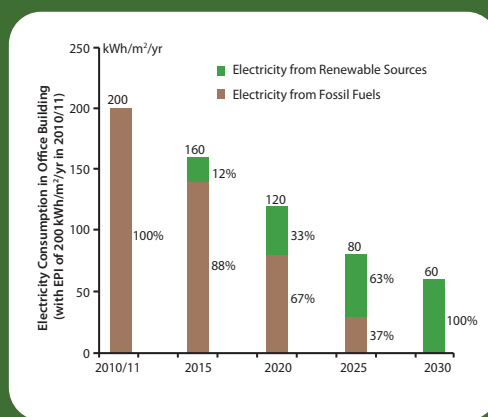
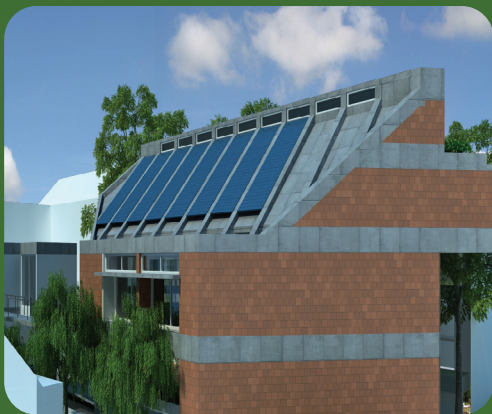


# Strategy Roadmap for Net Zero Energy Buildings in India



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# **Strategy Roadmap for Net Zero Energy Buildings in India**

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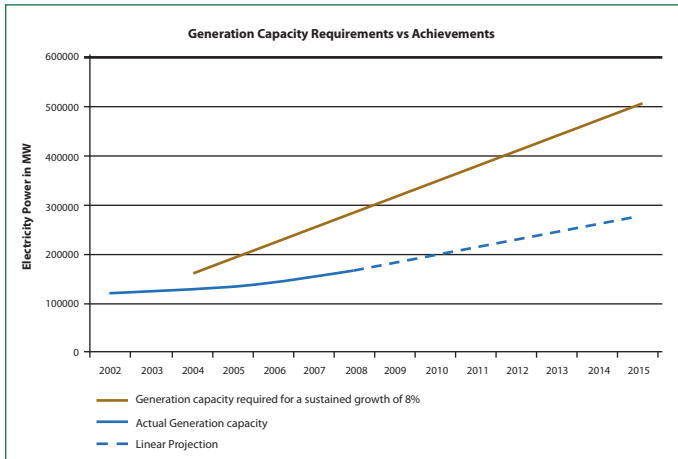
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## INTRODUCTION

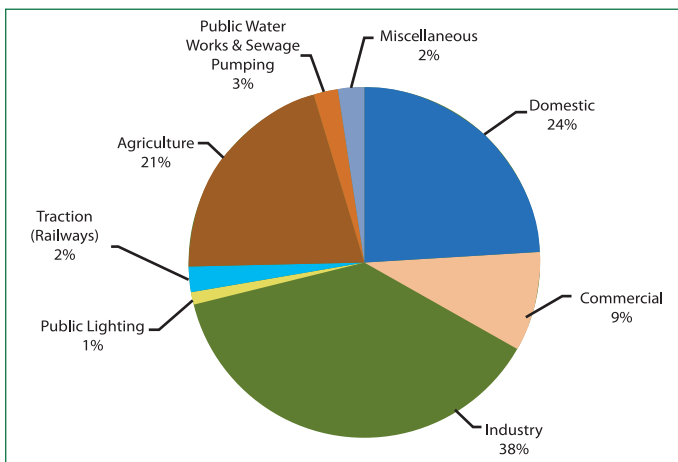
India is facing formidable challenges in meeting its energy needs. As per the Planning Commission's Integrated Energy Policy Report (Planning Commission 2006), if India perseveres with sustained growth rate of 8% per annum, its primary energy supply will need to grow by 3 to 4 times, and electricity generation capacity/supply by 5 to 6 times compared to 2003-04. It is estimated that by 2031-32, the country's power generation capacity of 800,000 MW would be required as against the installed capacity of 160,000 MW inclusive of all captive plants in 2006-07. Central Electricity Authority (CEA) has estimated that the country is currently facing electricity shortage of 9.9% and peak demand shortage of 16.6% (CEA 2009). Figure 1 shows continuous widening gap between electricity demand and actual achievement in the country.



Source: Adapted from Central Electricity Authority, All India Electricity Statistics-General Review 2006 and 2009, and Planning Commission's Integrated Energy Policy Report 2006

**Figure 1:** Electricity generation capacity and achievements in India

While it is essential to add new power generation capacity to meet the nation's growing energy requirements, it is equally important to look out for options that will help in reducing energy demand for various end-use sectors. Figure 2 shows electricity consumption in various sectors in India. Domestic and commercial sectors account for approximately one-third of total electricity consumption and these sectors are likely to consume around 37% of electricity in 2020-21. It is therefore, critical that policy interventions are put in place to improve energy efficiency in both new as well as existing buildings in these sectors.



Source: Adapted from Central Electricity Authority, All India Electricity Statistics. General Review 2009

**Figure 2:** Electricity consumption in various sectors in India

Around the world, there are many initiatives to improve energy performance of buildings with names such as “net zero energy”, “zero net energy” or “net zero carbon” buildings. Although these terms have different meanings, several countries have adopted this broad vision as a long-term goal for developing energy policies and programs related to the building sector. India has already identified buildings as one of the sectors in its fight against climate change. However, a long-term policy initiative that encourages the development of cutting edge research and cost-effective technologies can bring about step changes in the energy use in buildings.

