



# Addendum to the master plan to make Chandigarh a Solar City

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*Prepared for*

**Chandigarh Renewable Energy Science and  
Technology Promotion Society (CREST)  
Chandigarh**

Project Report No. 2008RT03

The Energy and Resources Institute



Addendum report  
August 2010

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# Addendum to the master plan to make Chandigarh a Solar City

## Introduction

The Master Plan for Solar City is a dynamic document meant to change with time, experience, and need. TERI prepared the master plan to make Chandigarh a solar city and submitted the final master plan to Chandigarh Renewable Energy Science and Technology Promotion Society (CREST) in July 2009. The development of master plan has benefited from the active participation of CREST, Public Works Department, Municipal Corporation UT, Chandigarh Administration, Municipal Water Supply Department, Forest Department, power utilities, electricity department of Chandigarh Administration; and other agencies with energy-related responsibilities.

The whole exercise of developing a Master Plan for making Chandigarh a solar city has been a collaborative endeavour along with all the major stakeholders in the city. Developing the city as a solar city requires an integrated urban planning approach, which simultaneously involves reducing reliance on fossil fuels by the application of energy conservation and efficiency measures and by replacing/complementing the conventional energy generation with the renewable energy. As decided in the beginning, this exercise did not include the industrial and transport sectors. The Master Plan has been developed on the basis of different energy saving and renewable energy options, along with those technological options that are feasible in long term only.

The key components of the study comprised

- Sector wise baseline energy consumption scenario,
- Energy planning (Sector wise)
  - Energy use projections
  - Energy efficiency measures and audit
  - Utilization of available renewable energy sources and
- Action Plans for development of solar city

Action plan clearly indicates various activities to be carried out for the development of Chandigarh as solar city with the short-medium and long term targets of energy conservation and the renewable energy development. The budgetary estimates for CREST have also been provided for the implementation of the master plan.

The master plan has been approved by the Chandigarh administration and the development activities have started based on the suggestions given in the master plan.

As Ministry of New and Renewable Energy (MNRE) is the central government agency responsible for the promotion of

development of master plan for solar cities and for monitoring the progress towards this, it organises the review meetings regularly at certain intervals. In the meeting held at New Delhi on 13 April 2010 the status of various solar city's master plan were discussed and the Chandigarh being the model solar city it has been proposed that the master plan shall also include Bureau of Energy Efficiency (BEE) plan for Chandigarh and the action plan is to specify sources and pattern of funding.

In this regard this addendum to the master plan is prepared comparing the energy saving potentials estimated in the master plan with that of BEE.

### Energy saving potential for Chandigarh estimated in the solar city master plan

In the master plan the energy savings potential for the residential sector, commercial sector and municipal sector has been estimated for short term (up to 2012), medium term (up to 2015) and long term (up to 2018). The projections are based on the historical energy consumption data for the residential and commercial sector whereas for municipal water pumping and street lighting, these are based on the energy audits of the said services. The base year for the projection was the year 2006-2007 data. The baseline and the projected energy demand in short term, medium term and long term for all these sectors are given in the Table 1.

**Table 1** Baseline electricity consumption situation and projected electricity demand in Chandigarh

Year	Domestic Sector	Commercial sector	Annual Energy consumption kWh			Total
			Water pumping	Street lighting	Industrial sector	
2006-7	435.35 MU	351.92 MU	81.27 MU	16.5 MU	272 MU	1064.34 MU
Short term (2012)	924	796	91.1	18.99	668	1830
Medium term (2015)	1433	1273	101.2	21.09	1040	2398
Long term (2018)	2103	1946	112.5	23.43	1528	3089

The energy savings potential has been estimated for all these sectors based on the possibility of replacement of existing old equipment with new energy efficient equipment/devices like CFLs in home lighting, street lights, water pumps etc. The summary of the projected energy consumption in BAU and the Solar City scenarios are given in the Table 2.

