PANAJI SOLAR CITY

MASTER PLAN

Sep 2014



GEDA

Submitted by

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PROJECT DETAILS

Project Name:

Master Plan for Development of Panajim City as a solar city under Solar City Program of Ministry of New & Renewable Energy, Govt. of India

Client:

Goa Energy Development Agency (GEDA)

Corporation of the City of Panaji

Goa

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Darashaw & Co. is extremely thankful to the CCP and GEDA officials for entrusting Darashaw & Co. in carrying out this prestigious assignment and their coordination and support throughout the study:

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We take this opportunity to express our appreciation for the excellent support provided by Local Service Providers, and Equipment Suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the Solar City Master Plan.

Thanking You

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EXECUTIVE SUMMARY

The programme of 'Development of Solar City' by the Ministry of New and Renewable Energy (MNRE), Government of India is aimed to promote the use of Renewable Energy in Urban Areas by providing support to the Urban Local Bodies (ULBs) for preparation and implementation of a Road Map to develop their cities as Solar Cities. The target set for the cities under the scheme is to reduce the consumption of fossil fuel to the extent of 10% in the coming five years. This target would be achieved through a mix of various Renewable Energy and Energy Efficiency Projects. This Master Plan is an outcome of the scheme and is prepared to envision and implement the scheme as per the guidelines of MNRE.

The Master Plan begins with an introduction to the current status of the energy scenario in cities of the modern world and emphasis on the need of sustainable practices in the form of renewable energy and energy efficiency. The 2nd chapter talks about the approach and methodology adopted by the consultant for preparation of the master plan. 3rd chapter talks about the international case studies on the success stories of similar Solar Cities throughout the world.

The 4th chapter talks about the stakeholder committee meeting and the views, points and suggestions raised by the various stakeholders during the first stakeholder committee meeting.

The 5th chapter draws the present energy baseline of CCP and highlights the energy consumption pattern of the last five years.

The 6th chapter talks about the Energy consumption, Forecasting and target setting of the city. Electricity consumption in the base year 2013-14 was as follows

Consumption of Energy Sources in Year 2013-14					
Energy Source	Electricity (MU)	Petrol (KL)	Diesel (KL)	Kerosene (KL)	LPG (MT)
Consumption	92	9008	7780	798	1246

Now if we convert these sources of energy into a common denomination, we can arrive at equivalent million units of electricity for all these different sources of

energy. The table shows these values converted into the same units of million equivalent of Electricity produced (in Million Units).

Consumption of Energy Sources in Year 2013-14 converted into Million Units of electricity equivalent.					
Energy Source	Electricity(MU)	Petrol (MU)	Diesel (MU)	Kerosene (MU)	LPG (MU)
Consumption	92	97	88	30	16

Now, the solar city programme envisage a 10% reduction in conventional energy demand through a combination of various demand side and supply side measures spread across all the sectors by the end of next 5 years. Accordingly, the target for CCP could be considered as a reduction of 10% of the total energy demand which turns out to be equal to 45 Million Units of electricity.

The target for the Solar city programme for CCP could be taken as the reduction in the demand of electricity equivalent by 45 MU by next five years through various supply and demand side measures in residential, commercial and institutional sectors.

The 7th chapter deals with the Green Building & energy efficiency for buildings in Residential, Commercial, Municipal and Industrial (Hotel) sector.

Chapter 8th talks about the energy planning in residential, commercial, municipal and Industrial sector.

The 9th and 10th talk about the various renewable energy and energy efficiency strategies and the implementable projects in the city. It gives a brief description of the various projects and the probable strategies that can be adopted in order to achieve the objectives of the scheme.

The 11th chapter talks in detail about the budget and five year action plan for the implementation of the solar city scheme. The total budgeted yearly expenditure is estimated as per the table below:

RE & EE Strategy for CCP	Energy Saving Target over 5 years period of implementation (MU per year)					% of savings target to achieve	Emission reduction
	1st Year	2nd Year Cumulative	3rd Year Cumulative	4th Year Cumulative	5th Year Cumulative		
RE for Residential Sector	0	1	2	3	5	10%	3333
RE for commercial	2	5	10	15	21	47%	17242
RE for Municipal	2	4	6	9	12	27%	10606
RE for Industrial	0	1	2	3	4	9%	3205
Total RE Strategy	**5**	**12**	**20**	**30**	**42**	93%	**31180**
EE for Residential	0	1	1	2	3	7%	2605
EE for Commercial	1.03	2.58	4.64	7.21	10.31	22.92%	8348
EE for Industrial	0.041	0.103	0.18	0.29	0.41	0.91%	333
EE for Municipal	0.13	0.33	0.59	0.92	1.32	3%	1299
Total for EE strategy	**2**	**4**	**7**	**11**	**15.25**	**34%**	**12584**
RE & EE Combined Strategy	6	15	27	41	57	127%	43765

The total indicative budget of solar city is estimated as Rs 243 crore which will be invested over a five year period. The year wise budget allocation is shown in the table below.

Budget Contribution						
MNRE Contribution	**Total (Lakhs)**	**Year 1**	**Year2**	**Year 3**	**Year 4**	**Year 5**
Renewable Energy Strategy - Residential	1371	137	206	274	343	411
Renewable Energy - Commercial	1755	176	263	351	439	527
Renewable Energy Municipal	866	87	130	173	216	260
Renewable Energy Strategy - Industrial	659	66	99	132	165	198
19.17%	**4651**	**399**	**599**	**798**	**998**	**1198**
State /City Contribution						
Renewable Energy Municipal	5520	552	828	1104	1380	1656
Energy Efficiency Strategy - Municipal	419	42	63	84	105	126
24.48%	**5938**	**594**	**891**	**1188**	**1485**	**1782**
Private User Contribution						
Renewable Energy Strategy - Residential	3156	316	473	631	789	947
Renewable Energy Strategy - Commercial	5615	561	842	1123	1404	1684
Energy Efficiency Strategy - Residential	1067	107	160	213	267	320
Energy Efficiency Strategy - Commercial	2227	223	334	445	557	668
Renewable Energy- Industrial	1537	154	231	307	384	461
Energy Efficiency Industrial	72	7	11	14	18	22
56.36%	**13674**	**1367**	**2051**	**2735**	**3418**	**4102**
Grand Total	**24263**	**2360**	**3541**	**4721**	**5901**	**7081**

As per the current schemes of MNRE for eastern states, the total direct contribution of **MNRE** has been estimated to be around **19 %** of the total estimated expenditure of Solar City. The share of the **state/City** and **end user** has been proposed to be **24 % and 56 %** respectively over a period of five years. However

the same is subject to change depending upon the methods of financing the projects adopted by the state.

The chapter also discusses about the various financing schemes and models in order to arrange the finances for the proper and timely execution of the various projects.

At the end, there are various annexure giving details of the action plan for the utilization of the fund allocated by MNRE for the implementation of the scheme over a period of five years

The Master Plan provides a framework to compare and analyze the alternative strategies and policies, in order to facilitate Councils review and decision making process. Achieving significant reduction in energy consumption requires collective effort by all city departments, other government departments, business, industries and citizens. The investigation showed the biggest potential for energy savings in the residential sector and huge potential for implementation of various solar projects.

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1 Introduction

1.1 Background

The inevitable process of urbanization brought with the environmental degradation, besmirched quality of life and knocked out the root of sustainable development of cities and towns. The limited resource bases of cities are not able to cope with the ever increasing pressure of people migrating from rural areas for the variety of reasons.

The people and governments are already working hard to cut greenhouse gases, and everyone can help. It should be our moral mission to get actively involved for preventing degradation of our environment and save the planet.

Cities are spatial manifestations of human and economic activities; buildings form a crucial part of this spatial manifestation. Estimates put construction alone responsible for approximately 40 percent of the total energy use worldwide, most of which is sourced from fossil fuels.

With nearly 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase from a low 14 percent in 1970s to nearly 33 percent in 2004-05.

Residential Energy Consumption in India

In India residential sector is responsible for 13.3 percent of total commercial energy use. Energy sources are mainly being electricity, kerosene, firewood, crop residue and renewable energy such as solar, wind, hydro. During the period 1990-2003, the two commercial fuels LPG and Electricity has grown at the average annual growth rate of 11.26 percent and 8.25 percent respectively.

Residential energy consumption can be broadly divided into six categories such as: Lighting, Cooking, Space Conditioning, Refrigeration, Water, Heating and Others.

Commercial Sector Energy Consumption

In India, 60 percent of the total electricity is consumed for lighting, 32 percent for space conditioning and 8 percent for refrigeration in the commercial sector. The commercial sector comprises various institutional and industrial establishments such as: Banks, Hotels, Shopping Complexes, Offices, and Public Departments supplying basic utilities.