## CONTEXT

To give impetus to energy conservation in the country, Government of India enacted the Energy Conservation Act (EC Act), which came into force on 1st March 2002. Under the Act, Government of India established the Bureau of Energy Efficiency (BEE) in March 2002, a statutory body under the Ministry of Power, Government of India. The EC Act directs BEE to spearhead improvement in energy efficiency through various regulatory and promotional measures. The EC Act has empowered the Government both at the Central as well as at the State level to put in place a legal framework that could help in creating an institutional set-up that promotes energy conservation in the country, and also helps in monitoring the efforts to meet the energy saving targets and energy intensity of the economy.

Under the Prime Minister's National Action Plan on Climate Change, the Government has launched eight national missions, out of which following three missions can promote higher energy efficiency levels in the buildings:

- National Mission on Enhanced Energy Efficiency
- Jawaharlal Nehru National Solar Mission
- National Mission on Sustainable Habitat

Refer Appendix 1 for more details on these Missions.

## BUILDING SECTOR

Residential and commercial buildings account for about 33% of the total electricity used in India.

The residential buildings consume 24% of total electricity consumption in the country which can be attributed to higher disposable income and better access to finance for purchasing home appliances among the households. This is leading to substantial growth of electricity consumption in recent years. On an average 45% of electricity in this sector is being used for space cooling and thermal comfort using air conditioners, fans and evaporative coolers; while lighting accounts for 28%. As per McKinsey, India had residential floor space of 8 billion square meters in 2005, which is expected to touch 37 billion square meters in 2030. Considering ever widening gap between electricity demand and supply, as being seen currently in the country, meeting electricity demands of the residential buildings in the coming years could be very challenging.

The commercial buildings sector which comprises of the office buildings, hotels, hospitals, educational institutes, retail malls, etc., consumes 9% of total electricity consumption in India. This sector has experienced electricity consumption growth rate of 12-14% in recent years which is attributed to the increasing electricity consumption in the existing buildings as well as increasing energy

intensity of newly constructed commercial buildings. ECO-III Project has estimated that in the year 2010 commercial buildings had a built up area of 0.65 billion square meters, and this is expected to grow to 1.9 billion square meters in 2030. This means that about 66% of commercial building stock that will be there in 2030 is yet to come up in the country. Appendix 2 gives an overview of building sector in India.

There have been landmark initiatives by the Government of India for improving energy efficiency in commercial buildings. The Energy Conservation Building Code (ECBC) launched by the Government of India under the Energy Conservation Act 2001, for voluntary adoption in the country, sets minimum energy performance standards for commercial buildings. BEE has also developed a Star Rating Program for existing commercial buildings, which is based on actual energy performance of the buildings, expressed as an Energy Performance Index (measured in terms of annual electricity consumption per unit of built up area).

Given the constraints in enhancing electricity generation capacity and over-dependence of fossil fuels for electricity needs, there is a pressing need to go beyond driving incremental increases in energy efficiency in buildings. Development of a new set of policies are needed to enhance energy efficiency initiatives and promote on-site generation of electricity through renewable sources for captive use in the buildings.

## NET ZERO ENERGY BUILDING - DEFINITION

A variety of definitions and descriptions exist in discussions on low- and zero-energy buildings. For the purpose of this document, the ECO-III Project starts with the definition for 'Net Zero Site Energy' used by Torcellini et al (ACEEE 2006) - a building that "... produces at least as much energy as it uses in a year, when accounted for at the site", but adding an important qualifier of renewable energy to the energy production on site, as well as an emphasis on energy efficiency. This reframes the definition as under:

A Net Zero Energy Building (NZEB) is defined as a highly energy efficient building which on annual basis consumes as much energy as it produces energy at site using renewable energy sources. In other words, a building is said to be a NZEB, when the difference between its annual total energy consumption and its annual on-site energy generation through renewable sources is zero.

Currently buildings are highly dependent on energy supplies from the utilities. For a building to qualify and reach the status of a NZEB requires substantial reduction in its energy consumption (derived from fossil fuels) by incorporating several energy efficiency measures at the design stage, and simultaneously equipping itself to generate its own energy at site through renewable energy sources to meet its remaining energy requirements.

## NZEB VISION

The overarching vision that this strategic roadmap is conceived with is that, from 2030, all newly constructed buildings in India must be NZEBs as defined above. This strategic roadmap is essentially aimed at answering the question—"What needs to be true so that, from 2030, all newly constructed buildings in India are built to be NZEBs?" The roadmap goes about answering this question by setting progressive targets that build towards the achievement of this vision. Additionally, the roadmap also examines the barriers that exist, and proposes how these barriers should be tackled, through stakeholder engagement and policy interventions. The

roadmap provides a number of recommendations and also suggests milestones, which need to be achieved on NZEB path for realizing the vision.

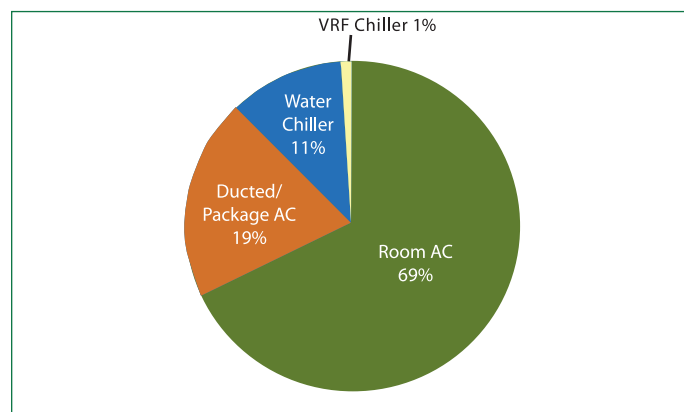
## DESIGNING FOR NZEB

Designing of a NZEB typically requires successful integration and optimization of several architectural concepts and strategies such as building orientation with respect to sun path, natural ventilation, solar shading, day-lighting, solar heat gains, thermal comfort as well as deployment of well proven insulation practices, energy efficient glazing, air conditioning and lighting systems, and incorporation of renewable energy technologies for on-site power generation.

