

# **Green Growth and Buildings Sector: Punjab**

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# Green Growth and Buildings Sector: Punjab

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## 1 Introduction

Punjab is located in the North Western region of India and is bounded on the West by Pakistan, on the North by the state of Jammu & Kashmir, on the North East by Himachal Pradesh and on the South by Haryana and Rajasthan. As of 2011, Punjab has 22 districts and a population of 27.7 million.

The urban population in Punjab is concentrated in its four main cities, namely in Ludhiana, Amritsar, Patiala and Jalandhar, with high rates of rural –urban migration. There is an obvious demand-supply gap in physical/social infrastructure of the cities due to fast growth rate. Poor water and air quality is prevalent due to industrial activities. Deficit of electricity during peak demand periods continue to impact the state inspite of its several efforts on bringing down the transmission and distribution losses, energy efficiency and conservation measures through various programs/policies. The CEA estimates indicate that the deficits in peak electricity demand in Punjab can be as high as 14%.

The state lies in the sub-tropical belt and is situated in the North-west of Indian subcontinent. The climate is characterised by the extreme hot and extreme cold conditions. The region lying near the foothills of Himalayas receive heavy rainfall whereas in the region lying at a distance from the hills, the rainfall is low and the temperature is high. The average annual rainfall ranges from 580mm in the plains to 960mm in sub-mountain regions, and decreases from North to South. The temperature ranges from minus 2° to 40° C (min/max).

The vision envisaged to attain green growth in the building sector for Punjab includes the following:

- To have optimal utilisation of land especially in urban parts (which is growing rapidly).
- Enhanced use of passive design measures and optimal use of active measures for thermal comfort
- Nearly Net zero buildings (energy, water and waste) by 2047 for both new and existing buildings
- Supply of alternative native high performance low-cost materials to high embodied energy materials such as steel, cement, bricks, glass, etc.

Nearly net zero energy buildings (NZEB) is mentioned here as there are considerable constraints in having NZEB in cooling dominant climate and drastic changes in technology (energy efficiency and energy generation through renewables) is required. Other pre-requisites of green-growth development such as balanced regional development, improved urban planning, and development in other sectors of the economy are not covered here.



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## 2 Overview of Building Sector in the context of green growth

The average contribution of the construction sector in the Net State Domestic Product (NSDP) at constant prices in the last decade stood at 7.7 per cent. There was a slow growth registered in the post economic recession era similar to national and global trends).

Housing activities have both forward and backward linkages which not only contribute to capital formation, generation of employment, and income opportunities but also to economic growth. Investments in the real-estate sector have a positive and multiplier impact on allied industries, such as cement, steel, sand, timber, architecture, etc. Estimates show that every rupee invested in housing and construction adds 78 paise to the GDP (Cushman & Wakefield 2014).

Though housing prices have skyrocketed over the years in many cities and towns as per the National Housing Bank's RESIDEX index of residential prices in India across cities, few cities like Ludhiana (Punjab) witnessed a 16 per cent decline.

In spite of the state's efforts to provide potable water to the entire population, several issues related to quantity and quality prevails. Water pollution due to discharge of industrial waste water, untreated discharge of municipal waste water in some towns and leaching of chemicals from synthetic fertilizers and pesticides into the soil, causes both surface water and ground water pollution. Also, the state is facing fluoride, chloride, nitrate, iron, and uranium contamination in ground water in areas where over extraction is taking place and also the problems of salinity in the southern parts of the state.

Municipal solid waste management (MSW) in urban areas continue to be a big unresolved issue. The estimated MSW generation increased from 4395.6 tons/day to 5526 tons/day between 2001-2011 (GOP 2014)<sup>1</sup>.

Increasing urbanisation has aggravated the housing shortage issues. As of 2007, the urban housing shortage in the State was 6.90 lakh units (MoHUPA 2006) and requirement for 2007-12 was about 12 lakh additional units (PHHP 2008).

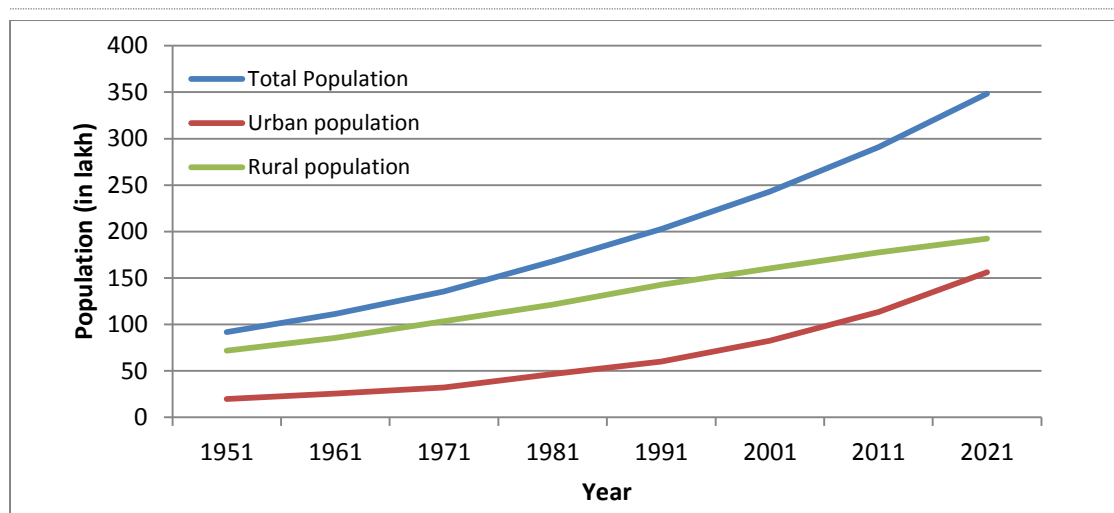
### 2.1 Urbanisation trends and Projected Demand for Real Estate Space in Punjab

India is a fast urbanising country. The urban population grew from 290 million in 2001 to an estimated 340 million in 2008 and is likely to increase to 590 million by 2030 (McKinsey 2010). Amongst the five states likely to be 50 per cent urbanised, Punjab stands at number five.

Figure 1 depicts the fast urbanising trends of the state. From 34% urban population in 2001 to 37.5% in 2011, the urban population is likely to increase to 47% by the year 2030.