Environmentalists have suggested one approach by reducing greenhouse gases emissions from a variety of sources with technologies available, rather than relying

on an enormous change in a single area. Strategies for mitigation of global warming include development of new technologies; carbon offsets; renewable energy such as biodiesel, solar power, biomass, geothermal and wind power; electric or hybrid automobiles; fuel cells; energy conservation; carbon credits; carbon taxes; enhancing natural carbon dioxide sinks; population control; and carbon capture & storage. Many environmental groups encourage individual lifestyle and political action against global warming. Plants and trees absorb CO2 as they grow, "sequestering" carbon naturally.

1.2 Energy Scenario

In the past sixty years India has achieved remarkable growth in development of electricity systems, from a meager installed capacity of around 1350 MW to 250256.95 MW of installed capacity as on 31 July 2014. While this growth is impressive, the needs of the nation are daunting. Some facts

- With 17.31% of world's population India has
    - Only 0.6% of global oil reserves and 7 % of coal reserves
- Rapidly growing Economy (2003-09) 8%; to grow 8-10% per annum
- Indian Power Sector (as of 31 July 2014)
    - Installed Capacity: 250 GW (per capita 779 kWh)
- India needs 300 GW of incremental power generation
    - Capacity to be added over the next 10 years
- GOI target for renewable Energy
    - 20% by 2020

However if India has to ensure GDP growth rate in excess of 8% for a sustained period of time, it has to ensure sufficient energy supply for industrial and commercial activity in the country, as energy is an essential input in the economic activity. To achieve this and to ensure sufficient electricity to all at reasonable rates, it is not only necessary to have an efficient and competitive power sector but there is also a need to explore all possible options for electricity generation and distribution.

1.3 Need for Renewable Energy

India has been dependant on fossil fuels such as coal, oil and gas for its energy requirements. As per data provided by Ministry of Power (MoP) today, more than 57% of its capacity is coal fuel dependant. Despite the recent discoveries of gas as well as initiatives to develop coal reserves, it is likely that our dependence on fossil fuels will continue in near future. However, in the last couple of years, the price of fossil fuels has shown a consistent upward trend.

As per data published by Ministry of Petroleum and natural Gas in Economic Report "Basic Statistics on Indian Petroleum & Natural Gas, 2011-12" India imports in year 2011-12 were about 81% of its total oil consumption and considering the past trend this share of imported oil is expected to reach 90% by 2031-32. The story of coal imports is not expected to be significantly different. It is envisaged that India will be importing 50-60 million tons of coal every year by the end of the eleventh five year plan. Given this scenario, it is of paramount importance that the country develops all possible domestic energy sources. India cannot afford to ignore any source of energy just because those sources are currently expensive, because the economic loss due to non – supply of electricity will be greater than the cost of selected sources of energy.

1.4 Role of Solar Power in Energy Security

While wind has been a success story in India and has great potential, wind is extremely site specific and therefore, not suitable or large scale distributed generation. Further the total wind potential (approx 50 GW) in the country is much less as compared to the total solar energy potential (approx 600 GW). Further, this estimated potential is done at current targets for technology efficiency. If technology is improved, solar energy potential could be further increased significantly.

Further, solar energy systems do not require any fuel and therefore, operating costs are negligible. Over a life time cycle, the costs of the solar energy applications like large solar farms, roof top installations, telecom towers etc. can be lower than that of conventional energy products especially the more expensive and highly polluting diesel generators. The other advantages of solar energy systems are that they are modular in nature, have long life, are reliable, and require low maintenance effort. This distributed source of energy is uniquely suitable for India.

1.5 Green City

The smart solution to the problem of unplanned growth of cities and towns would be to make affordable a new level of quality townships that would seriously consider the important role that environmental issues play globally, locally and domestically. Thus, the concept of the Green City was conceived.

What our cities will look like in the future will depend on, how they are planned or, much more important; whether they are planned at all. The key point is that planning has a key role in ensuring sustainability.

Many of the problems associated with our cities have happened because they have not been planned, or the planning has been ineffective or misdirected. Planning has seldom kept pace with the scale of urban growth and rapid urbanization it has also been unresponsive to the needs of the poor. Forced evictions in some cities have been justified by the so called need for "proper planning".

1.5.1 Goals and Objectives

The Goal of the Solar City program is to promote the use of Renewable Energy in Urban Areas by providing support to the CCP for preparation and implementation of a Road Map to develop their cities as Solar Cities. The objectives of the programme are given below:

- To enable/empower Urban Local Governments to address energy challenges at City - level.
- To provide a framework and support to prepare a Master Plan including assessment of current energy situation, future demand and action plans
- To build capacity in the Urban Local Bodies and create awareness among all sections of civil society.
- To involve various stakeholders in the planning process
- To oversee the implementation of sustainable energy options through public - private partnerships.

2 Approach and Methodology

2.1 Master Plan for Solar City

Master plan for solar city is both a perspective and a vision for the future development of a city; as a renewable energy city or an eco green city minimizing the demand for conventional energy at the end of fifth year. It presents the current stage of the city's existing energy demand and supply scenario. It sets out the directions of change, to reduce the demand for conventional sources, assessment of various renewable energy resources and identifying the thrust areas. It also suggests alternative routes, strategies, and interventions for decreasing the demand for conventional energy resources and to make renewable energy & energy efficiency be able to reduce at least 10% of the projected total demand of conventional energy. It provides a framework and vision within which projects need to be identified and implemented. It establishes a logical and consistent framework for evaluation of investment decisions.

Master plan for development of CCP as a Solar City is initiated by Goa Energy Development Agency & Corporation of the City of Panaji under the scheme for development of solar cities, a scheme of MNRE.

2.1.1 Objectives

The objective of development of Solar Cities is for:

- Preparation of a master plan for increasing energy efficiency and renewable energy supply in the city
- Setting-up institutional arrangements for the implementation of the master plan.
- Awareness generation and capacity building activities.

The program aims at minimum 10% reduction in projected demand of conventional energy at the end of tenth year, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources. Out of this at least 5% will be from renewable energy sources.

2.2 Study Approach

- The master plan exercise will be carried out through consistent stakeholder participation at various stages. Focus Group Discussion will be organized in all the stakeholder meetings to familiarize them with the purpose, process, and expected outcomes, and to build enthusiasm, understanding and commitment to the development of solar city. This helps in arriving at a

consensus between CCP and other stakeholders in confirming the identified sector strategies and various projects identified.

- Preparation of a master plan is a multi-stage exercise, involving:
- In-depth analysis of the existing situation, covering the detailed documentation of the existing energy demand and supply scenario for the city: The purpose of this stage is to review and analyze the current status of the city with regard to sector wise energy consumption and energy supply.
- Demand forecasting from financial year 2014-15 to 2023-24: Using the results of the first stage of analysis combined with consultations with key stakeholders and civil society, demand for energy is forecasted, by determining growth in energy use in different sectors.
- Formulating sector wise strategies, based on the techno economic feasibility of different renewable energy and energy efficiency options for each sector.

2.3 Methodology

- The Consultant has rich experience in working on similar assignments on city development plans and renewable energy in the past and hence the consultant has laid thrust on two aspects while developing the methodology. One is the past experience on similar kind of assignments and the other is related to the project requirement.

2.3.1 Mobilization

- Immediately after the signing of the contract and the orders to commence work, the Consultant mobilized the project team. Team comprising of planners and renewable energy specialists will study the intricacies of the project and hold discussions with the CCP & GEDA and concerned departments on the work plan that can be adopted for various stakeholder meetings, primary and secondary data collection and identification of various sector specific strategies.

2.3.2 Project Instigation

This task involved several sub tasks like:

- Reviewing case studies on various documents related to Green Cities/ eco cities prepared nationally and internationally.
- Meetings and consultations with stakeholders
- Appreciation of prevailing development policies

2.3.3 Preparation of Energy Baseline for 2012

Task 01: Database Identification and Anthology

- Primary and secondary data forms the backbone of any kind of research work and also helps in focusing the study towards the definite approach. Under this task, the database required and the departments responsible for such kind of data was identified at urban level during the data collection.
- Secondary data would be collected in relation to different sectors.
- Apart from the secondary data, sample surveys was conducted to cover aspects such as energy consuming appliances, consumption patterns, consumer preferences; efficiency of use etc by detailed survey of various household of various categories

Task 02: Preparation of energy baseline report

Here, all the information collected from Secondary and primary sources are analyzed to arrive at the energy baseline for each sector. In order to develop a better understanding of the energy consumption and supply of different sectors.

2.3.4 Demand Forecasting for 2014-15 to 20123-24

The energy demand for each of the sectors is established. This is done by taking into account the various parameters (e.g. Fuel consumption by outside vehicle, future commercial & Industrial growth etc.).