There is a growing realization internationally that major breakthroughs in reducing energy use in buildings will entail combining whole-building design approaches with state of the art energy-efficient technologies (e.g. super-efficient building envelope, low-energy comfort air conditioning and lighting systems, advanced metering and control systems, etc.) and on-site renewable energy technologies (e.g. building integrated photovoltaic, solar thermal, etc.).

Looking into the current trends, cooling load is going to be major energy consuming component particularly in air conditioned commercial buildings such as large private establishments and public sector/government offices, high end hotels, multi specialty hospitals, shopping malls, etc. in the State capitals and other major cities falling particularly in warm-humid and composite climate zones.

Cities falling under hot-dry climate zone however may have the option of using evaporating cooling and ceiling fans to meet thermal comfort in the buildings. Water availability could be an issue in some cities. Figure 3 indicates the use of air conditioning systems in India.



Source: 2007 Sales Data from Emerson Climate Technology

Figure 3: Market share of different types of AC units in India

Lighting requirements are also likely to rise due to higher demands for general lighting levels, task specific lighting requirements, and generally the needs for good visual comfort as well as improved productivity.

Basic issue for the building owners and users is related to inadequate availability of electricity supply from the utilities. Captive power generation through diesel/gas generation (DG/GG) sets among the commercial establishments has become a norm. The research and technological advancements worldwide have, however, shown that efficient harnessing of on-site solar energy, and energy from wastes in urban areas can gradually pave the way for NZEBs in next two decades, if pursued with strong commitment.

Three focus areas discussed below which need to be recognized and pursued by the building designers and developers' community for leading the NZEB path. These need to be supported, however, by appropriate policy and commitment from the Government.

## Designing for Solar Passive Building Envelope

While planning and development of newer townships and newer real estates such as commercial and institutional complexes, residential colonies, large shopping malls, etc., it is important to give sufficient attention to the following measures to reduce solar heat gain and improve day lighting level in the buildings:

1. Planning site orientation preferably with longer axis of the buildings to be in east-west direction, as far as feasible
2. Designing building fenestration with low window-wall ratio (preferably less than 40%) having lesser windows on south and west
3. Placement of large windows on north side of façade to enhance daylighting in the building
4. Adoption of horizontal shading devices (overhangs and louvers) on windows on south side, and vertical shading devices (side fins and louvers) on east and west side of building façade
5. Enhancement of use of natural and cross ventilation of air within the building
6. Planting of trees and vegetation around the building, wherever possible, to block direct solar radiation falling on the building

## Designing for Energy Efficiency

Once the above considerations are taken care of, following energy efficiency measures need to be integrated judiciously in the building design through whole building design approach:

### *Reduction of cooling load requirements*

1. Reduction of heat gains (external heat load) in building through windows, roof and walls by:
  - a) Using energy efficient windows (with glazing having low SHGC, U-factor and high VLT, and window frame material having low thermal conductivity)
  - b) Application of 'cool roof' (specialized coatings/paints with high solar reflectance and high solar emittance) on roof tops and terraces
  - c) Application of insulation materials on roof and walls (having high R-value or low U-factor)
2. Reduction of internal heat gains within the building: Building equipment and appliances such as, lighting systems, computers, photocopiers, IT servers, UPS, water coolers, refrigerators, fans, etc., generate heat and add to the cooling load requirements. Energy efficient systems not only consume lesser energy but also generate lesser heat.

### *Deployment of energy efficient air conditioning and cooling technologies*

1. Adoption of cooling systems and technologies with higher COP or EER such as variable refrigerant flow, radiant cooling, etc.
2. Utilization of vapor absorption chillers using waste heat from DG/GG sets
3. Adoption of energy efficient evaporating coolers, wherever

feasible

4. Utilization of efficient ceiling fans for temperate climate zones as preferred option over conventional air-conditioning systems

### *Reduction of lighting load*

Encouraging developments in energy efficient lighting technologies and control systems have been seen in recent years. However their penetration in real situations has not occurred. Rigorous adoption of following measures is crucial:

1. Enhancement the use of energy efficient CFLs and TFLs (T5) which have higher lamp efficacy over Incandescent Lamps and TFL (T12) for general lighting in buildings. Lamps based on LED technology which is likely to make a major impact in lighting load reduction strategy, need to be utilized wherever feasible
2. Optimization of general lighting and task lighting requirements
3. Integration of daylighting with interior lighting systems through efficient sensors and controls
4. Deployment of Low Pressure Sodium Lamp with high lamp efficacy for exterior lighting

## Designing for Renewable Energy

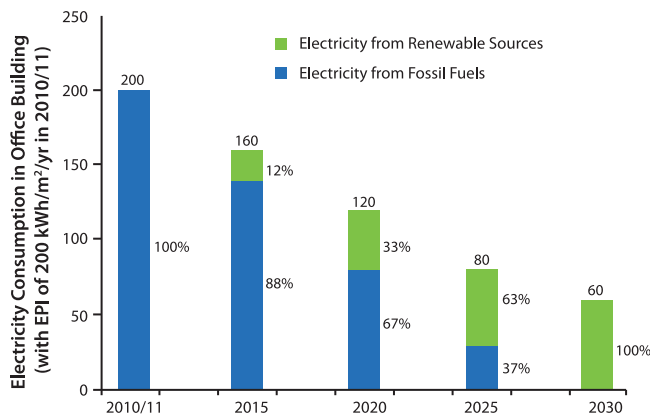
1. Designing buildings with Solar PV System on building roof/terrace, while ensuring availability of required space for solar panels
2. Inclusion of Building Integrated PV system particularly on south facing building façade
3. Selection of Solar PV modules with high efficiency of solar panels. Currently mono crystalline cells (230 Wp or more) with solar panel efficiency (13% or more) are available in the market. Extensive research has been going on world-wide to produce modules with efficiencies more than 20% for commercial applications
4. Deployment of solar water heating systems in hospitals, hotels, which need hot water throughout the year
5. Generation of on-site electricity from locally available wastes for meeting building's own electricity requirement