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<sup>1</sup> Department of Science and Technology, Government of Punjab last assesses in February 2014



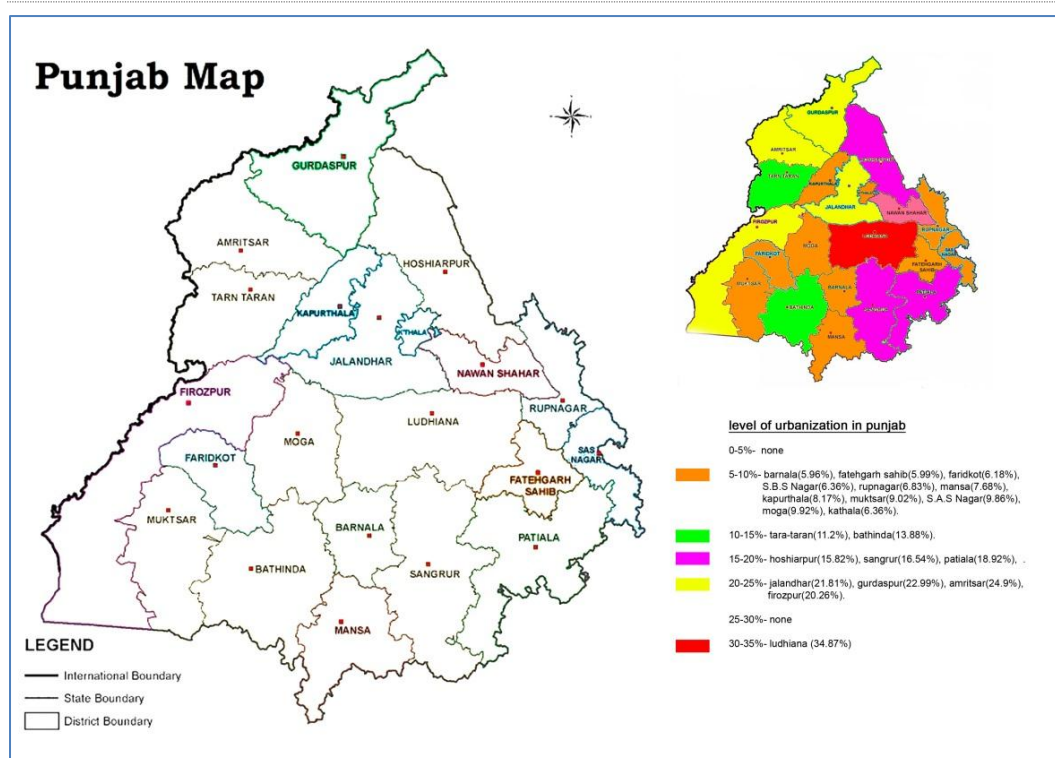
**Figure 1:** Urbanization trends in Punjab

**Source:** Census of India 1951,1961,1971,1981, 1991, 2001 and 2011

The annual compounded growth rate of the urban population is higher than that of the total population. The growth of urban population in the various size-categories of towns shows an interesting trend. Large cities and towns (class I and II) have been increasing at a faster pace with a larger population base (Planning Commission 2002).

Figure 2 depicts the level of urbanization in the state. The disproportionate increase in population in these towns in particular and in the other size categories in general has created huge deficiencies in such civic services, as water supply, sewerage, solid waste management and urban infrastructure, such as housing, transport and roads. Land is becoming scarce in towns and consequently the problem of housing is acquiring serious proportions. Provision of urban basic amenities and upgradation of existing infrastructure for additional urban population has become a challenging task.





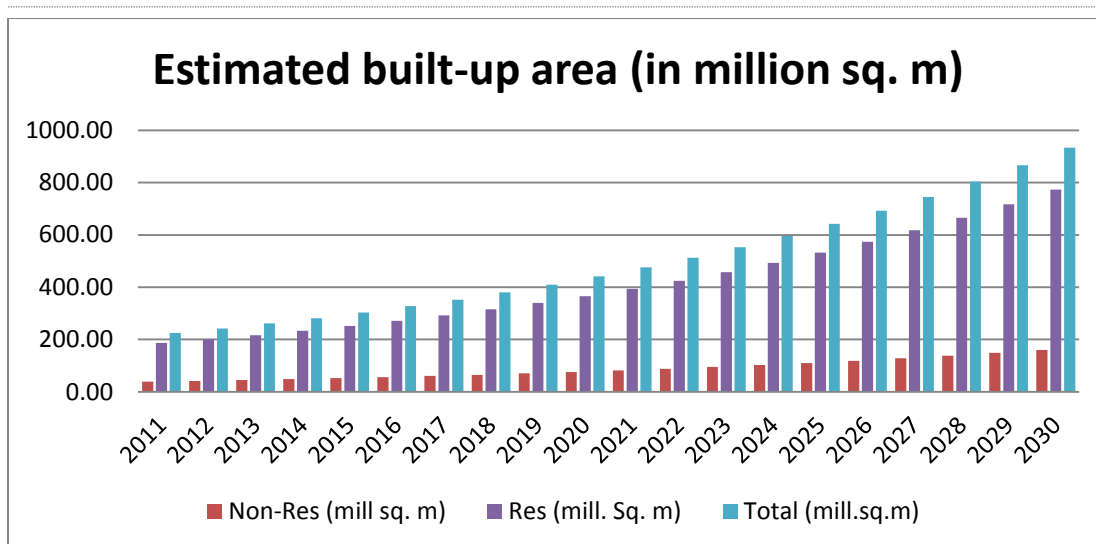
**Figure 2:** Level of urbanisation in Punjab

**Source:** GoP 2013<sup>2</sup> Regional disparities are observed in the state depicting varying levels of urbanisation (and development). Ludhiana is the most urbanised (in the centre) followed by Amritsar, Gurdaspur, Jalandhar and Ferozepur districts towards the west.

## 2.2 Built-up area projections

Similar to the data gap at the national level, there is a scarcity of data on built-up area for various building typologies or even residential and non-residential categories and the area added every year. However, based on NSSO and Census data, few assumptions on built-up area for non-residential categories, estimates have been made to establish the built-up area in 2011 and projections till 2030 (Figure 3).

<sup>2</sup> Based on presentation dated May 31, 2013, Sectoral discussions on Housing & Urban Poverty Alleviation, Govt. of Punjab)



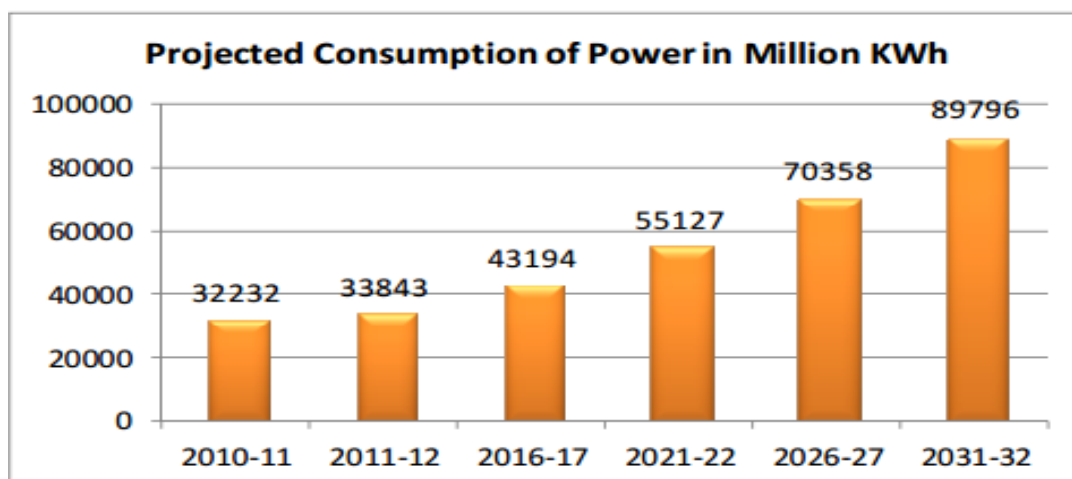
**Figure 3:** Estimated Built-up area in Punjab

**Source:** TERI’s projections

The real estate demand is likely to be led by the residential buildings, including affordable housing segment.