2.4 Strategic Vision

Strategic vision for developing CCP as a solar city has been decided on the basis of stakeholder consultation and focused group discussion during the preparation of solar city master plan.

3 Success Stories

3.1 Introduction

A large proportion of the world's population lives in cities, towns and urban regions, in which three quarters of the overall energy consumption occurs. Urbanization and economic development are leading to a rapid rise in energy demand in urban areas. The urban areas are heavily dependent on fossil fuels for maintaining essential public services for powering homes, transport, infrastructure, industry and commerce etc. It is generally recognized that a transformation of the present energy system is required in order to secure the energy supply and to mitigate the risks of climate change. The transformation can be made possible by a shift towards Renewable Energy Systems (RES) and a more national use of energy. One of the approaches to achieve such a transformation might be to convert more number of cities to solar cities.

3.2 Institutions involved on Solar Cities

Several institutions working on solar cities are given below.

- European Solar cities initiatives (ESCI)
- International Solar cities initiatives (ISCI)
- Solar city Task force

The following section discusses briefly about the initiatives and activities undertaken by these institutions.

3.2.1 International Solar Cities initiatives (ISCI)

International Solar cities initiative is the group who had organized the first solar cities congress in Daegu, Korea in 2004. The primary focus of ISCI is to set up the target for introduction of renewable energy and reduction of green house gas emissions on a longer term.

3.2.2 European Solar Cities Initiatives

The aim of the initiative is to support the European energy and climate policy by stimulating the interests of European "high performance" cities and surrounding regions (prospective "Solar cities"), the European research community and the European sustainable energy industry.

The initiative will mobilize a critical mass of participants to find efficient and rapid ways of implementing Renewable Energy Sources (RES) and Rational Use of Energy (RUE) in European cities through research, development, demonstration and information dissemination activities and through stakeholder participation (citizen

and others). The goal is to speed up the transformation of the European cities into solar cities.

A working definition of solar city is a city that aims at reducing the level of green house gas emissions through a holistic strategy for the introduction of RES and RUE to a climate stable and thus sustainable level in the year 2050.

3.2.3 Solar city Task force

Solar city task force is an advisory service to assist towns, cities etc. integrating renewable energy technologies and energy conservation and efficiency measures in order to reduce the green house gas emission. A general methodology has been developed based on the experiences and best practices adopted by different institutions internationally for providing such services.

3.2.4 European solar cities projects

The European Solar cities projects (EU Solar Cities) aims at promoting the wider and larger scale use of renewable energy (RE) within the context of long term planning for sustainable urban development. It is basically a study that addresses the planning and application of technologies for utilizing RES and RUE in an urban context and their relevance for reducing CO_2 emissions.

Solar city is seen as a city that has made firm commitments in order to reduce green house gas emission targets while incorporating renewable energy technologies.

Within the scope of this project several activities were conducted.

- The collection and assessment of information about different activities and programmes of selected European cities and city networks, with a description on their implementation and an assessment of their impact.
- The examination of these activities assisted in the development of two guide books for city actors, namely:
    - Good practice guide
    - Guide on CO_2 reduction potential in cities.

The results encompass a range of informative materials, with recommendations for replication to city actors and local governments.

The good practice guide is useful for city actors that require ideas and information for planning their own activities and strategies to implement clean energy sources and promote the reduction of harmful emissions. A set of generic good practices have been identified , which represent a good starting point for cities that require an introduction to the concept of implementing RES and RUE strategies and activities.

The CO_2 reduction potential assessment and issues impacting on CO_2 balances, is a comprehensive report that addresses reduction targets and baseline targets. This is

particularly useful for guiding cities interested in implementing a strategy, with basic steps identified to assist this process.

It has to be noted that there are many different approaches that are, and can be, used by cities, with different baselines and varied ways of presenting emissions reduction results. Although scientists are not unanimous in agreeing to the best way to measure emissions, or the most effective way to calculate emission reductions, the project team has the view that a delay in implementing the strategies and activities that will adequately reduce harmful emissions is in itself the most damaging approach.

Under this study eight cities were identified. Cities were selected from Austria, Belgium, Denmark, France, Germany and Italy. Sixty three city good practices from seven cities and one housing association have been identified. Every city needs to consider the results of its actions in terms of energy used and the effect it has on the environment.

A range of good practices recommended for replication have been identified and present a guide to urban actions that contribute to sustainability in cities, and actions that strengthen networks.

- 63 city good practices
- 22 city network good practices.

4 Stakeholders Consultation

The success of the Solar City Master Plan depends on the extent of people participation. As it is very rightly said **"Planning is an exercise 'For' the people, 'Of' the people and 'By' the people".** People perception and views should be given an important position in any development programme as the whole exercise is done for the common good of the people.

As per the guidelines, Consultants were supposed to organize its **first inception workshop** with assistance from GEDA & CCP. The aim of the workshop was to familiarize various stakeholders the purpose, process and expected outcomes of the Master Plan. Stakeholders included elected representatives, Municipal commissioner and people from local departments like PWD, Electricity Department, Town and country planning department, development Authority.

4.1 Formation of Stake Holder Committee

A stake holder committee comprising of the Municipal corporation officials, Department of Electricity officials, PWD, NGOs, and Press etc. was formed. The Solar City Cell members will participate in the discussions at every stage during the course of preparation of the City Development Plan. The Steering Group members of Goa State Solar City Cell are as follows:

- Municipal commissioner, CCP
- Project Officer GEDA, Goa
- Additional District Magistrate
- District Supply Officer
- Principal, ITI, Goa
- Executive Engineer, Department of Electricity

4.1.1 Problems and suggestions highlighted by the stakeholders

The problems and issues identified by the elected representatives and administrative staff and other stakeholders are encapsulated as under:

- Primary Survey type has to be Presented, like questionnaire filled, consumers approached etc.
- Transport Sector has been included as much as possible in Solar City master plan. Due to technical and geographical constraints direct intervention is not possible at this stage in transport sector. CCP should introduce battery operated vehicle for reducing the conventional fuel demand in transport sector.

- Project to be Included: Solar Panel mounted on top of the Building to capture the sunlight and feed the electricity generated into the grid.
- Solar Water heating system & Star ratings of Buildings should be promoted in housing complex and commercial buildings.
- Renewable energy and water conservation projects should be identified for Hotel Industries.
- Separate chapter on Green Building should be included in Master Plan.
- Bus Depot and Bus stands should also be considered for installation of solar rooftop systems.
- Waste to energy analysis for future should be made in the Master Plan, like type of project, area required for the project, cost of project, technology used.
- Buildings or parks can be utilized for street lighting through solar energy.

5 Sector wise Energy Consumption & Baseline

5.1 Introduction

Energy baseline is the amount of energy that would be consumed annually in Business As Usual (BAU) scenario. This BAU is without consideration of any energy conservation measure and is entirely dependent upon the historical data, engineering calculations, metered energy consumption in systems, building load simulation model, statistical regression analysis or a combination of these. This chapter is focused on present energy consumption in residential, institutional, commercial and municipal sector with its overall energy consumption scenario for Panaji city.

5.2 About the city

Panaji the capital city of Goa comprises 30 wards like fountain has, Mala, St Tome, Alto Pilots, Boca de Vaca, Portais, Bhatlem, Tonca, Alto Guimaraes, Campal, St Inez, Gaspar Dias, Ribandar, Dona Paula, etc. Panaji's history is long. Historical accounts of this place date back to Kadamba King Shasthadeva (1007-1050).

The Corporation of the City of Panaji is the oldest civic institution in Asia. It received the status of a Portuguese city in 1843. It is also the world's smallest municipal corporation, catering to the civic needs of Goa's capital city of Panaji. Goa one of the youngest states, which was incorporated into Indian Union (in 1962). The City Panaji is the capital of the state of Goa, and it is the headquarters of the North Goa district. The official name is Panaji, though in the local language (Konkani) the Panaji gets pronounced as Ponnji, Ponnje, or Ponjhe.

Panaji is a tiny city that packs in a large punch, built around a church facing a prominent square and lies on the banks of the Mandovi estuary in the district of North Goa.

Panaji is the important center in terms of Indo-Portuguese cultural heritage. Panaji is spotted as one of the most attractive tourist destination centers in India, and it attracts around 2.0 Lakhs of National tourist and 0.35 Lakh of international tourist annually.

The City Panaji is located in 15.25° North Latitude 73.5° to East Latitude and about 60 Meter above the Mean Sea Level. The city is bound by the Rua de Querem creek on the north that has been artificially trained to flow along its east side, the Mondovi river on the north, the hillock of Altinho on the south east and the St.Inez Nullah and Taleigaoon the west.