## NZEB TARGETS

Commercial buildings can be classified into number of categories depending upon what functions are being carried out in the building. Broadly these can be categorized as office buildings, hotels, hospitals, shopping malls, universities/schools, convention centres, call centres, data centres, etc. Energy consumption in each one of these could vary significantly from others. Also within the same category, energy consumption in different buildings, can also vary substantially depending upon the energy intensiveness of facilities deployed and services offered, and to what extent the working space in the building is air conditioned.

For instance, the energy consumption per unit built up area of a multi-specialty hospital could be many times that of an unconditioned or partially air conditioned government hospital. Same is true for office buildings. Well organized compilation of buildings' energy data in the country is still in infancy. Thus fixing a specific NZEB energy consumption targets for each category of the buildings becomes a complex task. However considering an example of a typical office building having entire built up area being fully air conditioned, the electricity consumption can

be considered as 200 kWh/sq.m/year. This is broadly based on data generated by BEE, ECO-III Project and other institutions. Figure 4 depicts how the NZEB target path of office buildings of such category should perform, giving emphasis on gradual reduction of their overall energy consumption. It also shows how the rising share of electricity generated from renewable energy sources should replace the share of electricity drawn from the utility in a span of twenty years.



Source: USAID ECO-III Project, 2011

**Figure 4:** NZEB targets for electricity consumption in a typical office building (fully air-conditioned)

## BARRIERS ON NZEB PATH

To promote the concept of NZEB, the ECO-III Project in association with BEE and CEPT University organized two Roundtables, one on “Technologies for Net Zero Energy Buildings” in May 2011 at New Delhi and another on “Net Zero Energy Buildings: Concept to Completion” in July 2011 at CEPT University, Ahmedabad. The Roundtables were very well attended by various stakeholders, viz., technology manufacturers and suppliers, architects, engineers, building designers and developers, etc. Based on interactions and inputs received from the stakeholders, the following barriers on NZEB path have been identified.

- 1. Limited awareness on the concept of NZEB:** The general concept on NZEB is gaining importance and recognition in the developed countries though its definition and interpretation vary from country to country. For promoting NZEB, there is a need to define first NZEB for the country in easy to understand terms. This will help various stakeholders to address various aspects and issues related to NZEB on a convergent perspective.
- 2. Policy and Program on NZEB not existing:** Government has taken a number of initiatives to improve energy efficiency in commercial buildings in last couple of years. As mentioned earlier, these include development of ECBC and Energy Star Rating Program for commercial buildings promoted by Bureau of Energy Efficiency and Ministry of Power. The Ministry of New and Renewable Energy has been promoting renewable energy systems including technologies for electricity generation from wind power, solar energy and bio-mass by providing several financial subsidies in India. However so far there has not been any specific policy or a well defined government program to integrate these initiatives and promote a common NZEB strategy for the country.
- 3. Market for commercial NZEBs does not exist:** Construction business is driven by short-term profits where building construction cost is an important factor affecting the management decision. Financial benefits of NZEB are mainly for the building users. Building developers and construction companies do not see this as a specific advantage for them for developing NZEBs. There is also no demand for NZEBs from the Government for the construction of their own and public sector buildings. The building users from private sector also find difficult to understand and see any short term or long term financial gains for going for NZEBs.
- 4. Absence of public awareness on residential NZEBs:** Government has been quite successful in promoting energy efficient home appliances such as air conditioners, refrigerators, ceiling fans, etc. in the household sector through its on-going energy star rating program. However the developers of multifamily residential building complexes and individuals who intend to build their homes are not aware of energy efficient architectural guidelines and renewable energy opportunities which can fit effectively into their buildings’ functional requirements. Therefore such efficiency measures do not get incorporated at the design stage.
- 5. Higher costs of EE and RE technologies for NZEB:** A range of advance energy efficient technologies and systems for buildings, initially developed in other countries, are being made available by a few vendors for the indigenous construction industry. However their higher first cost over the conventional building material and systems impedes their penetration in real situations. Similarly renewable energy technologies even though not difficult to procure from indigenous vendors, are normally seen as high cost cosmetic technologies. These technologies are yet to find their place in building design despite several fiscal incentives being offered by the Government to the building owners. The building developers and designers on the other hand, because of their insufficient experience and doubt on energy performance generally do not promote these technologies in their building designs unless the building owners demand and agree to pay higher initial cost towards the construction of the building.
- 6. Limited design expertise in the market:** There is inadequate knowledge and expertise on NZEB concepts amongst majority of building designers and architects on upcoming energy efficient building materials and technologies, solar passive architecture, and lack of knowledge and working experience on renewable energy systems. Thus the designer community is not proactive in promoting NZEBs. Lack of motivation and inclination of architects to learn something new and highly technical subject such as NZEB remains a major barrier.
- 7. Lack of specialized energy simulation and modeling skills:** Designing of a NZEB typically requires successful integration and optimization of several architectural concepts, deployment of energy efficient technologies and renewable energy technologies. This integration and optimization process essentially requires computer based energy simulation and modeling tools and associated specialized skills to evaluate multiple options and assessment of building’s performance at the design stage. A number of



energy simulation softwares are available in the market but there are a very few professionals in India who have the requisite energy simulation expertise that can assist large pool of practicing architects and engineers in developing good NZEB designs.