**Table 2** Summary of electricity consumption in BAU scenario and solar city scenario

Year		Domestic Sector (MU)		Commercial Sector (MU)		Street lighting (MU)		Water pumping (MU)	
		BAU	SC	BAU	SC	BAU	SC	BAU	SC
2007		435.35		351.92		16.5		81.27	
2012	Short term	924	894	796	763	18.99	14.24	91.13	86.99
2015	Medium term	1433	1373	1273	1216	21.09	15.82	101.24	93.19
2018	Long term	2103	2014	1946	1864	23.43	17.57	112.48	99.70



The percentage energy saving potentials estimated in the master plan are given in Table 3.

**Table 3** Sector wise energy savings potential estimated in the master plan

Year	Annual Energy saving potential						
	UNIT	Domestic Sector	Commercial sector	Water pumping	Street lighting	Industrial sector	Total
Annual consumption in 2006-7		435.35 MU	351.92 MU	81.27 MU	16.5 MU	272 MU	1064.34 MU
Energy savings							
Short term (2012)	MU	30	33	4.14	4.75	NA	71.5
	%	3.25%	4.15%	4.54%	25.01%	NA	3.91%
Medium term (2015)	MU	60	57	8.05	5.27	NA	130.4
	%	4.19%	4.48%	7.95%	24.99%	NA	5.44%
Long term (2018)	MU	89	82	12.78	5.86	NA	189.9
	%	4.23%	4.21%	11.36%	25.01%	NA	6.15%

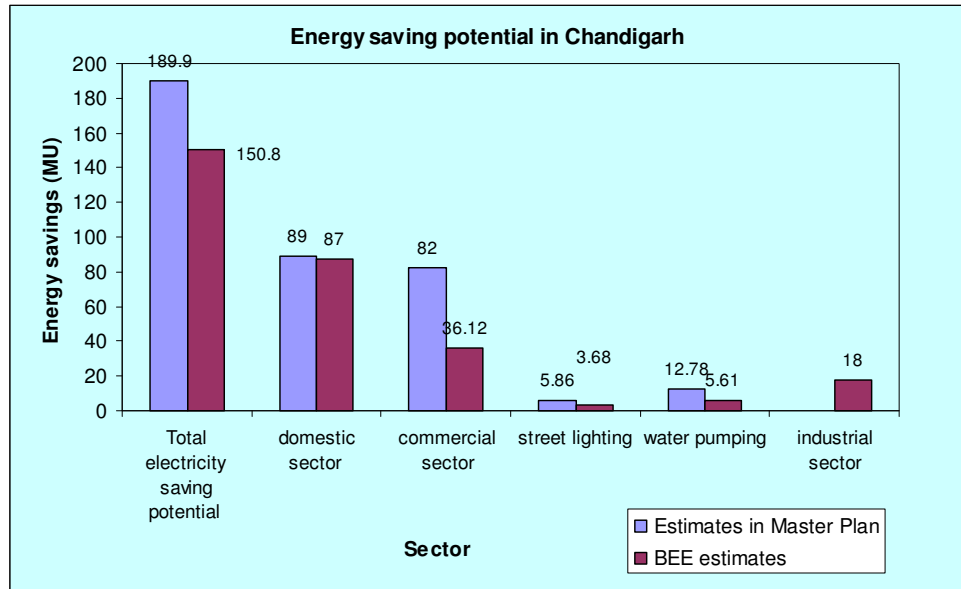
### Energy saving potential for Chandigarh estimated by Bureau of Energy Efficiency

Bureau of energy efficiency (BEE) has carried out the study of state wise energy consumption and conservation potential in India. The energy conservation potential for different states is based on the generic figures achieved from the study of selected states. The energy saving potential estimated by BEE for Chandigarh is essentially based on the generic annual energy saving potential and is given below in table4 and the detailed BEE's estimation is given in Annexure-1

**Table 4** Energy consumption and conservation potential in Chandigarh

Year	Annual Energy saving potential (%)					
	Residential Sector	Commercial sector	Water pumping	Street lighting	Industrial sector	Total
Energy consumption in 2008	435 MU	352 MU	28.03 MU	14.72 MU	255 MU	1064.34 MU
Annual energy saving potential (MU)	87	36.12	5.61	3.68	18	150.8
Annual energy saving potential (%)	20-25%	20-30%	20%	25%	7-10%	12.98%

The solar city master plan covers the short term, medium term and long term energy conservation potential in Chandigarh and the estimations are based on the Chandigarh specific conditions and parameters with strategic implementation of the energy efficiency measures in different sectors. A comparison analysis is presented in the figure1. The BEE has estimated the annual energy savings based on the generic figures achieved from the some states survey/study.