### 2.3 Key trends of electricity consumption in the Buildings sector

The compounded annual growth rate (CAGR) of electricity consumption in Punjab between 1990-91 and 2010-11 is estimated to be 5.1%. If it is assumed to grow at the same rate annually, then power consumption in the state is likely to increase from 32232 Million kWh in 2010-11 to 55127 Million kWh by 2021-22. Further by the end of 2031-32, it is likely to grow to 89796 million kWh. The electricity demand is rising sharply on account of rapidly increasing use of electrical energy for agricultural operations, progressive industrialization, urbanization, increasing affluence and intensive rural electrification programme.

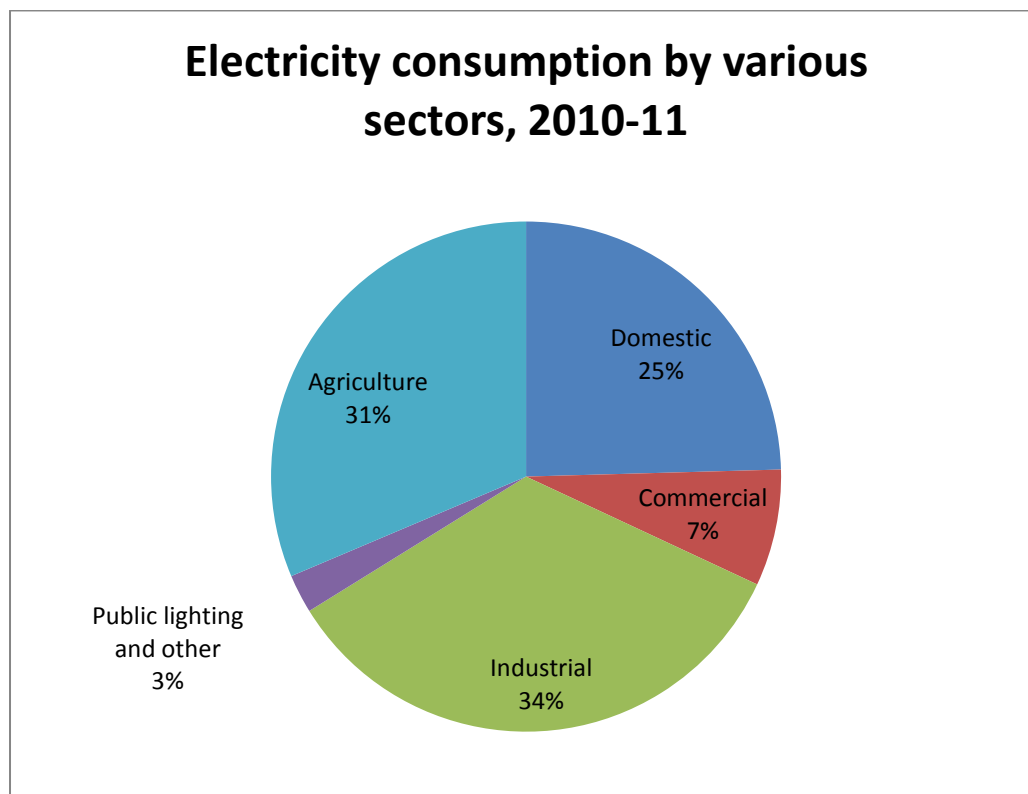


**Figure 4:** Electricity consumption in Punjab

**Source:** SAPCC 2014

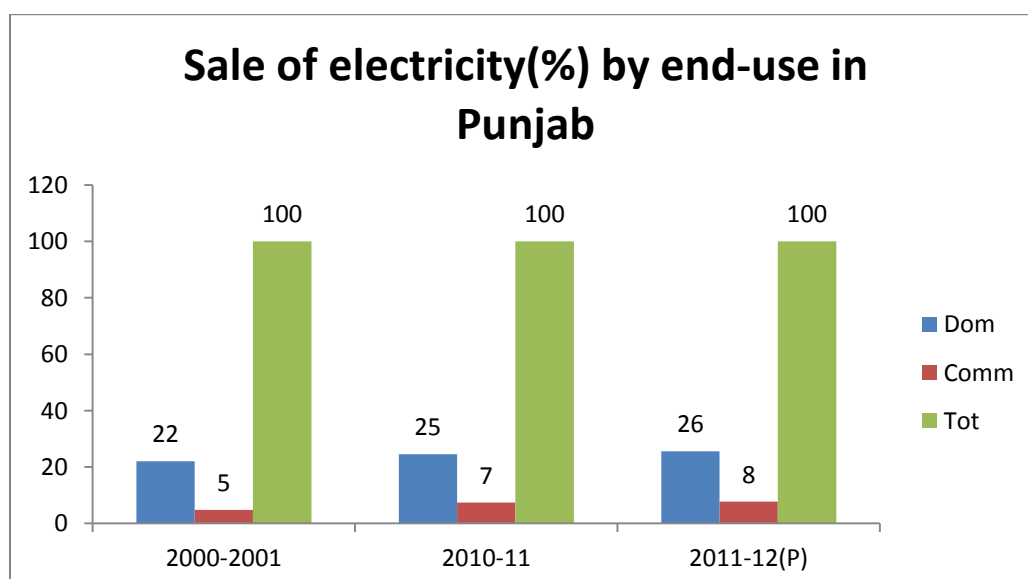
## 2.4 Electricity consumption by end-use

Buildings constitute a big proportion of electricity consumption (almost equal to consumption by the industrial sector, Figure 5). Within the building sector, domestic sector forms the bulk consumer and has been growing consistently (Figure 6).