Panaji is the travel & transit hub of Goa. The city is well connected by roadways, airways, waterways and railway network (Map 3.1). to the urban centers in the state, national capital and important cities in the neighboring states. Being Goa's capital city and administrative headquarter, it is well connected by road to the towns and cities within the state and with important towns in neighboring states, as it is served by National Highway No. 17 and 4A. Goa, Maharashtra and Karnataka state transport corporations operate from Panaji's Kadamba bus stand.

As Panaji is located along the river Mandovi, on island of Tiswadi in land/waterways have also developed to some extent. It is well connected by airways, from Mumbai (Bombay), Bangalore, Cochin, Delhi, Chennai (Madras), Mangalore and Trivandrum. The airport is located at Dabolim, which is about 35 km away from the city of Panaji. Panaji is also connected by air with Secunderabad, and Jaipur in addition to above towns. The railway station is located at Madgaon.

Figure 5-1: Satellite Image of Panaji City

5.2.1 Demographic Profile

The Figure below gives us the population data for CCP. The table 6.1 shown below gives us the yearly population, its increase in absolute terms as well as in percentage for CCP.

Figure 5-2: Population Growth of Panaji

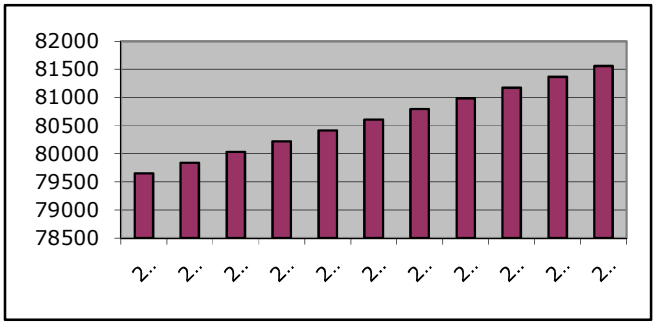


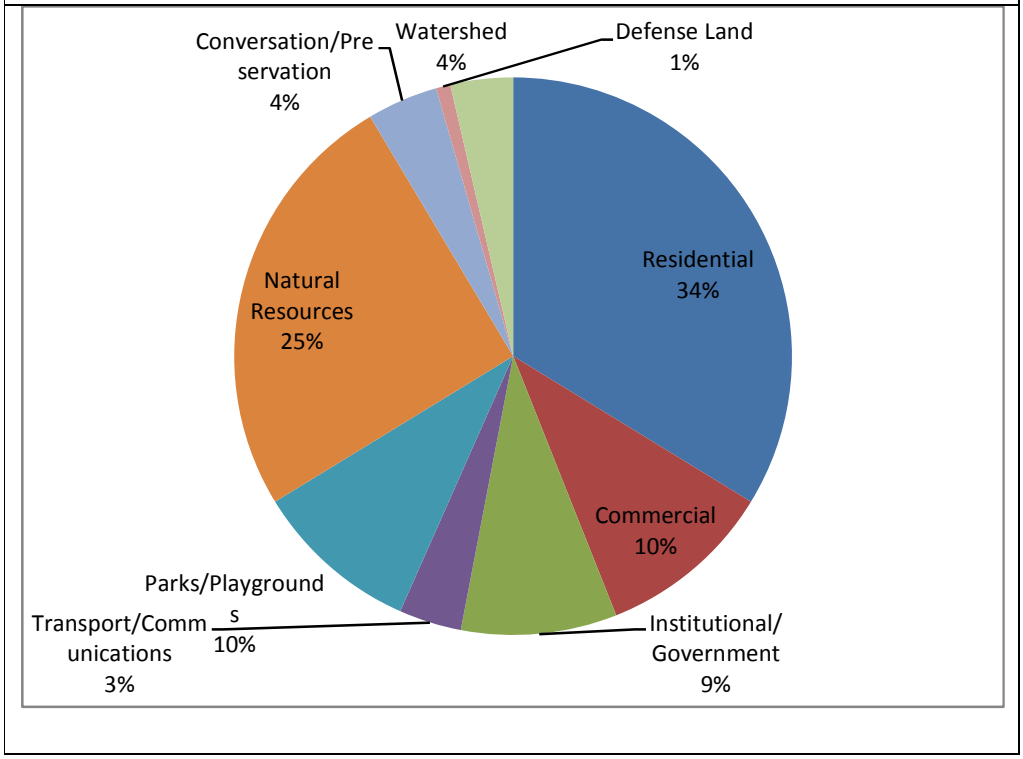
Table 5.1: Year wise population: urban Agglomeration - Panaji

2014	79650
2015	79841
2016	80032
2017	80223
2018	80414
2019	80605
2020	80795
2021	80986
2022	81177
2023	81368
2024	81559

5.2.2 Land Use Pattern

The total area of CCP is 830 ha. The land use pattern is as per North Goa Planning and Development Authority has been shown in figure 6.3

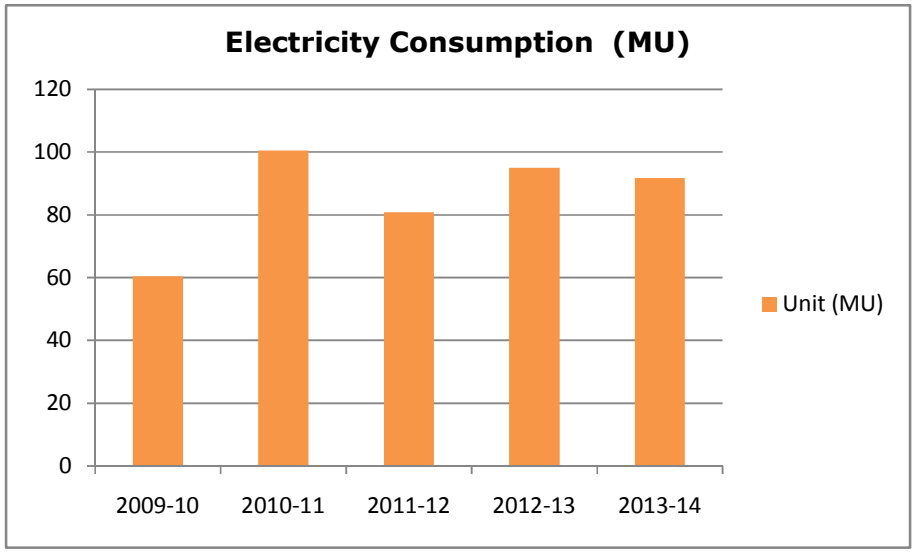
Figure 5-3: Land use pattern of CCP



5.2.3 Electricity Consumption Scenario

In order to have a better understanding about energy conservation potential, it is imperative to understand the profile of the energy consumption under the business as usual scenario (BAU). The following sections focus on present energy consumption pattern in residential, industrial and commercial sector with its overall energy consumption scenario.

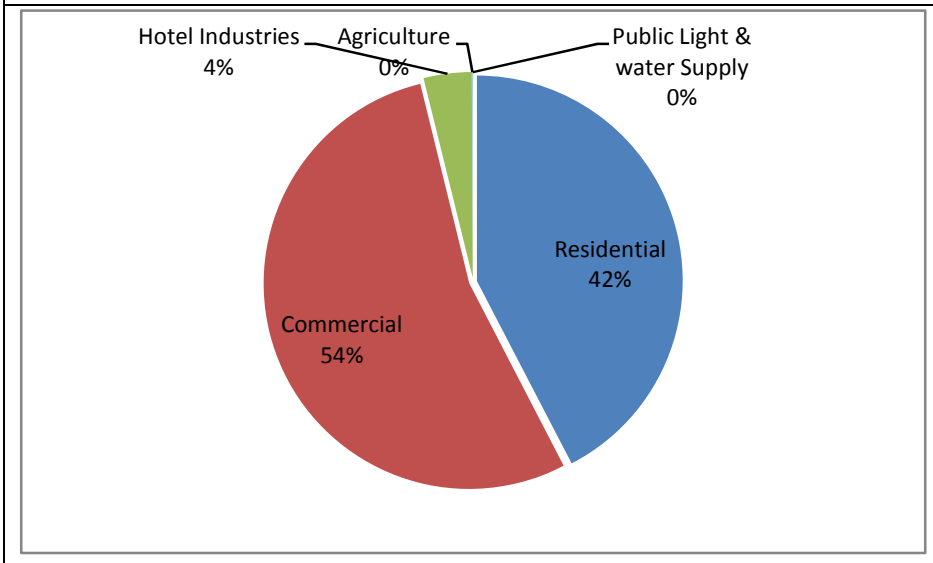
Figure 5-4: Total Annual Electricity consumption (MU)



Source: Department of Electricity

The total energy consumption for Panaji city is shown in the Figure 5.4. As can be seen from the figure, the electricity consumption has become 1.5 times that of the year 2007-08 and it stands at 92 MU for the year 2013-14.