**Figure 1** Comparison of the electricity saving potential estimated in the master plan and in the BEE's plan for Chandigarh.

For domestic sector the master plan assumed that there would be implementation of the energy efficient devices in the domestic sector by 30% in short term, 60% in medium term and 90% in long term and the energy saving potential in long term is estimated to be 89 MU whereas in the BEE estimation the annual saving potential in domestic sector is estimated as 87 MU that is 20-25% of the BAU scenario.

Similarly for commercial sector the energy saving has been calculated in the master plan assuming that the commercial sector of Chandigarh will replace suggested devices in following manner; 10% by 2009, 40% by 2012 (short term), 70 % by 2015 and 100 % by 2018. With this the estimated energy saving potential in 2018 is 82 MU that is 4% of the BAU scenario in that year. In the BEE's estimation only the commercial sector with connected load greater than 500 kW have been considered which amounts to 180.6 MU of electricity consumption in the year 2008 and the annual energy saving potential is estimated to be 36.12 MU. So the total saving potential as estimated in the master plan and in BEE's plan are close.

For the energy saving potential in the municipalities the estimated saving potential for street light is almost same in both the master plan as well as in the BEE's plan for Chandigarh that is about 25% of the BAU scenario. The estimated energy saving in water pumping given in master plan is 11.36% in long term whereas BEE estimated it as 20% per annum for water works and sewerage.

As both the master plan and BEE has similar projections of the energy saving potential in different sectors except for the sectors where the assumptions are different, no major change in

the action plan is required. The target for the energy conservation, energy generation, action plan to achieve these targets and the estimated budget for the same is already given in the solar city master plan. The same is explained here again with some modifications.

## Master plan

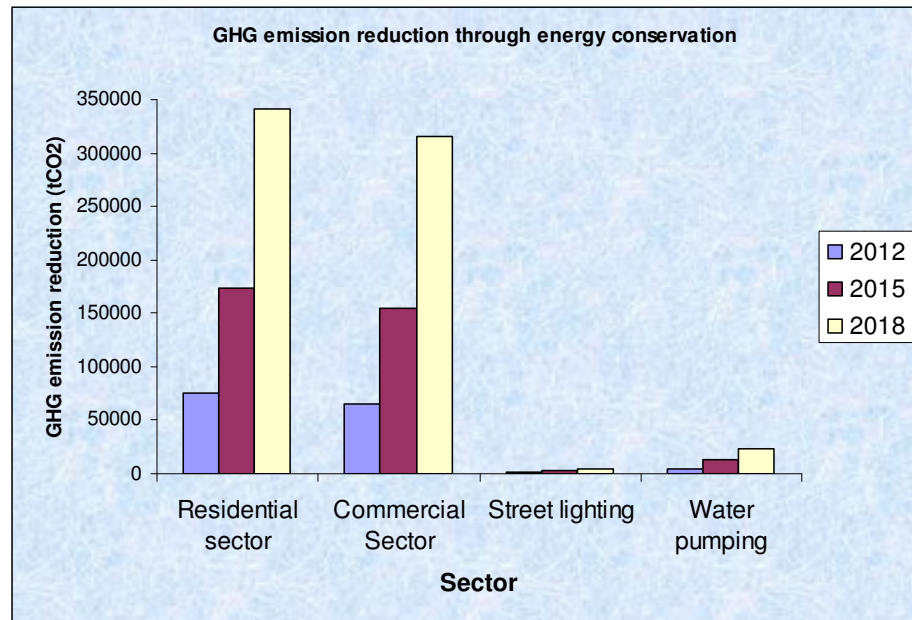
Based on the analysis of potential for demand side measures along with that of supply side augmentation through renewable energy technologies, the following targets are proposed for Chandigarh in order to develop it as a “**Solar City**”. These targets are based on the detailed energy audits in Chandigarh and renewable resource potential assessment and assuming that the level of BEE’s energy saving potential will be achieved in long term. The target for energy conservation and generation for Chandigarh are given in Table 5.