**Figure 5:** Electricity consumption by end-use

**Source:** Punjab Statistical Abstract 2012

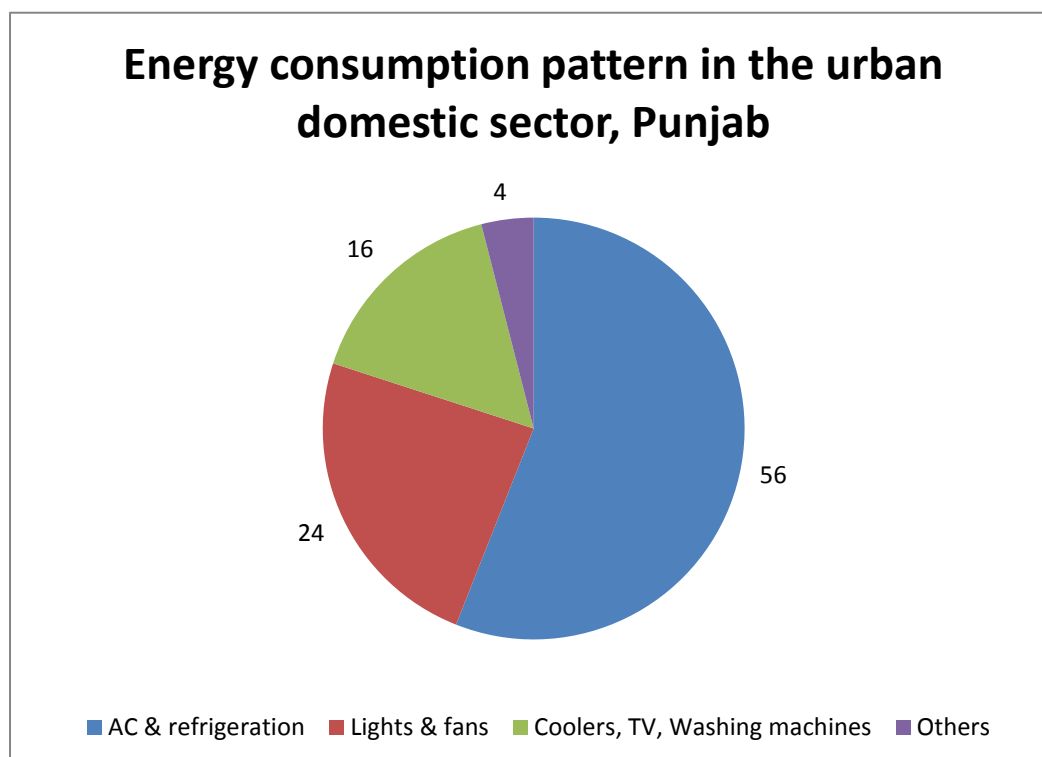


**Figure 6:** Electricity sale (%) in domestic and commercial sector

**Source:** Punjab Statistical Abstract 2012

## 2.5 Electricity Consumption Pattern in Residential Buildings

The residential sector accounted for 26% of the total electricity sales in 2011-12. Air-conditioning and refrigeration forms the bulk of the energy consumption in the sector followed by lights and fans (Figure 7). As per BEE estimates, the electricity saving potential (avoided electricity consumption potential) in Punjab by use of labeled appliances alone is 15-20 per cent (Jerath et al. 2014).



**Figure 7:** Energy consumption pattern in Domestic Sector

**Source:** BEE/ NPC 2009

## 2.6 Commercial sector

The annual electricity sale to commercial sector is estimated to be 2.82 Billion kWh in 2010-11. The commercial sector constitutes government & private establishments, hospitals, hotels, restaurants, educational institutions, malls etc. During the period 2007-08 to 2010-11, there was a 10% increase in commercial buildings drawing power over 500 KW. These together drew an amount of 453 MU from the grid, accounting for 14% of the total power consumption in the commercial sector in Punjab (GOP 2014)<sup>3</sup>.

## 2.7 Electricity saving potential

Although, the electricity saving potential of each option may vary with building typology, climate zone, space conditioning needs and the initial base design proposed by the client/designer, on an average it is estimated that the implementation of energy efficient

<sup>3</sup> Department of Science and Technology, Government of Punjab, February 2014

options would help in achieving around 30% electricity savings in new residential buildings and 40% (WBCSD 2008) electricity savings in new commercial buildings.

The biggest challenge to Net Zero Energy Buildings in composite zone is achieving a net zero energy status. An empirical study done for a typical daytime office building using best available technology for composite climatic zone shows that the best performance case gives an EPI of nearly 50 kWh/sq. m/year and a height of 1 floors (to have sufficient roof space for solar PV to generate enough power to meet the demand of the building). NZEB therefore is relevant for yet to be urbanised towns and cities, peri-urban areas or low-rise /day-time occupied buildings in such zones. Highly urbanised areas are coming up with high rise structures (given the scarcity of land in prime areas) where supplementing the entire energy demand with on-site energy generation through clean means is not possible for air-conditioned spaces. In such scenarios, the possible approach could be to increase the share of clean energy from renewable sources in the energy supply basket, achieve maximum energy efficiency in all buildings, utilise all possible open spaces (including available roof tops) for solar PV generation (given the universal feasibility of solar PV across the country). There is thus, an urgent need to give equal emphasis on the various urban planning issues from green growth perspective (including energy efficiency, energy generation, water and waste management, etc.) to have a realistic target of net zero settlements (and buildings).

### 3 Key Stakeholders engaged in Buildings Sector

Table 1 provides an overview of the key stakeholders of the building industry with a focus on stakeholders that have a significant role in promoting building energy efficiency in the state.

**Table 1:** Key stakeholders in buildings sector

Stakeholders	
<b>State Government Ministries/Departments/Boards</b>	Housing & Urban Development Department, Department of Science Technology Environment and non-conventional energy, PEDDA, PWD, Department of Planning, Punjab Pollution Control Board
<b>Local Governments</b>	Various line departments at district , city and town level
<b>Private Sector Building/Construction Organisations/service providers/Associations</b>	Developers, Architects, Consultants, facility managers, Energy Auditors, Service providers CREDAI-State Chapters and City Associations
<b>Financial Institutions</b>	HFC, Banks, MFCs
<b>Research &amp; Academia</b>	e.g., IIT Ropar, Thapar University, Punjab Technical University, Punjab Engineering College, Central University of Punjab, GuruNanak Dev University, Indian Institute of Education Science and Research

Source: TERI 2014

### 3.1 Housing and Urban Development Department

The department deals with the formulation and implementation of schemes like low income group housing scheme, subsidized industrial housing scheme, etc., and all matters related to the Punjab Regional and Town Planning and Development Board, 1995. Apart from the Housing department, there are three Development Authorities under this viz., Greater Mohali Area Development Authority, Punjab Urban Development Authority and Bhatinda Development Authority.

### 3.2 Department of Science, Technology, Environment and Non-Conventional energy

The Department of Science, Technology, Environment and Non-Conventional Energy has the responsibility of making arrangements for processing the new technology for agriculture and industry. It establishes a liaison with Research Institutions, National Laboratories, Universities and Department of Science and Technology of the Government of India. Under this department, there is one key organization (Punjab Energy Development Agency) which looks after energy efficiency and renewable energy integration in the building sector.

### 3.3 Punjab Energy Development Agency

To give focussed thrust to renewable energy sector, Govt. of Punjab set up Punjab Energy Development Agency (PEDA) in the year 1991. PEDA is presently the state designated agency of the Bureau of Energy Efficiency(BEE), Ministry of Power for Implementation of the Energy Conservation Act 2001.

PEDA is also the state nodal agency of the Ministry of New and Renewable(MNRE) Energy for promotion & development of Renewable Energy Program/Projects.

Thus, it is the key agency for implementing EE features and RE integration in the building sector (apart from looking at other sectors of economy).

### 3.4 Public Works Department

Public Works Department (Buildings and Roads) is a premier agency responsible for construction, upgradation and maintenance of roads, buildings and bridges in the state. Public Works department has been maintaining material database and has standardized the Specifications, common schedule of rates, confidential analysis etc. for adoption by all other departments, Boards and Corporations of the State Govt. (Revision of rates and Schedule of rates as per Punjab ECBC provision is under process).

The PWD (B&R) has been entrusted by the state Government to undertake primarily the following tasks as

- Construction & Maintenance of New Roads & Bridges,
- Design, Construction & Maintenance of Govt. buildings,

- Undertaking Deposit Contribution works relating to different Departments of Govt. of Punjab as well as of other Local Bodies,
- Fixation of rent of Private premises requisitioned for housing Govt. offices.

### 3.5 Department of Planning

The Department of Planning deals with all matters relating to the formulation; follow up, appraisal and readjustment of Annual Plans and Five Year Plans; and sub-plans for special areas. The department conducts business on all matters relating to coordination of plans of the administrative departments besides all matters pertaining to the Planning Commission, Government of India. The Department of Planning is also responsible for collection, compilation analysis and interpretation of Economic and Statistical data and coordination of Statistical activities of various departments in the state. The Department of Planning has two wings i.e. Punjab State Planning Board and Economic & Statistical Organization, Punjab.

### 3.6 Local Governments

The local governments at the city level that is the Municipal Corporation/ Municipality/ Development authorities formulate the Building bye laws for building construction within the city municipal limits.