**8. Management constraints among collaborating partners:**

Construction of NZEB is not likely to be a construction as usual. The primary construction company is required to involve number of specialists and multilevel subcontractors. An effective monitoring of their performance and taking corrective actions could become very complex. This can cause functional and communication gaps among the project team partners leading to management disruptions in the construction delivery process. Thus despite ensuring the availability of number of experts and professional islands in the form of collaborating partners, monitoring and achievement of common objectives and goals of NZEB project can be very challenging.

**9. Inadequate implementation services for on-site integration:**

Usually vendors supply and install their technologies and systems individually, and this normally leads to a piecemeal approach, poor workmanship and inadequate holistic integration at the project site. Such practices can reduce the potential of energy efficiency and on-site energy production resulting in limited gains and unsatisfactory experience.

**10. Inadequate technology and products testing facilities:**

Many manufacturers tend to claim higher performance of their technologies and products, and these are difficult to evaluate at the design and procurement stage because requisite testing and certification facilities are practically non-existent in the country, keeping in view the actual needs. This requires extensive financial support and human resources development to create and manage such facilities.

## DEVELOPMENT OF CONSORTIUM ON NZEB

Keeping in view above barriers on NZEB and for realization of potential benefits, there is an urgent need to put together a dedicated group representing various stakeholders that have the knowledge, experience, and the expertise to make this happen. In this context, it is advisable to establish an Academia-Industry-Government Consortium (an enhancement of the Public-Private Partnership model) to bring together all the stakeholders including technology providers to promote a well directed NZEB program, build knowledge base and develop expertise in the country to pursue large scale development of NZEBs in the coming years. The vision of the Consortium should be that “all new buildings constructed in India after 2030 are Net Zero Energy Buildings”, even though this vision appears to be very ambitious at present.

The Consortium needs to be planned to provide an active forum to address NZEB barriers and catalyze appropriate actions at all concerned levels for next two decades. However in the initial period of five years, the Consortium needs to focus its efforts in achieving the following objectives:

- Concepts and process of development of NZEBs are widely disseminated amongst the stakeholders
- Energy efficient and renewable energy technologies are integrated in NZEB designs
- Policies and Programs on NZEB are initiated by the Central/

State Government

- Monitoring mechanism of NZEB Program is put in place and made functional at the State and/or Central level

To spearhead the NZEB Program in India, it is important to identify an independent institution to act as a Centre on NZEBs that drives the functions of the Consortium. The Centre for Sustainable Environment and Energy at CEPT University which is a leading institution on buildings could possibly be the potential candidate for the Centre. The University already hosts the Regional Energy Efficiency Centre for Buildings established in 2010 under a bilateral program between the Government of India and USAID. It also has Building Energy Performance Lab which has been developed with financial support from MNRE, Glazing Society of India and USAID.

## ROLE OF STAKEHOLDERS

### Government: NZEB Policy and Program

The Government at the Central as well as at the State level need to form a unified policy and program towards NZEBs, giving its enhanced commitment towards integration of energy efficiency and renewable energy at the design stage of the buildings. The Government also needs to establish NZEB targets for commercial and residential building sectors. Government also needs to promote and endorse the constitution of NZEB Consortium. It needs to support the design and construction of NZEB buildings belonging to the government and public sector as well as the building developers in the private sector. To demonstrate its commitment, it should initiate pilot projects in new government buildings in different States and also facilitate private builders in doing so through the enhancement of existing fiscal incentives. These could include specific tax rebates, reduced excise and import duties on efficient technologies, differential energy tariffs to the building owners/users, reduced capital costs and interest rates, etc. It also needs to support R&D initiatives that have potential to assist faster development of NZEBs in the country.

### Private Sector: Building Industry

Builders, building owners and users can be the most influential in driving the way buildings are designed, built and operated. This stakeholder group needs to be engaged to participate in pilot projects. Building equipment manufacturers and suppliers need to be involved to ensure that they bring in cutting edge technologies and materials which can substantially reduce energy consumption and enhance on-site power generation. Supportive partnerships with individual companies as well as industry associations through the proposed Consortium can play a major role in undertaking pilot projects.

### Academic & Research Institutions

These institutions can assist in creation of newer generation of architects and engineers through academic and professional education, also facilitate in capacity building programs for the practising architects and building construction community at various levels. In association with proposed Consortium, these institutions can also undertake specific market and policy level studies and enlighten various stakeholders involved in the NZEB Program and provide their technical services in development of pilot projects. They can also be involved in continuous monitoring and dissemination of information on the developments taking place in different countries on NZEBs, through workshops, conferences, etc.