**Table 5** Targets for energy conservation generation and green house gas emission reduction

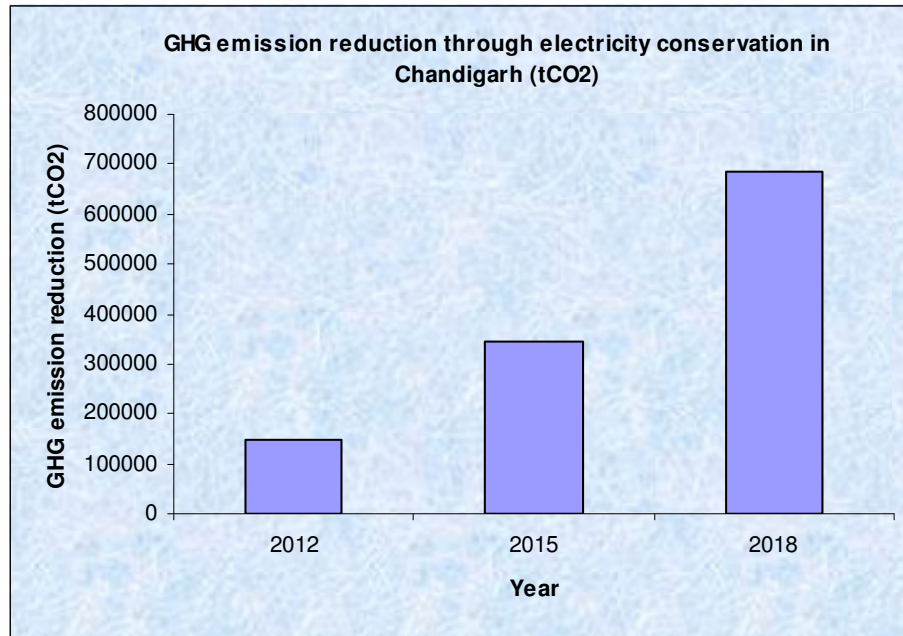
Description	Target		
	Short Term (till 2012)	Medium Term	Long Term (till 2018)
1. Energy Conservation*	Reduction in present energy consumption		
1.1 Residential sector	10%	15%	20%
1.2 Commercial sector	10%	15%	20%
1.3 a Municipal sector (Water pumping)	5%	8%	12%
1.3 a Municipal sector (Street lighting)	10%	20%	25%
2. Coverage of solar water heating systems (as a proportion of total heating demand in residential and commercial sectors)	10%	25%	45%
3. Roof Top solar energy based electricity generation	2.5 MW	5.0 MW	10.0 MW
4. Large solar energy based electricity generation at Landfill site	3.0 MW	5.0 MW	5.0 MW
5. Large solar energy based electricity generation at Patiyala ki Rao site	5.0 MW	15.0 MW	25.0 MW
GHG emission reduction (tCO <sub>2</sub> /annum)	90973	214051	404969

\* As a percentage of reduction in energy consumption over projected consumption in BAU scenario

Based on the above given targets of energy conservation in different sectors the sector wise GHG emission reduction potential and total GHG emission reduction potential through energy conservations are given in figure2 and figure3 respectively