Figure 5-5: Sectoral electricity use pattern



Source: Department of Electricity

Figure 5.5 shown gives us an idea about sectoral electricity use pattern of Panaji city for the year 2013-14. It shows that commercial and followed by residential sectors are the most power consuming sector and others are having only 3% of total consumption.

Table 5.2: Sector wise Total Number of Consumers

Type of User	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013
Residential	11361	11944	13109	13546	13400
Commercial	6037	6346	6966	7198	7469
Industrial	91	95	96	100	105
Institutional	105	107	110	111	113
Municipal					
Hotel Industries	76	76	76	77	78

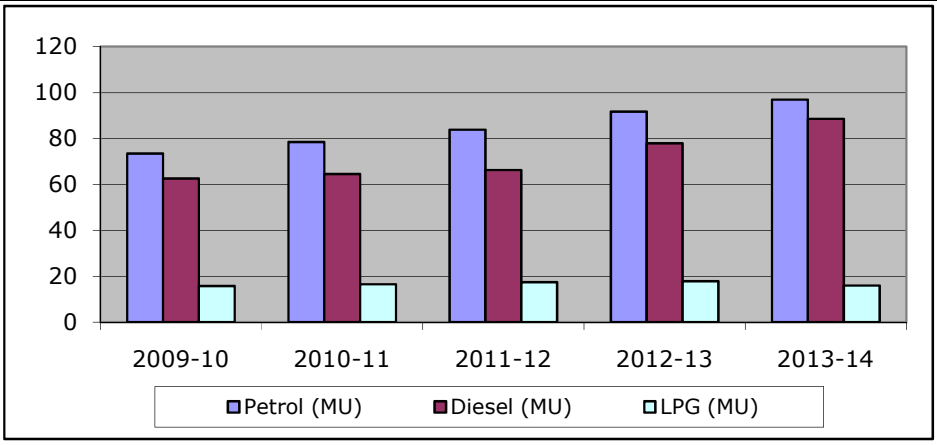
Source: Department of Electricity

The total number of consumer per year has been shown in the table 5.2 for domestic, commercial, Industrial, Institutional and Municipal sector. All sectors are not having variation with respect to number of consumers in the last five years. It shows that there is no so much growth in the city.

5.2.4 Consumption Scenario of Petroleum Products

The transport, commercial, institutional and residential sectors are the major consumers of petroleum products (Petrol, Diesel and LPG). Liquid Petroleum Gas (LPG) is mainly used in commercial, institutional and residential sector. Petrol and diesel are used mainly in transport, residential, commercial and institutional sectors. The following figure shows the annual consumption pattern of petroleum products for the last 5 years.

Figure 5-6: Annual consumption of Petroleum Products (MU)



Source : Oil Marketing companies area office

The consumption of petroleum products is increasing, especially for petrol and diesel. It clearly shows that there has been a considerable change in annual petrol consumption pattern. The consumption of petrol and diesel has increased

substantially in the last couple of year. The increase in consumption of petrol may be attributed to transportation sector as the number of households has increased substantially in the last couple of year. Further, the number of commercial establishments has increased substantially in the last couple of year to cater to this increase in the floating population. Consumption of diesel has decreased in last 2 years. The consumption of LPG in the city has increased in the past 5 years due to rise in commercial activity and increase in household consumption. There is decrease in consumption of LPG in year 2013-14. It is due to new subsidy scheme of central government for residential LPG cylinder.

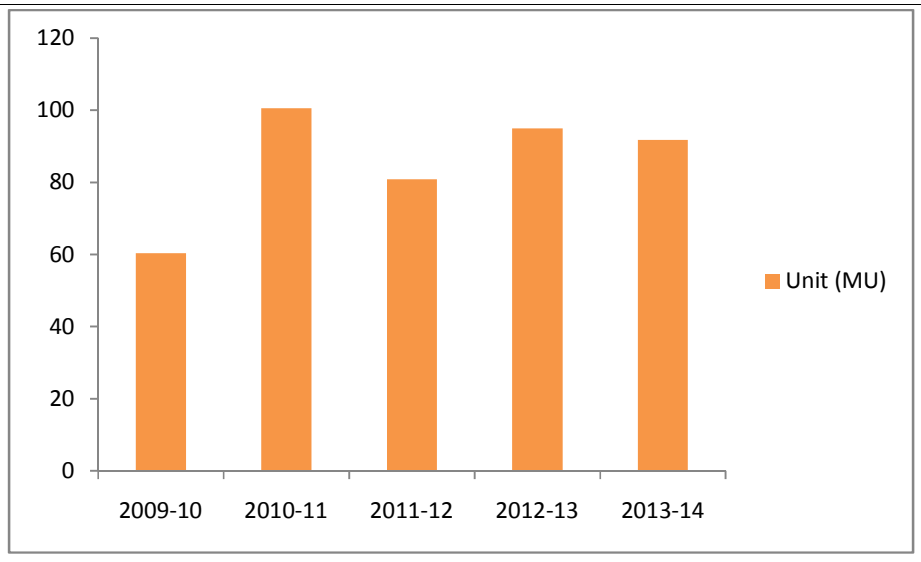
5.2.5 Residential Sector

The population of Panaji city is 79650 for 2014. The Socio economic profile of CCP is indicated in the Table 6.3 below.

Table 5.3: Social & Geographical profile of CCP

Particulars	Year- 2014
Population	79650
Area (ha)	830
Number of households	13400

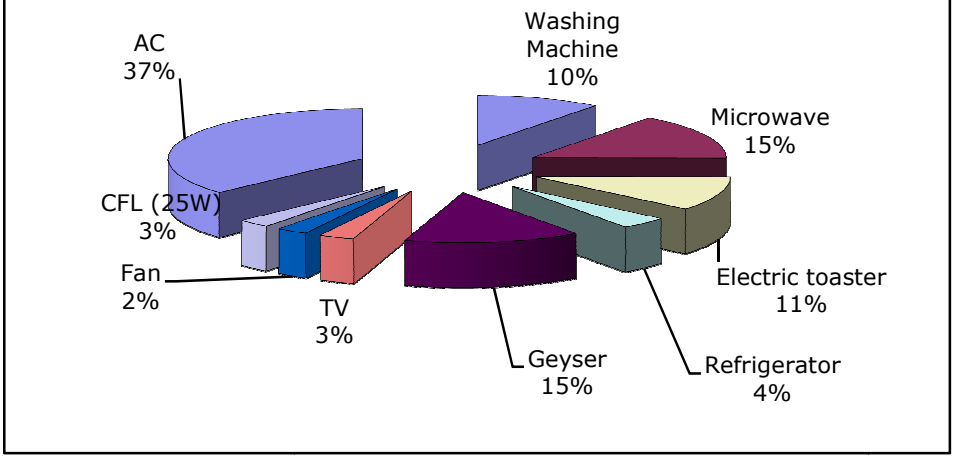
Figure 5-7: Annual electricity Consumption – domestic (MU)



Source: Department of Electricity

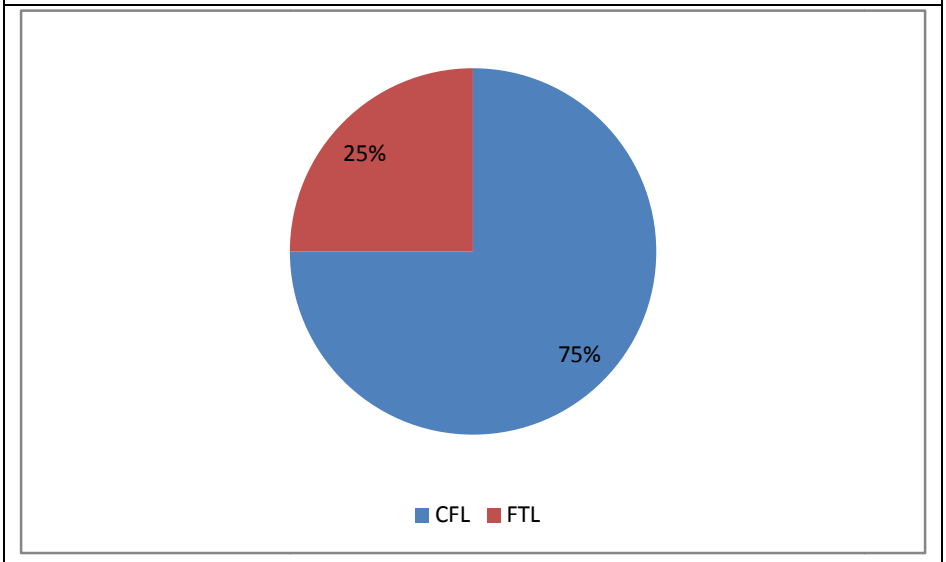
The annual electricity consumption pattern is shown in the figure 5.7. As can be seen from the figure, the consumption of energy has increased 1.5 times in the last five years in Panaji city. Currently it stands at around 92 MU.