### 3.7 Associations

The Confederation of Real Estate Developers Associations of India (CREDAI) is the apex body for private sector developers. As part of CREDAI Association, there are six city associations, viz., CREDAI Punjab, CREDAI Amritsar, CREDAI Bhatinda, CREDAI Zirakpur, CREDAI Ludhiana and CREDAI Jalandhar. The associations bring the connect of the developers with the government, policy makers, investors, financial institutions etc. and are considered to be a strong focal point for any major initiative in the building sector (e.g., green buildings initiative).

### 3.8 Developers

#### 3.8.1 Government

A significant proportion is also developed by the state ministries/ departments who construct buildings for their own usage or as part of their development plans- offices, housing colonies, hospitals, schools, universities. Various city development authorities and state housing boards play a significant role in planned and organized growth of cities. They are involved in planning, development and management of housing and commercial properties; urban restructuring and allotment of sites for public utilities. One of the main objectives of all development authorities and housing boards is to provide housing and basic amenities to the economically weaker sections of the society at an affordable price.



### 3.8.2 Private Developers and Builders

There are hundreds of private real estate developers and builders involved in real estate development and building construction projects in the state.

### 3.8.3 Public Sector Undertakings and Private Companies

A lot of construction is done by public sector undertakings and private companies to build buildings for their own usage.

### 3.8.3 Individual Plot Owners

Individual plot owners construct buildings for residential or commercial purposes on the plots owned by them.

### 3.8.4 Service Industry

The service industry comprises of various agencies and service providers like planners, architects, structural engineers, mechanical and electrical engineers, contractors, energy consultants, energy auditors, etc. Design and construction and maintenance of energy efficient buildings require an integrated effort from all the above mentioned agencies.

### 3.8.5 Electricity Utilities

There are several ways in which electricity utilities can contribute towards reducing the end-use electricity consumption in residential and/or commercial buildings. In Punjab, the Punjab State Electricity Regulatory Commission has introduced in 2012 regulations on Demand Side Management (DSM) and several provisions to promote energy conservation and efficiency, including financial incentives such as appropriate tariff interventions to support DSM.

### 3.8.6 Financing Institutions

This includes bank lending, private equity, foreign direct investments, external commercial borrowing and housing finance.

## 4 Existing Policies/interventions to promote green growth in Building sector

Several policies have been formulated by policy makers to mainstream energy efficiency and green buildings in the state. These policies directly or indirectly address the issue of building energy /green measures.

There are a number of policies on managing energy demand and supplementing supply through the use of renewable energy, which contribute to climate mitigation by reducing or avoiding GHG emissions. Many of these policies are contained in the Five Year Plans (FYP)



developed by the Planning Commission to guide economic policy in India (the 12<sup>th</sup> FYP covers 2012-2017).

Apart from participating and aligning with the several programs and missions run by the central government, there are several polices/programs/schemes run at the state and local level for promoting energy efficiency and/or some of the green measures (like rooftop solar PV provision, rain water harvesting).

#### 4.1 Punjab Energy Conservation Building Code

The Energy Conservation Act (2001) led to the formation of the Bureau of Energy Efficiency (BEE) that started the formulation of the Energy Conservation Building Code (ECBC). The scope of ECBC is to provide minimum energy standards for buildings having a connected load of 100kW or contract demand of 120kVA. It aims to reduce baseline energy consumption by setting minimum energy performance standards for new commercial buildings, including for building envelopes, mechanical systems and equipment, including heating, ventilation and air conditioning (HVAC) systems, interior and exterior lighting system, service hot water, electrical power and motors.

PEDA has amended ECBC as per composite climate zone applicable for the state of Punjab and called as The Punjab ECBC. Provision of renewable energy systems and use of Punjab ECBC in building byelaws vide notification issued by Dept. of Housing & Urban Development, Govt. of Punjab are some of the key recent achievements in this regard.

#### 4.2 GRIHA Incentives/mandates

The Department of Housing and Urban Development, Government of Punjab has notified that an additional 5% floor area ratio free of charges shall be permissible to buildings that provide relevant certificates from the Bureau of Energy Efficiency or from GRIHA (Green Rating for Integrated Habitat Assessment).

#### 4.3 New and Renewable Sources of Energy Policy-2012

In alignment with its overall thrust on promoting renewable energy, it has come out with the New and Renewable Sources of Energy (NRSE) Policy – 2012' for the period 2012-2017. The policy aims at systematic and faster development of renewable energy sources to achieve a capacity addition of 800 MWs by 2017. The policy charts a road map for putting such resources of state to efficient usage in a time bound manner. The policy proposed contains some key measures to address the constraints and ensure substantial capacity additions and energy conservation in the next 5 years.

The state government hereby lays down the following targets in the NRSE sector:

- To add generation capacity of 1000 MW by the year 2020 bringing the share of NRSE to the level of 10% of conventional power.

- Given the current consumption per unit of economic and social activity, motivate all sectors of the economy to ensure conservation of energy to the extent of 20% within the next 20 years.
- To strive and facilitate the achievement of the Renewable Purchase Obligation(RPO) by the state Licensee as fixed by Punjab State Electricity Regulatory Commission (PSERC) from time to time.

#### 4.4 Power generation from Solar Energy

A 2 MW solar photovoltaic (PV) project has already been commissioned in Village Awan of Amritsar. Seven solar PV projects have been allocated to private developers on BOO (Build Own and Operate) basis in the state under LT/11KV programme of Jawaharlal Nehru National Solar Mission, Govt. of India.

A major *rooftop programme for solar photovoltaic power project* has been launched in the state under which the rooftop SPV power projects are being setup at various important govt., institutional, and religious buildings namely Punjab Raj Bhawan, Punjab Civil Secretariat , Golden Temple, Wagah Border, Punjab Agricultural University, Ludhiana and Pushpa Gujral Science City , Kapurthala.

PEDA shall also undertake a solar rooftop programme in the state for the domestic and commercial sectors through grid interconnectivity by deploying net metering in consultation with MNRE.

#### 4.5 Key initiatives of PEDA to promote energy efficiency in the building sector

Punjab has issued notifications for mandatory use of CFL, Solar Water Heating Systems, BIS approved & minimum 4 Star Labeled pump sets and promotion of energy efficient buildings.

Demo projects have been initiated for development of energy efficiency in municipal street lighting & water pumping in existing govt. buildings. Use of BEE star labeled electrical appliances in all government organizations has also been mandated.

In order to ensure the participation of all depts., an energy conservation action team has been constituted under the chairmanship of Secretary, Science and Technology, Environment and NCES which reviews implementation of various schemes in depts. under their control. All govt. depts. have also been requested to create energy conservation cells to promote energy efficiency and reduce gap between demand and supply.

#### 4.6 Clearance for NRSE Projects

Setting up of NRSE projects involves sanctions/clearances from a number of Government Agencies/Departments. The state government shall provide the clearances in a time bound manner through a single window mechanism within a period of 60 days.

## 4.7 Net metering policy for Solar Rooftop

Punjab state govt. has approved the net metering policy for Solar rooftop systems in Sep 2014, a draft for the same has been notified by Punjab Energy Development Agency (PEDA). According to the policy, any consumer of electricity of distribution licensee in the state can setup a solar rooftop system under net metering provision, which can be owned by him or by a third party. The new policy will encourage renewable energy generation in the State. Installed minimum capacity is kept as 1kWp up to a maximum of 1 MWp.