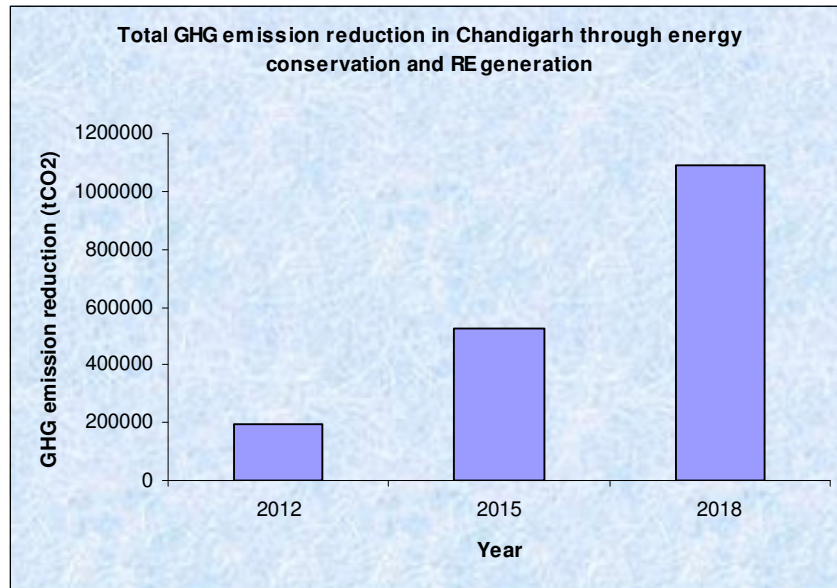


**Figure 2** Sector wise GHG emission reduction potential in Chandigarh based on targeted energy conservation



**Figure 3** Total GHG emission reduction potential in Chandigarh based on targeted energy conservation

The total GHG reduction potential through the energy conservations and the Renewable energy generations in Chandigarh are given in Figure 4.



**Figure 4** Total GHG emission reduction potential in Chandigarh based on targeted energy conservation and the Renewable Energy generation

The short-term targets for energy conservation are based on the energy conservation options identified in the energy audit. To achieve the medium and long-term targets the key implementation points of the proposed Master Plan to make Chandigarh a Solar City would be same as given in the main report

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### Budget estimation for Solar City initiative

The detailed action plan for developing Chandigarh as solar city has been given in the master plan. The action plan has various components and actions which include implementation of energy conservation in Government buildings, as well as commercial and residential sectors. Further the action plan also includes activities related to implementation of different renewable energy technologies for different applications. These actions are of different types like direct implementation, awareness creation, providing subsidy and other promotional measures. Based on the different activities/ initiatives suggested in the action plan a tentative budget for undertaking these activities has been prepared for short term (till 2012), medium term (till 2015) and long term (till 2018). The budget estimated for making Chandigarh as a solar city with possible funding sources is given in table 6. It may be emphasized that in most of the cases, the majority of funding would be made through public-private partnerships.

**Table 6** Budget estimated for implementation of different activities for making Chandigarh as a Solar City

Sector (s)	Proposed Measures	Targets	Role of CREST / Chandigarh Administration	2012 (Short Term)	2015 (Medium term)	2018 (Long Term)	Source of Funding
Residential	Solar water heating systems	824500 lit per day capacity systems in 2009-10. Increase of 5% in installed capacity every year	1.Promotion and awareness creation 2.Providing subsidy support in initial phase (first 100000 lit capacity systems)	53.47 (Million Rupees)	77.21 (Million Rupees)	101.94 (Million Rupees)	Jawaharlal Nehru National Solar Mission (JNNSM)
	Promote use of efficient LPG stoves and efficient cooking devices such as microwaves	Achieve 10% reduction in projected LPG consumption as compared to BAU	Awareness creation	2.0 (Million Rupees)	1.0 (Million Rupees)		Oil marketing companies, private companies
	Promote use of alternate lighting systems such as SPV systems in villages to reduce kerosene consumption	Targets can be decided by CREST after survey of requirements	Awareness creation. Subsidy for five years for say 1500 Solar Home Systems	6.0 (Million Rupees)	1.50 (Million Rupees)		JNNSM
	Promote use of roof top solar PV systems	10 MWp capacity systems by 2018	Subsidy support for first 10 MWp capacity systems of up to 5kWp capacity each as per MNRE guidelines				JNNSM, Electricity Utility
	Promote energy conservation through promotion of energy efficient devices (CFL, air conditioners, microwaves, washing machines, TV, etc)	Increased use of these devices in the city	Awareness creation, specific support schemes for CFL and Air conditioners?	6.0 (Million Rupees)	1.50 (Million Rupees)		BEE/ State Energy Conservation Fund; private industry
Commercial	Promotion of energy efficiency through awareness creation	achieve 10% share of energy efficient devices in the city	Promotional schemes and awareness creation	10.0 (Million Rupees)	2.5 (Million Rupees)		BEE/ State Energy Conservation Fund; private industry
	Replacement of existing ballasts by efficient ballasts in all street lights	100% replacement of ballasts	Investments/ financial support to CMC (Chandigarh Municipal Corporation)	110.0 (Million Rupees)			Jawaharlal Nehru National Urban Renewal Mission (JNNURM)
	Replacement of booster water pumps in drinking water schemes with energy efficient pumps	Replacement of 250 nos of pumps of each 10 HP capacity	Investments/ financial support to CMC	8.12 (Million Rupees)	2.56 (Million Rupees)		JNNURM
	Promotion of solar water heating systems in industries, hotels, hostels etc	100000 lit per day capacity systems in three years	Subsidy and awareness creation , providing soft loans / reduction in electricity bills/ cess for others	1.69 (Million Rupees)	0.56 (Million Rupees)		MNRE-GEF SWHS programme; JNNSM