Figure 5-8: Household Energy consumption pattern



Since it's a new city, it is assumed that all the households are electrified. The household electricity consumption pattern based on our sample survey is indicated in the figure 5.8. It shows that the AC is having maximum connected load in the total load. Largest chunk of electricity is being used in operating the AC followed by Microwave as every household use these appliances on daily basis. A nominal portion of electricity is used in Television. The same sample survey indicates that there is a good awareness among the people about use of CFL (Compact Florescent Lamp). If we further delve into the sample survey data about type of luminaries in the household, we can see the contribution of various luminaries used for lighting in the figure 5.9. As the chart shows that CFL is used for the 75% of total lighting requirement.

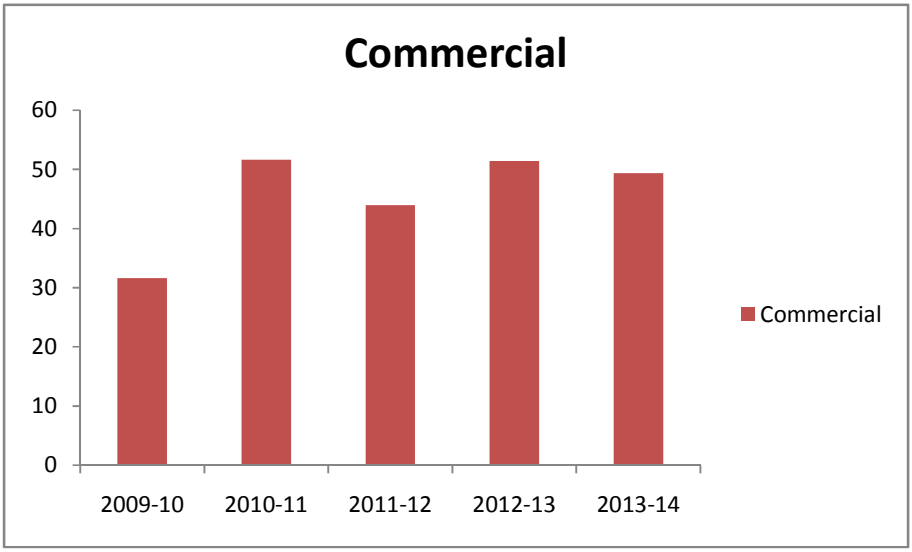
Figure 5-9: Contribution of different luminaries in electricity consumption



5.2.6 Commercial sector

The commercial sector growth is almost stable in Panaji. To cater these floating population commercial setups is coming up. The commercial sector has got both the HT as well as LT consumers. The electricity consumption of the commercial sector is 49 MU in year 2013-14 which is shown in the figure 5.10.

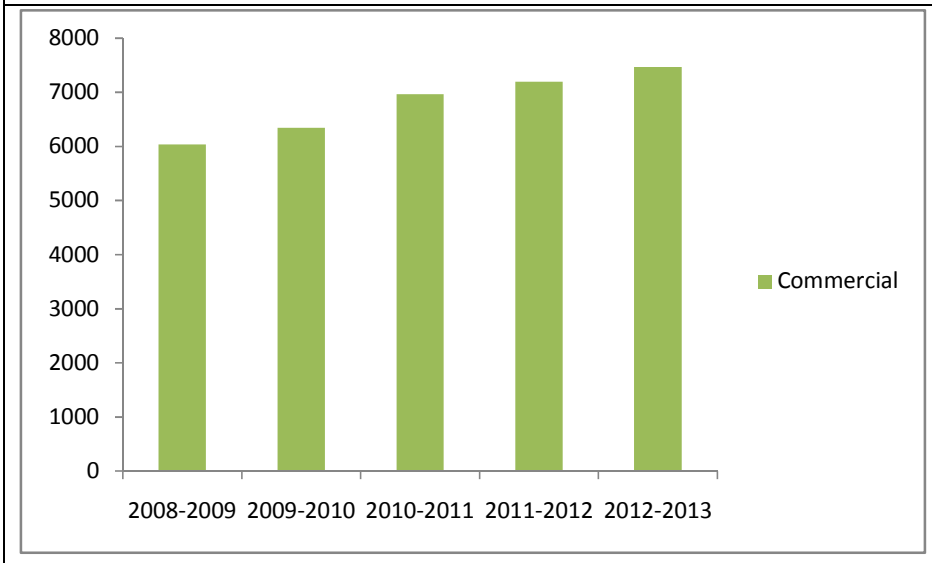
Figure 5-10: Commercial Sector Electricity Consumption



In order to have a better understanding about energy conservation potential, it is imperative to understand the profile of the energy consumption under the business as usual scenario (BAU). The following sections focus on present energy consumption pattern in commercial sector with its overall energy consumption scenario.

The average number of consumers per year has been shown in the figure 5.11 for commercial sector. The number of commercial consumers has increased 6037 in FY 2009-10 from 7469 in FY 2003-14.

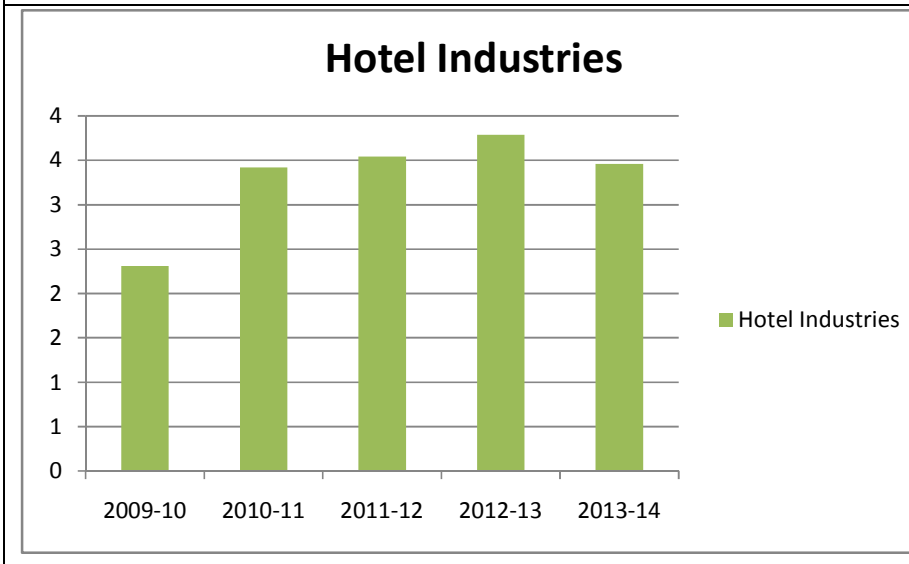
Figure 5-11: No. of Commercial consumers



5.2.7 Industrial Sector

The industrial sector growth is almost stable in Panaji. The Industrial sector has got both the HT as well as LT consumers. The electricity consumption of the Industrial sector is 3 MU in year 2013-14 which is shown in the figure 5.10.

Figure 5-12: Industrial Sector Electricity Consumption

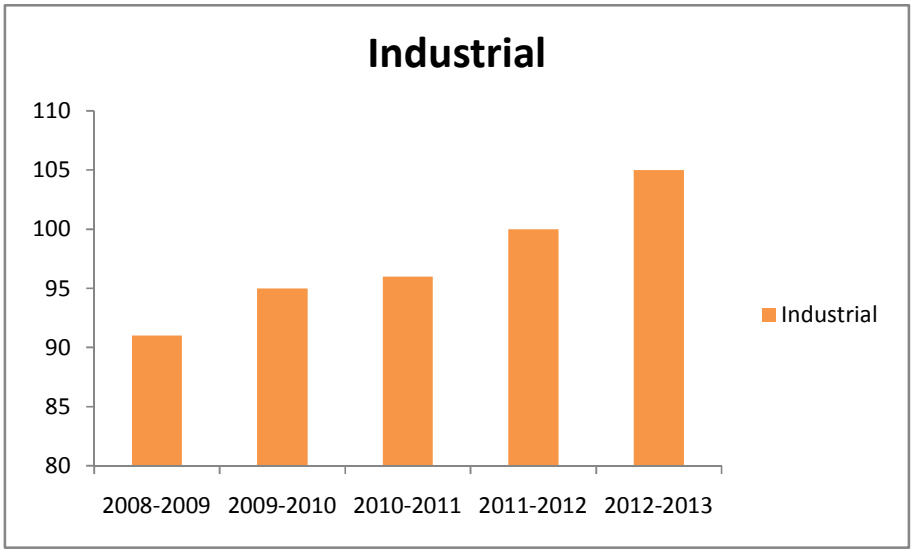


In order to have a better understanding about energy conservation potential, it is imperative to understand the profile of the energy consumption under the business as usual scenario (BAU). The following sections focus on present energy

consumption pattern in commercial sector with its overall energy consumption scenario.