## 4.8 Development of Solar Cities programs, Ministry of New and Renewable Energy

The Solar city aims at minimum 10% reduction in projected demand of conventional energy at the end of five years, through a combination of enhancing supply from renewable energy sources in the city and energy efficiency measures. The basic aim is to motivate the local governments for adopting renewable energy technologies and energy efficiency measures. As part of this, a total of 60 cities are/have been supported by the Central Ministry. As part of this, master plan for the cities of Chandigarh, Amritsar and Ludhiana have been developed and for SAS Nagar (Mohali) it is being developed.

Further to the above support, RE projects with an aggregate capacity of 7.32 MWp eq. solar PV projects and 505100 lpd (7894.5 m<sup>2</sup>) SWH systems have been sanctioned in Chandigarh, Mysore, Rajkot, Agartala, Faridabad, Thane, Aizwal, Puducherry, Nagpur, Surat, Vijaywada & Shimla solar cities (MNRE 2015).

## 4.9 Interventions on Rainwater harvesting (storage and recharge), storm water management through Sustainable Urban Drainage Systems (SUDS), integration of biodiversity with built-up area

Building bye-laws have been amended (PUDA Building Rules, 1996) to make rain water harvesting system mandatory in all buildings of above 400 sq m/ 500 sq. yds. Municipal corporations of Ludhiana and Jalandhar have also framed Bye-laws to make RWH mandatory in new buildings.

In urban areas for all the residential projects, commercial projects and other mega projects, Punjab Pollution Control Board (PPCB) has made it mandatory to implement the rain water harvesting.

There has hardly been an instance of consciously integrating storm water management through SUDS<sup>4</sup> to avoid the ever-increasing urban flooding problems and alleviate ground

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<sup>4</sup> SUDS mimic nature and typically manage rainfall close to where it falls. SUDS can be designed to slow water down before it enters streams, rivers and other watercourses, they provide areas to store water in natural contours and can be used to allow water to soak (infiltrate) into the ground or evaporated from surface water and lost or transpired from vegetation (known as evapotranspiration).

SUDS are technically regarded a sequence of management practices, control structures and strategies designed to efficiently and sustainably drain surface water, while minimising pollution and managing the impact on water quality of local water bodies. ([www.sudrain.org](http://www.sudrain.org))

water recharging issues. Integration of bio-diversity and improvement of quality of life is not attempted at all except for few private initiatives.

## 4.10 Punjab State Action Plan on Climate Change (SAPCC)

Punjab SAPCC has been prepared in line with the eight missions of the National Action Plan on Climate Change. The two relevant missions from built environment perspective are the Sustainable Habitat Mission and the National Mission On Enhanced Energy Efficiency (NMEEE).

### 4.10.1 Sustainable Habitat mission

The heat island effect in urban areas is likely to be enhanced with increase in ambient temperature and the demand for energy for space cooling will be on the rise. With extreme precipitation events (>150mm) becoming frequent, and number of days of rainfall <100-150 mm decreasing, urban areas lying within flood plains of Punjab are likely to face flash floods due to more built up area and less area that can percolate water into the soils. Increasing ambient temperatures also have implications on capacity of water to absorb pollutants, which increases even if pollutant discharge into river water or drains is as per the regulated limits. Keeping in view these concerns, the state aims to develop policies and strategies that enable the habitats to adapt to climate change. Climate proofing through building envelopes, rainwater harvesting, increasing recharge capacities of soils, enhancing monitoring of disease prevalence, promoting energy efficiency, conservation of energy and harnessing energy from waste will be some of the key tools towards developing sustainable habitats.

### 4.10.2 Punjab mission for Enhanced Energy Efficiency

In line with the National Programmes and schemes under the NMEEE (National Mission on Enhanced Energy Efficiency), following key strategies look at the EE aspect of the building sector (as part of the state efforts to achieve the national objectives).

Strategy 1: Achieve energy efficiency of the order of 15-35% in buildings (commercial & institutional buildings such as hotel, malls and govt. buildings) based on ECBC/GRIHA norms.

Strategy 2: Achieve energy efficiency in street lighting by replacing conventional street lights with LEDs.

Strategy 3: Promote energy efficiency in consumer appliances.

Strategy 4: Create demand for energy efficient appliances, technologies and programs by educating the public and private sector on their options.

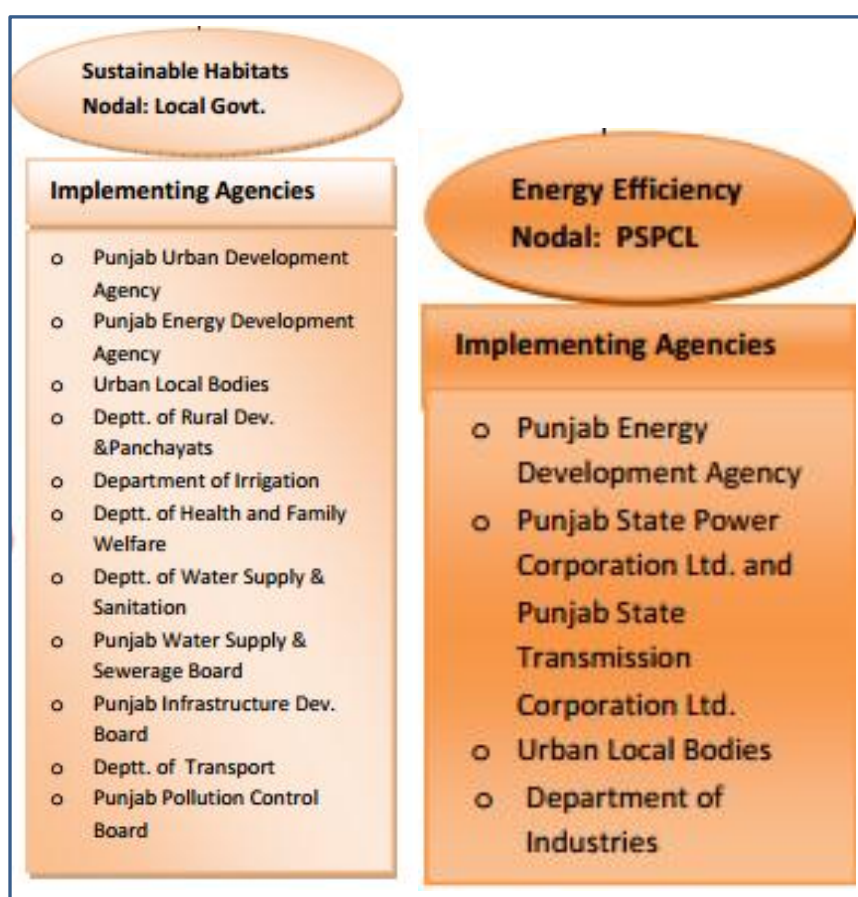
Table 2 shows the envisaged financial outlay for the above strategies in 12<sup>th</sup> and 13<sup>th</sup> FYP is given below.