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Sector (s)	Proposed Measures	Targets	Role of CREST / Chandigarh Administration	2012 (Short Term)	2015 (Medium term)	2018 (Long Term)	Source of Funding
	Promotion of energy efficient green buildings	At least 50% of the new building are certified under GRIHA or similar rating systems	Implementation of Schemes through facilitation and cost sharing schemes	10.0 (Million Rupees)	2.5 (Million Rupees)		MNRE & Private investment
	Promotion of roof top systems in commercial /government, institutional and industrial buildings	Total 10 MWp capacity solar systems	Financial support to the utility for purchase of power at higher rate/ preferential tariff	400.0 (Million Rupees)	300.0 (Million Rupees)	300.0 (Million Rupees)	JNNSM, Electricity Utility
<b>Power generation</b>	Solar PV power plant	25 MWp power plants in phased manner	Subsidy support / Capital investments / preferential tariff / Soft loans	800.0 (Million Rupees)	1100.0 (Million Rupees)	600.0 (Million Rupees)	JNNSM & private investment
	Solar PV power plant	5 MWp power plants in phased manner in Landfill area	Subsidy support / Capital investments / preferential tariff / Soft loans	300.0 (Million Rupees)	200.0 (Million Rupees)		JNNSM & private investment
<b>Awareness creation</b>	Establishment of 'Chandigarh Solar City Cell'	To set up Solar City Cell to develop, implement and monitor various schemes, to coordinate the development of Chandigarh as Model Solar City	Funding , creation and establishment of the cell and monitor its working	10.0 (Million Rupees)	7.5 (Million Rupees)	5.0 (Million Rupees)	MNRE / UT Chandigarh
	Awareness creation for all schemes, development of solar city park and exhibitions	Awareness creation	Develop and fund awareness creation/promotional schemes (included in the above)				MNRE / UT Chandigarh
<b>Total</b>				<b>1717.28 (Million Rupees)</b>	<b>1696.83 (Million Rupees)</b>	<b>1006.94 (Million Rupees)</b>	

## ANNEXURE 1 BEE plan for Chandigarh



### **Electricity Consumption & Conservation Potential in Chandigarh**



### 1. ENERGY SAVING POTENTIAL IN AGRICULTURAL SECTOR

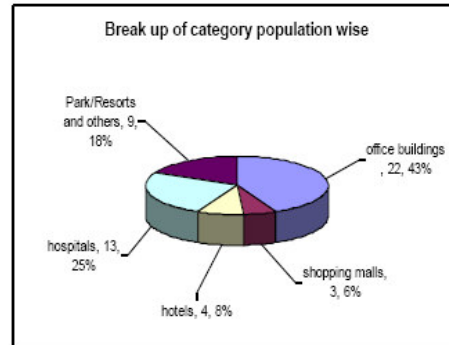
The annual electricity sale to agriculture sector is 1.31 MU. The major energy consumption is in the area of energising agricultural pumps. The population of agricultural pump sets is around 160, accounting for a connected load of 987 KW and annual consumption of 1.3 MU.