The total number of consumers per year has been shown in the figure 5.13 for Indutrial sector. The number of commercial consumers has from increased 91 in FY 2009-10 to 105 in FY 2003-14.

Figure 5-13: No. of Commercial consumers

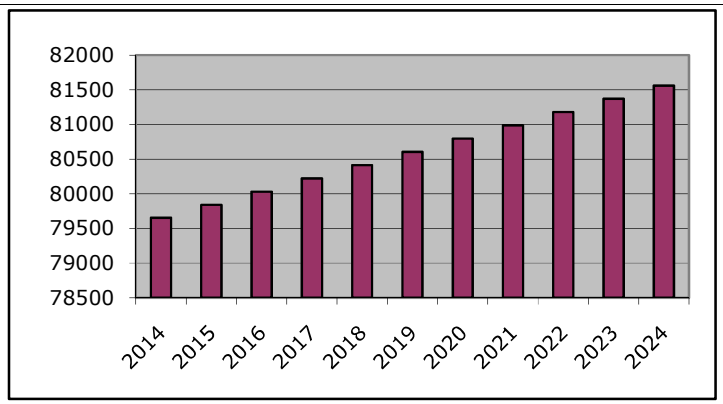


6 Energy Forecasting and Target Setting

6.1 Introduction

As discussed the current situation in the earlier section, now we are doing the trend analysis for the population data, we get the following data for the projected population as shown in figure 6.1. It shows that by the end of 2024, the population will grow up to 82,000.

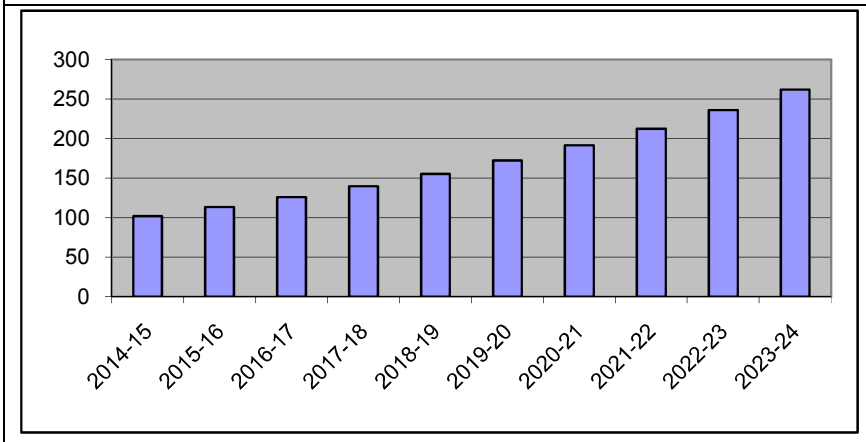
Figure 6-1: Projected population data for Panaji



6.2 Projection for electricity demand up to 2023-24

Based on the total electricity consumption data for Panaji for the past five year, a trend analysis has been done for preparation of BAU scenario and the same has been projected for the next 10 years as shown in figure 6.2. It clearly shows that by 2023-24, the annual electricity consumption of Pani City would be around 262 MU in BAU scenario which is about 2.85 times the total electricity consumption of the city in the year 2013-14.

Figure 6-2 Total Projected Annual Electricity consumption (MU) in BAU scenario



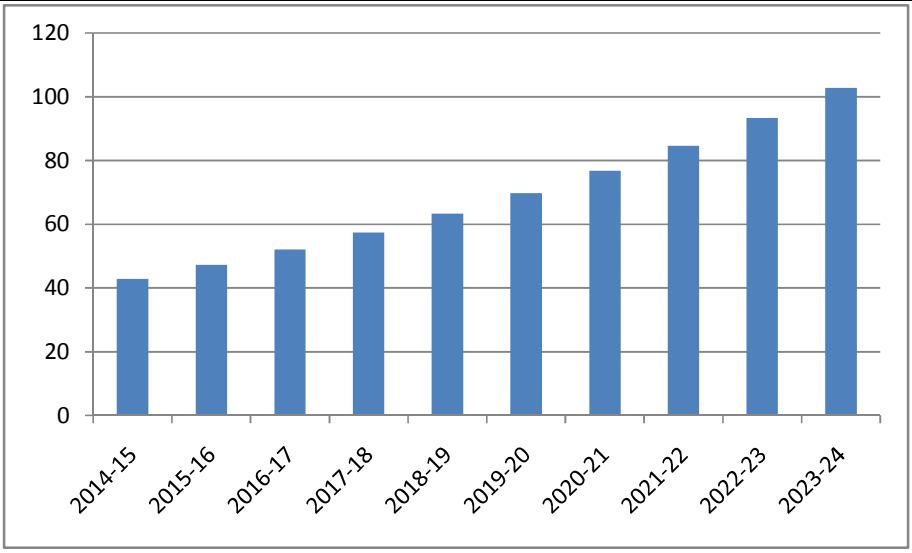
Source: Department of Electricity & Darashaw Analysis

The projection of different sectors has been given in the following sections.

6.2.1 Residential Sector

All the demand forecast/projection in the following sections has been done through time series analysis of data gathered from various sources for historical data.

Figure 6-3: Projected Annual Electricity consumption (MU) in BAU scenario – Residential



Source: Department of Electricity & Darashaw Analysis

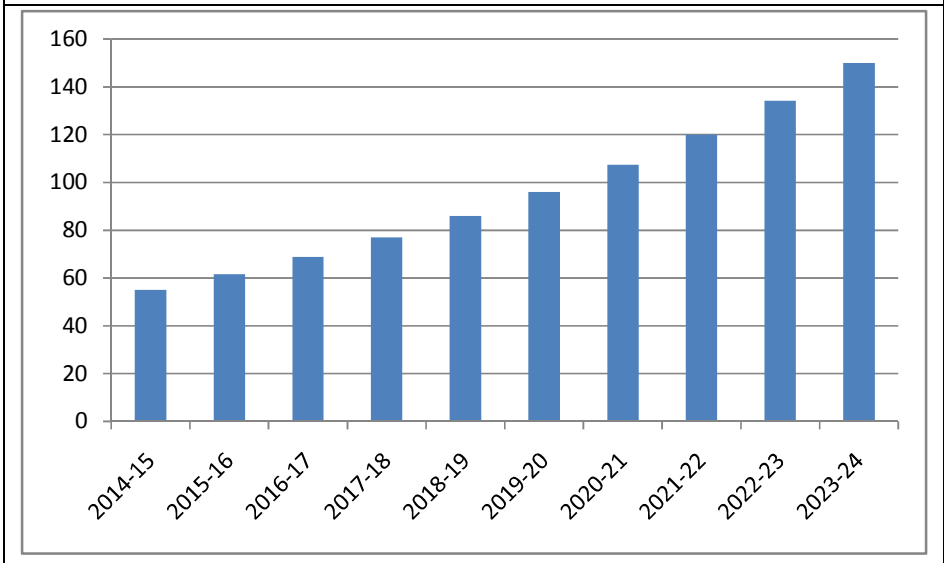
Based on the electricity consumption data, a trend analysis has been done for preparation of BAU scenario and the projection of electricity demand has been done

for the next ten years as shown in the figure 6.3. It shows that in case of BAU scenario, the electricity consumption in the residential sector would go up to 103 MU by 2023-24, which was 39 MU in FY 2013-14. It means that the expected growth in electricity consumption in the residential sector would be more than the growth rate of the total electricity consumption for Panaji. This could be attributed to the spurt in commercial activity to cater to the floating population of the city. Residential consumption will increase due to increase in number of consumers.

6.2.2 Commercial Sector

The commercial sector is growing at a considerable rate in Panaji. Some of these establishments are HT consumers and others are LT consumers. The total energy consumption from all these commercial consumers have been projected for the next ten years on the basis of past five year data using regression analysis and shown in figure 6.4. It clearly shows that by the end of 2023-24, the annual electricity consumption in commercial sector will be around 150 MU in BAU scenario, which was 49 MU in FY 2013-14.