**Table 2:** Financial Outlay in the 12<sup>th</sup> and 13<sup>th</sup> Plan

	12 <sup>th</sup> Plan	13 <sup>th</sup> Plan	Total
Strategy 1	1.5 Cr	1.5 Cr	3 Cr
Strategy 2	1826 Cr	1826 Cr	3652 Cr
Strategy 3	9.25 Cr	7.5 Cr	16.75 Cr
Strategy 4	7 Cr	5 Cr	12 Cr

Note: 1 Cr INR is roughly 162,456 USD

The SAPCC also lays out a detailed implementation framework to achieve the proposed strategies under various missions. Responsible bodies for the above two missions are given as under:



**Figure 7:** Implementing agencies for Punjab Sustainable habitats and energy efficiency missions

**Source:** Punjab Mission on Climate Change

### 4.10.3 Punjab Energy Conservation Action Plan

As part of the Eco-II project, Punjab has developed Energy Conservation Action Plan (ECAP) which aims:

- To proactively fulfil all the mandates of EC act, in co-ordination with BEE and state Government, and other stakeholders.
- To promote the cause of energy efficiency addressing all commercial energy sources (e.g. coal, liquid petroleum gas, oil and electricity).
- Reduce energy consumption in generation, transmission, distribution through end use DSM programs and large scale end use energy efficiency improvements, rational and judicious use.
- Address the concerns of utilities such as demand shortage as well as power shortages through focused DSM initiatives.
- Promote reduction of GHG emissions in the state of Punjab.
- Promote use of energy efficient technologies, equipment, processes and appliances.
- Promote awareness in respect of EC Act, energy efficiency, standards, best practices, etc.
- Create awareness in the state regarding national energy efficiency programs such as ECBC to promote energy efficiency in buildings and standards & labelling to promote manufacture and use of energy-efficient appliances.
- Reduce energy consumption in domestic Sector through user education and awareness creation

## 5 Barriers in greening the building sector

Punjab is a progressive state and has introduced several appropriate legislations/policy/programs/missions to look at several key concerns of the buildings sector. However, in spite of the appropriate legal framework, the sector faces several barriers to greening the building sector. The current focus of the several efforts is limited to only energy efficiency and some bit of measures to introduce rainwater harvesting (for storage and/or recharge) with limited success. The increased influence of glass architecture for commercial buildings is very much on the rise which results in non-use of daylight (due to excessive glare), large cooling loads, increased energy and water demand. The regulatory frameworks for implementation of Punjab ECBC code and it's subsequent integration in the building bye- laws and specifications of materials/rates in the state PWDs is yet to be done.

The existing capacities of the local authorities to monitor the implementation of the state code are inadequate and a simplified, robust framework needs to be built in to achieve/over achieve the targets as defined in the Sustainable Habitat Mission of Punjab SAPCC.

Absence of any clear cut strategies for reduction in urban heat island effect (in spite of the mention as one of the objectives of the Sustainable Habitat mission) is observed.



Enhanced precipitation as claimed in the SAPCC is further going to worsen the urban flooding issues of the urban centres in the state. This needs to be prevented by adequate strategies such as mandatory provision of Sustainable Urban Drainage systems (SUDS)/Low Impact Development Strategies at building at neighbourhood scale apart from major urban planning interventions on micro/macro watershed management, retrieval and conservation of water bodies (which acts as sponges in instances of high precipitation apart from reducing the urban heat island effect and enhancing the biodiversity of a place).

Subsidised energy prices, water prices and basic services provision are some strong barriers, although these subsidies are meant to increase the access for certain population groups (thus creating major obstacles in removing such public subsidies).

Lack of knowledge among practitioners (due to lack of integration and looking at a holistic perspective), architects, engineers, service providers, inadequate capacities (skill development in the construction sector), lack of robust financial systems to facilitate green growth changes, absence of green financial products are some of the problems faced by the state.

Data collection, collation and analysis are key obstacles observed in the state. As part of the SAPCC, this issue has been rightly flagged and few suggestions on the data collation and access have been given. This need to be further detailed out and implemented by the State with one key nodal agency.

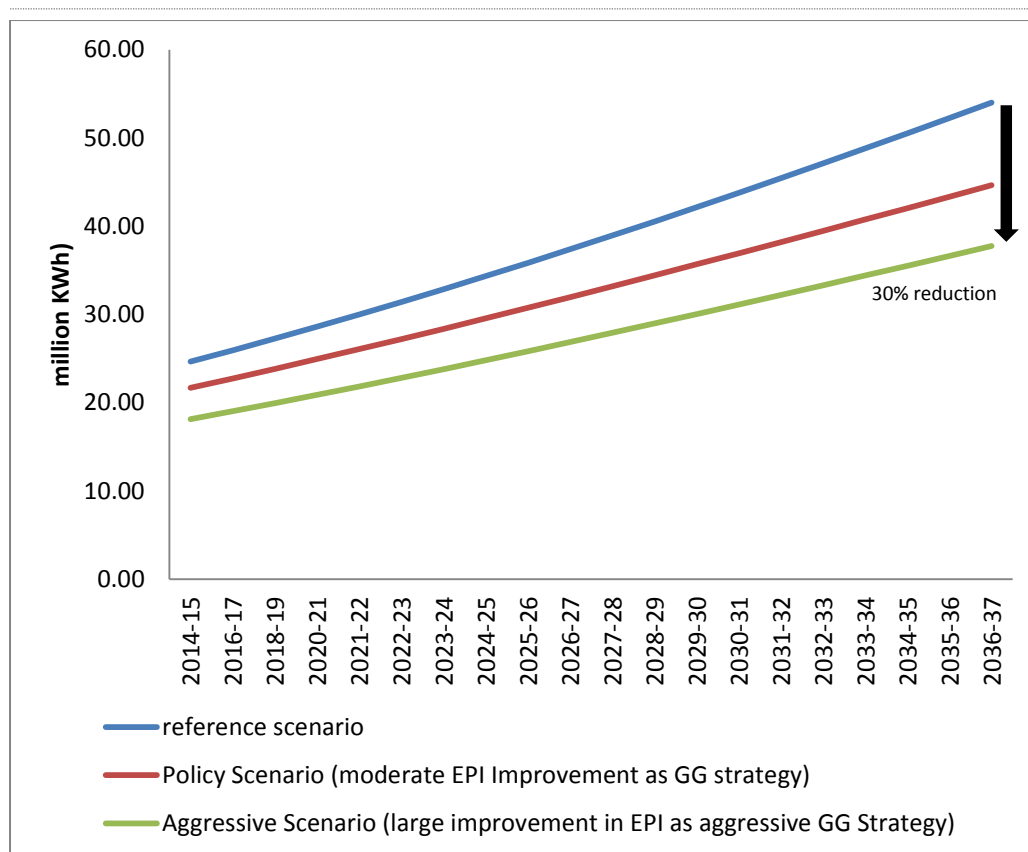
Construction approvals processes are being expedited as part of some of the local bodies' initiatives. This needs to be further enhanced across the State with more financial/non-financial incentives on promoting projects which cater to green buildings.

## 6 Ways forward

Punjab is a progressive state and has well laid out several climate proofing strategies which essentially cover most of the parameters proposed for greening of the building sector. The Punjab Action Plan on Climate change is a well laid out document and if implemented properly can give a lot of benefits/co-benefits for a liveable healthier built environment.

Since buildings have a lock-in effect, it is globally recommended to have stringent energy efficiency measures in the shortest possible time.

Projections done by TERI team on having large improvements in building performance (stated in terms of Energy Performance Index) and covering both residential and commercial sectors indicate a 30 per cent reduction/avoided electricity consumption by 2035-36 over the business-as-usual case (Figure 8). It is therefore, strongly recommended to pursue large improvements in building performance for both new and existing buildings in the state.