Based on several studies carried out on agricultural pump sets efficiency, it has been found that the pump efficiency varies from 25-35% due to various factors. By adopting BEE star labeled agricultural pump sets, the efficiency can be enhanced up to 50-52%. It is estimated that, by replacement of existing pumps with the BEE star labeled pumps, the achievable saving potential is 30-40% and sectoral saving potential works out to be 0.39 MU per year.

### 2. ENERGY SAVING POTENTIAL IN COMMERCIAL SECTOR

The annual electricity sale to commercial sector is 352 MU and accounts for 30 % of the total electricity sold. The commercial sector constitutes Government & private establishments, hospitals, hotels, educational institutions, malls etc. For assessment of saving potential, only those buildings with over 500 kW connected load have been considered.

There are 51 commercial buildings in the state accounting for annual energy consumption of 180.6 MU which works out to about 51 % of the sectoral consumption. The break up of category population wise is shown in the figure.



Various studies reveal that energy savings potential in commercial buildings varies from 20-30%. The annual energy savings potential for 51 commercial buildings is assessed to be 36.12 MU.

### 3. ENERGY SAVING POTENTIAL IN MUNICIPALITIES

The annual electricity sale to public lighting and public water works & sewage works out to 42.75 MU. Among the 550 consumers with a connected load of 3600KW annual electricity consumption for street lighting is 14.72 MU and for the supply of 69.25 mgd of water with around 300 installations, connected load is around 9100 KW with annual consumption for PWW is 28.03 MU.

Based on sample studies, the energy savings potential for street lighting in municipalities & corporations is assessed to be 25% and works out to 3.68 MU per annum. While the energy savings potential for water works & sewage in municipalities &

corporations is assessed to be 20% and works out to 5.61 MU per annum. The aggregate sectoral saving potential among the above works out to 9.29 MU.

#### 4. SME CLUSTERS

There is no energy intensive SME in Chandigarh (UT).

#### 5. ENERGY SAVING POTENTIAL IN DOMESTIC SECTOR

In Chandigarh, the annual electricity sale to domestic sector is 435 MU which accounts for 37.5 % of the total electricity sold. The domestic sector electricity consumption varies with respect to rural and urban segments and climatic seasonal variations. In the rural segment major use of electricity is towards lights & fans. In the urban segment the typical energy consumption pattern includes the following.

S.No.	Appliances	Energy consumption in %
1	AC & refrigeration	56 %
2	Lights & fans	24%
3	Coolers, TV, Washing M/cs etc	16%
4	Others	4%

The energy use in air conditioners also varies significantly with seasons and climatic conditions.

The major avenues for energy savings in rural domestic sector include:

- Replacement of GLS bulbs with CFLs
- Adoption of BEE star labelled domestic appliances like ceiling fans, refrigerators, AC units, tube lights etc

The savings potential in rural segment by adopting CFLs and BEE star rated products is 40-50%.

The savings potential in urban segment by adopting BEE star rated products is 15-20%. On the whole, the energy savings potential in domestic sector is estimated 20-25% which accordingly works out to 87 MU per year.

#### 6. ENERGY SAVING POTENTIAL IN INDUSTRIES

The annual electricity sales to the industry sector including low & medium voltage consumers (SME) and high voltage consumers (large industries) is 255 MU and works out to 23 % of the total electricity sold. The larger industries segment is covered for energy efficiency under the mandates of EC Act as designated consumers, while SME segment is being addressed for energy efficiency through cluster based initiatives by Bureau of Energy Efficiency.

Based on several studies & energy audits, the electrical energy saving potential in the industry sector varies from 7-10%. The energy savings potential for the sector is assessed to be 18 MU.

#### 7. TOTAL ENERGY SAVING POTENTIAL IN CHANDIGARH

No.	Sector Reference	Estimated annual Saving Potential (MU)
1	Agricultural	0.39
2	Commercial	36.12
3.	Municipalities	9.29
4.	SME	NA
5.	Domestic	87
6.	Industries	18
<b>TOTAL</b>		<b>150.8 MU (0.151 BU)</b>

The total energy saving potential for the state among the above sectors is **0.151 B** representing 12.98 % of the annual energy sold.