## RECOMMENDATIONS ON STRATEGY ROADMAP FOR NZEBs

1. Government of India should state country's definition of "Net Zero Energy Building". It could possibly consider the definition given by ECO-III Project, which is restated below:
 

"A Net Zero Energy Building is defined as a highly energy efficient building which on annual basis consumes as much energy as it produces energy at site using renewable energy sources". In other words, a building is said to be a NZEB, when the difference between its annual total energy consumption and its annual on-site energy generation through renewable sources is zero.
2. Government of India should constitute an inter-ministerial coordination mechanism, a unified policy and a national program and targets on NZEBs involving Bureau of Energy Efficiency, Ministry of Power, Ministry of New and Renewable Energy as well as the Ministry of Urban Development.
3. A national level NZEB Consortium with an overall objective of promoting NZEBs needs to be created in India to actively involve and encourage architects, consultants, builders, technology providers and other stakeholders. The Consortium is proposed to be housed in CEPT University, an independent institute which has been working in buildings and energy efficiency for the last many years. The CEPT University, in consultation with Government of India should constitute a high level 'Advisory Committee on NZEB', involving policy makers, eminent specialists and domain experts to give a national perspective to the NZEB Program.
4. A NZEB Steering Committee at CEPT should be constituted to overview, guide and monitor the functioning of the Consortium periodically. Consortium should drive its functions by getting financial support from the Central/State Government, private sector membership and funding from the bilateral/multilateral agencies, international foundations, etc.
5. Government of India needs to review the existing fiscal incentives on advanced renewable energy technologies for

### MILESTONES ON NZEB PATH

Year	Milestones
2011	<ul style="list-style-type: none"> <li>• Government of India (GOI) recognizes NZEB concepts and formally takes initiatives to develop a roadmap to achieve the proposed NZEB vision by 2030</li> <li>• Ground work is started for forming NZEB Consortium – comprising of key stakeholders from private sector, government, and academic institutions</li> <li>• Process for identifying potential government buildings and private buildings for undertaking NZEB pilot projects is started</li> </ul>
2012	<ul style="list-style-type: none"> <li>• A Government directive that announces that by 2030, all new buildings are to be NZEBs, is put in place. This announcement includes intent to move in this direction by 2030 through a well drawn NZEB roadmap</li> <li>• NZEB Consortium is in place – engagement with all key stakeholders is well under way</li> <li>• National level NZEB roadmap till 2030 including 5-year NZEB targets is in place</li> <li>• GOI reviews the existing fiscal and financial incentives on energy efficient technologies and renewable energy technologies from NZEB perspectives</li> <li>• First set of 4-5 pilot projects (Government buildings) are identified, and design process for pilot projects starts</li> <li>• First set of 4-5 pilot projects (Privately owned buildings) are identified, and design process for pilot projects starts</li> </ul>
2013	<ul style="list-style-type: none"> <li>• GOI issues newer fiscal/financial incentives and policies that promote NZEBs</li> <li>• Pilot projects are under implementation</li> <li>• A few pilot projects start being operational</li> </ul>
2015	<ul style="list-style-type: none"> <li>• All identified pilot projects are constructed and are made operational for demonstration</li> <li>• Experiences including achievements of targets are documented and disseminated</li> <li>• On the basis of experiences, newer set of incentives and support are introduced by GOI</li> <li>• Second set of new 4-5 pilot projects (with higher efficiency levels in comparison with the first two sets) each from the government and private segments identified, and design process starts</li> </ul>
2020	<ul style="list-style-type: none"> <li>• Second set of pilot projects are made operational</li> <li>• Experiences and achievements of targets are documented and disseminated</li> <li>• Third set of pilot projects with higher emphasis on energy efficiency and renewable energy are initiated</li> <li>• GOI starts the process of mandating that all new buildings that constructed in 2030 onwards are to be NZEBs</li> </ul>
2025	<ul style="list-style-type: none"> <li>• Third set of pilot projects are operational, experiences and achievements documented and disseminated</li> <li>• Fourth set of pilot projects which are designed almost very close to NZEB are identified and initiated</li> <li>• GOI enforces the mandates that all new buildings constructed after 2030 are NZEBs</li> </ul>
2030	<ul style="list-style-type: none"> <li>• Fourth set of pilot projects are operational, experiences and achievements documented and disseminated</li> <li>• Stakeholders are fully equipped to meet GOI mandates on NZEB</li> <li>• Construction of NZEBs becomes a norm in reality</li> </ul>

power generation as well as energy efficient technologies pertaining to buildings primarily with a view to promote newer time bound policies and schemes to give impetus for the construction of NZEBs in India. The Government should gradually withdraw these when the cost of these technologies come down due to higher off take in the market and paybacks on investments on such technologies and systems become commercially attractive.

6. The Government (Centre/State), to demonstrate its commitment towards NZEB path, and acquire first hand experience, should initiate 4-5 pilot projects in the on-going 5-year span (ending 2015) in different cities/states possibly in different climate zones for constructing government buildings. These buildings should be designed primarily to reduce overall energy consumption through energy efficiency measures while ensuring that on-site power generation through renewable energy sources replaces significantly energy derived from fossil fuels. For every subsequent 5 year period, 4-5 pilot new projects should be promoted with higher levels of energy efficiency and higher reliance on on-site power generation.
7. The Government should engage, collaborate and mainstream concerned stakeholders such as major building/real estate developers, most prolific architecture firms and building owners from the private sector who are willing to incorporate NZEB concepts and design features in their upcoming commercial buildings (e.g hotels, hospitals, shopping malls, etc.) or high-rise residential buildings to undertake pilot projects. In next 5 years, the Government should facilitate such 4-5 pilot projects to construct commercial or residential buildings similar to the approach adopted for Government promoted pilot projects. This should be followed by 4-5 new pilot projects in every subsequent 5 year span.
8. Case studies on all pilot projects should be documented by the Consortium for wider dissemination of experiences.
9. Programs should be initiated to build capacity of building construction companies to equip them with specialized project management and execution services for effectively implementing NZEB projects in real situations.
10. Long term energy savings and self reliance on energy needs, and corresponding financial and environmental benefits of NZEBs should be identified and documented by the Consortium with Government support. These should be disseminated widely among all the stakeholders, including concerned Government organizations such as CPWD and state level PWDs, town planning departments, urban local bodies, private sector building developers, building designer and construction community, building equipment manufacturers, academic and research institutions, etc.
11. For public awareness, mainstreaming of well established architectural guidelines and best practices for net zero energy residential buildings and complexes should be promoted widely through awareness campaigns. Help desks should be created in various institutions for providing basic assistance to all concerned.
12. Large pool of professionals and young architects should be identified in the country and trained to run building energy simulation tools so that their services can be fruitfully utilized

by building designer community in designing NZEBs.

