Surat Electricity Company Ltd./Solar energy Centre
SERC	State Electricity Regulatory Commission
SLDC	State Load Dispatch Centre
SNAs	State Nodal Agencies
SSG	State Sector Generator
STU	State Transmission Utility
S&L	Standards and Labeling
TERI	The Energy and Resources Institute
TFL	Tubular Fluorescent Lamps

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