**Figure 8:** Specific energy consumption in buildings sector in Punjab

**Source:** TERI calculations

Some of the key action points which are required in the context of green growth are as follows:

### Short-term

- All new commercial buildings to be Punjab ECBC compliant
- Enabling conditions for affordable housing-land, finances, etc. to overcome the social barrier for a greener economy.
- Retrofit measures to make the existing building stock energy efficient and water wise, to overcome the various environmental challenges posed by the sector; Target setting to achieve say 20% retrofit to be completed by 2020.
- New stock to be built on the principles of Green Buildings(including Punjab ECBC compliance) to accrue social, environmental and economic benefits
- Implementation of the Punjab Sustainable Habitat Mission and creation of an enabling environment to overcome the various technological/financial barriers.
- Need to integrate the principles of Low impact development/sustainable urban drainage systems at all zonal plans, neighborhood plans (new and retrofit) on a priority basis in



areas more prone to urban flooding/flash floods. To begin with, 3-4 cities/towns may be taken on a pilot basis, which could be expanded in the next phase.

- Alternate building materials which perform equal or better than the conventional ones to bring in environmental sustainability and building up a database for the entire supply chain to promote such materials
- Capacity building at various levels including skilled manpower for enabling green construction. Attractive financing solutions for developers for investing in EE buildings, ESCOs and communicating through various media the benefits of green buildings at no incremental cost. Also life cycle costing of the property & potential savings on annual electricity bills should be made available to the buyers along with the property brochure; including attractive financial models for affordable housing sector. Access to finance for the under privileged is also an issue to overcome the various financial barriers faced in greening of the sector.
- Creation/strengthening of centres of excellence to promote green buildings and neighbourhoods. academia, industry and state/local government to work in collaboration for this.
- Incorporation of green/ energy efficiency features in Municipal bye laws and all related documents (e.g., state specifications, plinth area rates) followed by the state government- a must for achieving the environmental benefits associated with greening of building sector.
- Punjab ECBC to be revised (made more stringent and implementable) for the next phase. For the revision, benchmarking exercise could be taken up for the state itself based on sample surveys for identified building typologies (similar to the US Commercial Building Energy Consumption Survey (CBECS)).

### **Mid-term**

- All existing and new commercial buildings to be compliant with the revised Punjab ECBC
- All new residential buildings to follow the revised building bye laws
- New retrofit program for making residential buildings
- At least 25% of all existing and new commercial buildings to be net zero/zero plus energy/waste/water buildings
- Based on experience gained from the pilots done in Phase I, integration of the principles of Low impact development/sustainable urban drainage systems at all zonal plans, neighborhood plans (new and retrofit) in the entire state.
- All financial institutions, banks and housing finance and micro-finance companies to be actively engaged in greening of the building sector

- Continued capacity building program evolving with the changing codes/standards requirements

**Long-term**

- 100% of all existing and new buildings to be net zero/zero plus energy/waste/water buildings
- Low impact development based neighbourhood planning and green master plans executed for all cities and towns
- Lifestyle changes introduced in the masses for a low carbon lifestyle due to intensive awareness building over the years
- The buildings and city/town/zonal plans adopt climate resilience at all levels

### Case Study on Green Buildings: PEDA Office Complex, Chandigarh, India

**Location:** Chandigarh (Latitude 30 °N)

**Climate:** Composite

**Rating:** BEE 5 star

**Energy performance index (EPI):** 14 kWh/m<sup>2</sup>/year (non-air-conditioned building)

**Architect:** Arvind Krishan

**Architectural Design:** This building has a 3 Dimensional form responding to solar geometry i.e., minimizing solar heat gain in hot dry period and maximizing solar heat gain in cold period. Overlapping floors at different levels in space floating in a large volume of air, with interpenetrating large vertical cut-outs enclosed within an envelope. These are integrated with light wells and solar activated naturally ventilating, domical structures.

**Daylight:** On the southwestern façade, dome shaped concrete structures have horizontal and vertical intersecting fins with glass fixed in the voids to allow natural light with reduced glare. These allow indirect light to enter the building in summers and direct sunshine in winters.

The atrium is covered by a lightweight shell roofing of 10 cm of high-density EPS (extruded polystyrene) sandwiched between high-grade FRP (fibre-reinforced plastic) sheets and reinforced with steel; specifically angled to allow sun in winters and block in summers.

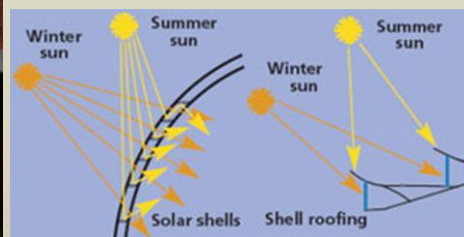
**Maintaining thermal comfort:** The envelope attenuates the outside ambient conditions and the large volume of air is naturally conditioned by controlling solar access in response to the climatic swings during summer and winters. The large volume of air is cooled during the hot period by a wind tower, integrated into the building design, and in cold period this volume of air is heated by solar penetration through the roof glazing generating a convective loop. The thermal mass of the floor slabs helps attenuate the diurnal swings.

#### Envelope Specifications:

**Walls:** North and East → Brick wall-5mm air gap- Brick wall; South and West → Brick wall-50mm rock wool wrapped in polyurethane sheets 5mm air gap- Brick wall

**Roof:** (Outside to inside) mud phuska and brick tiles- rockwool-and-polyurethane insulation- 50mm air gap- concrete slab

**Photovoltaic Panels:** More than 50% of the buildings electricity demand is met by 25kWp solar plant and BIPV on the atrium.



**Source:** [http://high-performancebuildings.org/case\\_study\\_ecm1.php](http://high-performancebuildings.org/case_study_ecm1.php)

<http://www.downtoearth.org.in/content/greenest-all>

<http://www.peda.gov.in/photo-gallery.html>

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## **About TERI**

A unique developing country institution, TERI is deeply committed to every aspect of sustainable development. From providing environment-friendly solutions to rural energy problems to helping shape the development of the Indian oil and gas sector; from tackling global climate change issues across many continents to enhancing forest conservation efforts among local communities; from advancing solutions to growing urban transport and air pollution problems to promoting energy efficiency in the Indian industry, the emphasis has always been on finding innovative solutions to make the world a better place to live in. However, while TERI's vision is global, its roots are firmly entrenched in Indian soil. All activities in TERI move from formulating local- and national-level strategies to suggesting global solutions to critical energy and environment-related issues. TERI has grown to establish a presence in not only different corners and regions of India, but is perhaps the only developing country institution to have established a presence in North America and Europe and on the Asian continent in Japan, Malaysia, and the Gulf.

TERI possesses rich and varied experience in the electricity/energy sector in India and abroad, and has been providing assistance on a range of activities to public, private, and international clients. It offers invaluable expertise in the fields of power, coal and hydrocarbons and has extensive experience on regulatory and tariff issues, policy and institutional issues. TERI has been at the forefront in providing expertise and professional services to national and international clients. TERI has been closely working with utilities, regulatory commissions, government, bilateral and multilateral organizations (The World Bank, ADB, JBIC, DFID, and USAID, among many others) in the past. This has been possible since TERI has multidisciplinary expertise comprising of economist, technical, social, environmental, and management.



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