13. Government of India in partnership with the State Government need to take steps to develop suitable testing and certification infrastructure to facilitate faster development of NZEBs in the country. Financial assistance from concerned private sector entities and international agencies could be sought.
14. US, European Union and a few other countries have taken political and policy decisions to go for NZEBs in the coming years. Therefore it may be advisable for the Government of India should develop appropriate collaboration networks with them to acquire and share knowledge and experiences for mutual benefits. The Consortium can play a significant role in this activity.

## CONCLUSION

Commercial and residential sectors account for about one-third of electricity used in India. In the next 20 years, these sectors will add new floor space that will be twice and thrice respectively of what currently exists in these two sectors. Government of India in its fight against climate change has launched a national building energy conservation code to meet minimum energy performance in new commercial buildings. However, considering the relatively long lifespan of buildings, there is a pressing need to go beyond driving incremental increases in energy efficiency in the country. Newer vision, policies and programs coupled with constitution of a Stakeholders Consortium can ensure that all buildings constructed after 2030 will be NZEBs.

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## Jawaharlal Nehru National Solar Mission

The National Solar Mission is a major initiative of the Government primarily aimed to harness solar energy extensively in the country. The objective of the National Solar Mission is to establish India as a global leader in solar energy. The Mission targets are:

- To create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.
- To ramp up capacity of grid-connected solar power generation to 1000 MW within three years – by 2013; an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff. This capacity can be more than doubled – reaching 10,000MW installed power by 2017, or more, based on the enhanced and enabled international finance and technology transfer. The ambitious target for 2022 of 20,000 MW or more, will be dependent on the ‘learning’ of the first two phases, which if successful, could lead to conditions of grid-competitive solar power. The transition could be appropriately up scaled, based on availability of international finance and technology.
- To create favorable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.
- To promote programmes for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.
- To achieve 15 million sq. meters solar thermal collector area by 2017 and 20 million by 2022.
- To deploy 20 million solar lighting systems for rural areas by 2022.

The Ministry of New and Renewable Energy is the concerned Ministry to implement the Mission.

## National Mission on Enhanced Energy Efficiency

The National Mission on Enhanced Energy Efficiency (NMEEE) aims to reduce the energy intensity of India and in turn also reduce the carbon dioxide emissions. The NMEEE spells out following new initiatives for enhancing energy efficiency in the power sector and energy intensive industrial sectors which are termed and notified as ‘Designated Consumers’ under the Energy Conservation Act 2001:

- **Perform Achieve and Trade Scheme (PAT)** a market based mechanism to enhance cost effectiveness of improvements in energy efficiency in the selected Designated Consumers industries, through certification of energy savings that could be traded. The PAT mechanism plans to assign energy

efficiency improvement targets to the individual industrial units, with the provision of allowing them to retain any energy-efficiency improvements in excess of their target in the form of ‘Energy Savings Certificates’. Under performing units will be allowed to purchase these certificates to meet their energy saving targets.

- **Market Transformation for Energy Efficiency** includes accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable.
- **Energy Efficiency Financing Platform** allows for the creation of mechanisms that would help finance demand side management programmes in all sectors by capturing future energy savings.
- **Framework for Energy Efficient Economic Development** to develop two fiscal instruments to promote energy efficiency - the Partial Risk Guarantee Fund and Venture Capital Fund for Energy Efficiency.

Bureau of Energy Efficiency and Ministry of Power are responsible for implementing the Mission.

Under the EC Act, ‘Commercial buildings and establishments’ segment though has been identified as a ‘Designated Consumer’ but so far this segment has not been notified as ‘Designated Consumers’ by the Government.

## National Mission on Sustainable Habitat

National Mission on Sustainable Habitat (NMSH) also aims to make cities sustainable through improvements in energy efficiency in buildings, management of solid waste and shift to public transport. Mission aims to promote energy efficiency in buildings as an integral component of urban planning and urban renewal through following initiatives:

- **The Energy Conservation Building Code:** which addresses the design of new and large commercial buildings to optimize their energy demand, extends its application to the existing building stock through incentives
- **Recycling of material and urban waste management:** Development of technology for producing electricity from waste, R&D programmes focusing on bio chemical conversion, waste water use, sewage utilization and recycling options, wherever possible
- **Better urban planning and modal shift to public transport:** Making long term transport plans to facilitate the growth of medium and small cities in ways that ensure efficient and convenient public transport.

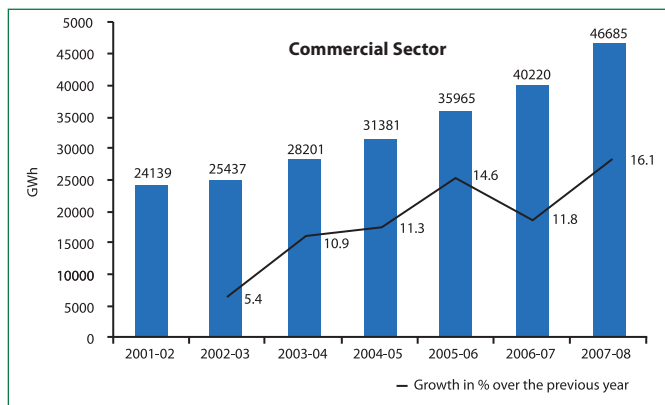
The Ministry of Urban Development is the concerned Ministry to implement the Mission.

### Commercial Building Sector

Commercial building sector in India is expanding rapidly at over 9% per year spurred largely by the strong growth in the services sector. Under the Energy Conservation Act 2001, Government of India launched Energy Conservation Building Code (ECBC) in 2007 for its voluntary adoption in the country. ECBC sets the minimum energy performance standards for “large commercial buildings” after taking into account the five major climatic zones of India. Once made mandatory, the state governments will be responsible for enforcing ECBC through local municipal authorities in the States, which also enforce building bye laws at the city level.

The Ministry of Urban Development (MoUD) owns the overall responsibility of implementing energy efficiency in buildings, including Energy Conservation Building Code (ECBC) under the National Mission on Sustainable Habitat.

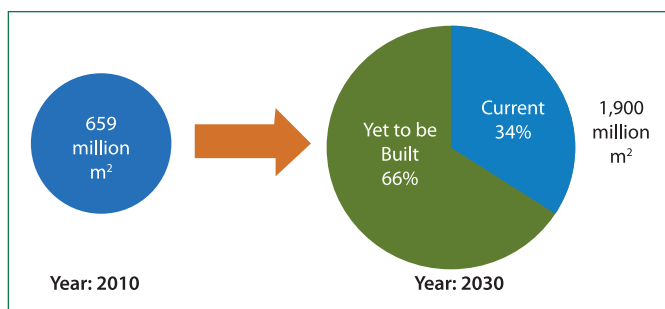
Figure 5 shows the growth in electricity consumption in commercial sector in India. The commercial buildings include office buildings, hotels, hospitals, educational institutes, retail malls, etc. According to CEA, electricity consumption in the commercial sector in India at present accounts for about 9% of the total electricity consumption in the country, but has shown a growth of 12-14% in last four years.



Source: Adapted from Central Electricity Authority All India Electricity Statistics. General Review 2006 and 2009

Figure 5: Growth in electricity consumption in commercial sector in India

This growth is attributed to the ever increasing energy consumption in existing buildings as well as increasing energy intensity of newly constructed commercial buildings such as air conditioned offices, multi specialty hospitals, luxury hotels, retail malls, data centres, etc., which are being built all over the country. Recent study by USAID ECO-III project has estimated total built up area of 0.65 billion m<sup>2</sup> of commercial buildings for the year 2010 that is expected to grow to 1.9 billion m<sup>2</sup> in 2030 assuming a annual growth rate of 5-6% (Figure 6).



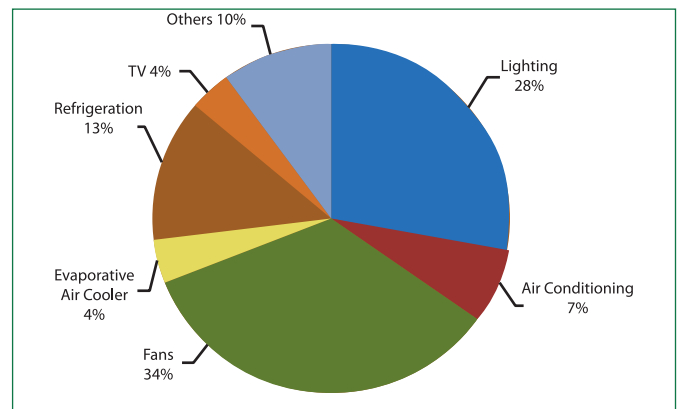
Source: USAID ECO-III Project, 2010

Figure 6: Projected growth in commercial buildings in India

This means that around 66% of building stock that will be there in 2030 is yet to come up in the country – a situation that is fundamentally different from developed countries – requiring a carefully crafted set of policy interventions to encourage energy efficiency in new buildings through a combination of regulatory and market mechanisms.

### Residential Building Sector

Residential sector consumes 24% of electricity consumption in India. Figure 7 shows India’s electricity use breakdown in residential buildings. On an average, space conditioning (cooling through air-conditioning units, fans and evaporative air coolers) accounts for 45% of total electricity consumption in the residential buildings, while lighting accounts for 28%.



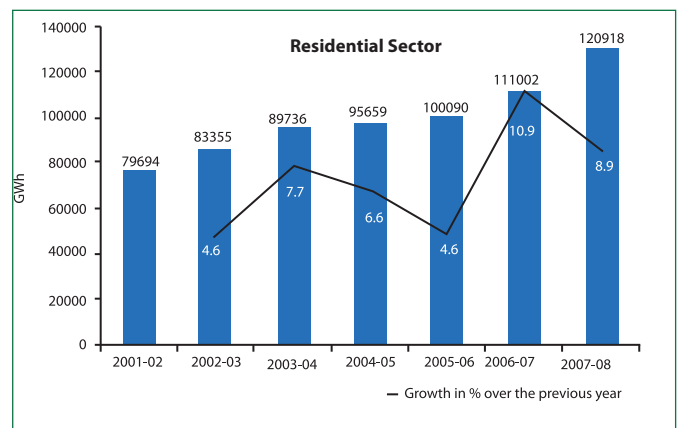
Source: LBNL, 2009

Figure 7: Electricity use in residential buildings in India

As per McKinsey, India’s residential floor space is expected to touch 37 billion square meters in 2030 against the 8 billion square meter estimated for 2005.

Figure 8 shows substantial growth of electricity consumption in the residential buildings in recent years. This can be attributed to higher disposable income and better access to finance for purchasing consumer durables including home appliances. Load shedding, by utilities has been forcing large residential complexes to have diesel power generation as stand by.

This highlights that the new residential buildings also need to be promoted for energy efficiency as soon as possible.



Source: Adapted from Central Electricity Authority, All India Electricity Statistics. General Review 2006 and 2009

Figure 8: Growth in electricity consumption in residential sector in India







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