Figure 6-4: Projected Annual Electricity consumption (MU) in BAU scenario – Commercial



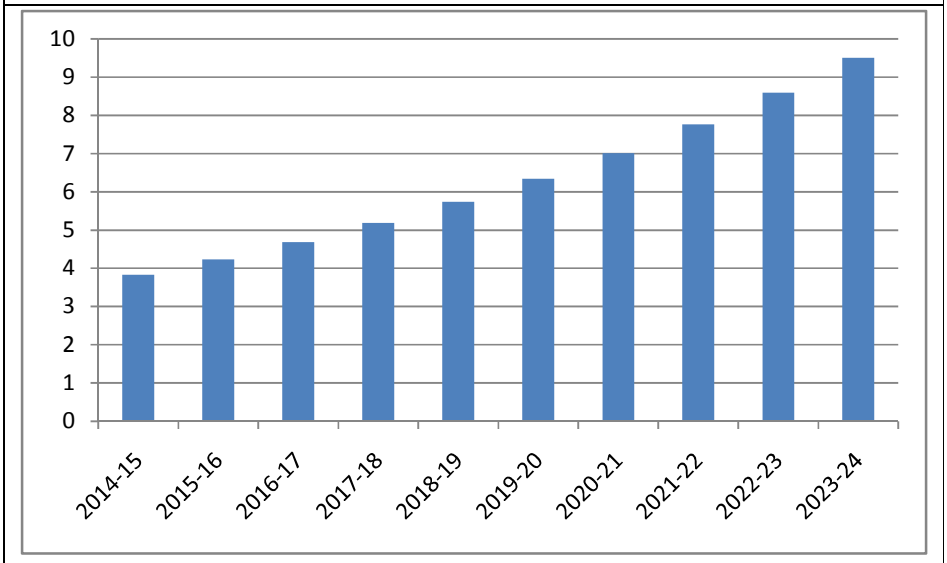
Source: Department of Electricity & Darashaw Analysis

6.2.3 Industrial Sector

The Industrial sector is having almost stagnant growth in Panaji. Some of these establishments are HT consumers and others are LT consumers. The total energy consumption from all these commercial consumers have been projected for the next ten years on the basis of past five year data using regression analysis and

shown in figure 6.5. It clearly shows that by the end of 2023-24, the annual electricity consumption in commercial sector will be around 10 MU in BAU scenario, which was 3 MU in FY 2013-14.

Figure 6-5: Projected Annual Electricity consumption (MU) in BAU scenario – Industrial



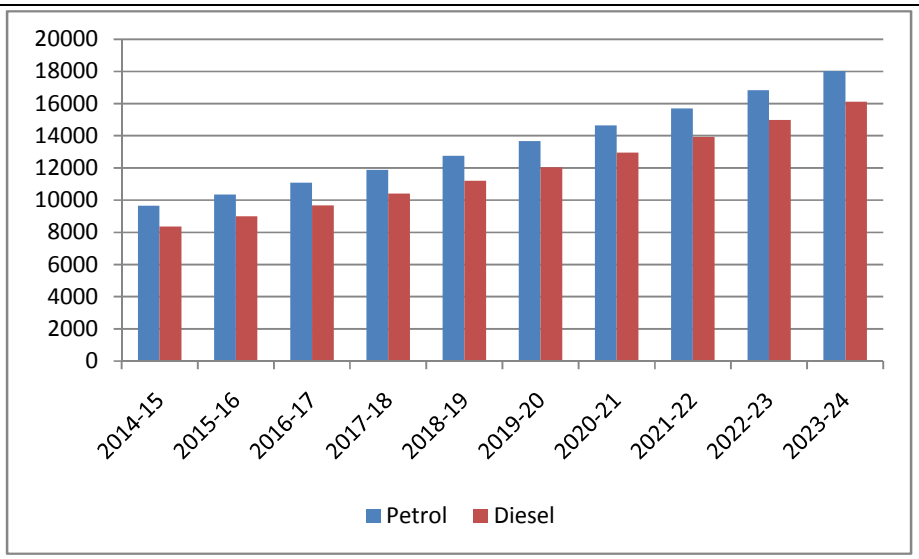
Source: Department of Electricity & Darashaw Analysis

6.3 Projection of demand of Petrol, Diesel and LPG for next Decade in Business as usual (BAU) scenario

6.3.1 Projected demand for Petrol and Diesel

Forecast/projection for petrol, Diesel and LPG has been done through time series analysis of data gathered from various sources for historical data. The fuel consumed is projected for next ten years considering the appropriate growth rate.

Figure 6-6: Projected Annual Petrol & Diesel consumption (KL) in BAU scenario



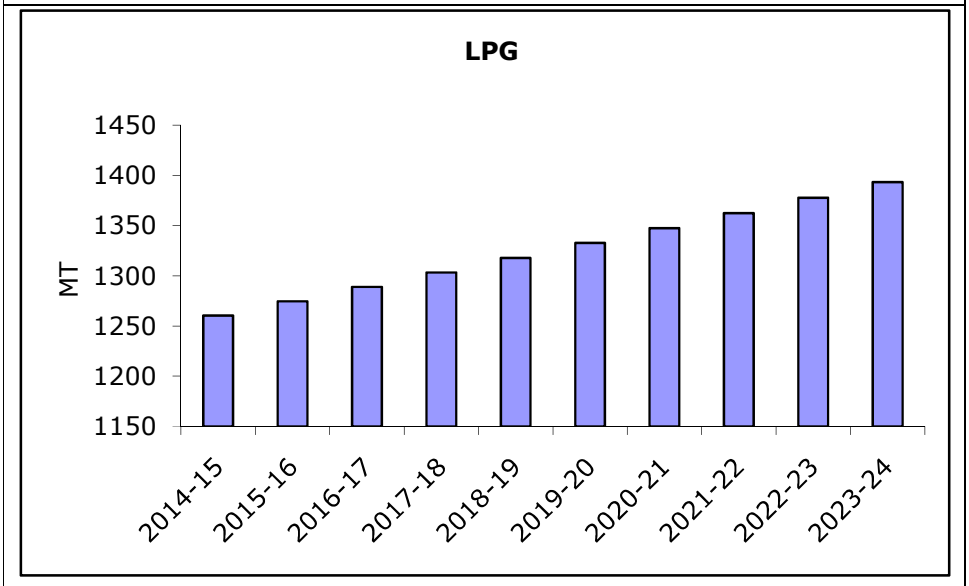
Source: Oil Marketing companies & Darashaw Analysis

Based on the fuel consumption data, a trend analysis has been done for preparation of BAU scenario and the projection of fuel demand has been done for the next ten years as shown in the figure 6.6. It shows that in case of BAU scenario, the Petrol and Diesel consumption would go up to 18038 KL and 16122 KL respectively by 2023-24, which was 9008 KL and 7780 KL respectively in FY 2013-14. Projections for petrol have been done based on growth rate of 5 years CAGR and for petrol and diesel is 7.2% and 7.6% respectively has been considered.

6.3.2 Projected demand for LPG

The consumption of gas will keep on increasing in the BAU scenario. The projection of LPG consumption is shown in figure 6.7 in MT. The projected consumption of LPG has shown a considerable increase over next 10 years. LPG consumption is projected on the basis of 5 years CAGR. It shows that in case of BAU scenario, the LPG consumption would go up to 1393 MT by 2023-24, which was 1246 MT in FY 2013-14. It clearly shows that by the end of 2023-24, the annual LPG consumption will increase due to increase in no. of households & Population.

Figure 6-7: Projected Annual LPG consumption (MT) in BAU scenario



Source: Oil Marketing companies & Darashaw Analysis

6.4 Target Setting

As shown in the previous sections, the demand of energy is going to increase unabated in the Business as Usual scenario. If we convert all the energy derived from fossil fuel source to equivalent amount of electricity in Million Units, we can arrive at a baseline of 2013-14. The total equivalent electricity consumption thus derived in the baseline year could be taken as the basis and the target setting can be done accordingly (10% reduction in next 5 years). The following table 6.1 shows the consumption of electricity as well as fossil fuel projected in the baseline year.

Table 6.1: Consumption of Energy Sources in Year 2013-14

Energy Source	Electricity (MU)	Petrol (KL)	Diesel (KL)	Kerosene (KL)	LPG (MT)
Consumption	92	9008	7780	798	1246

Now if we convert these sources of energy into a common denomination, we can arrive at equivalent million units of electricity for all these different sources of energy. The table 6.2 shows these values converted into the same units of million equivalent of Electricity produced (in Million Units).

Table 6.2: Consumption of Energy Sources in Year 2013-14 converted into Million Units (MU) of electricity equivalent.

Energy Source	Electricity(MU)	Petrol (MU)	Diesel (MU)	Kerosene (MU)	LPG (MU)
Consumption	92	97	88	30	16

Now, the solar city programme envisage a 10% reduction in conventional energy demand through a combination of various demand side and supply side measures spread across all the sectors by the end of next 5 years. Accordingly, the target for CCP could be considered as a reduction of 10% of the total energy demand which turns out to be equal to 85 Million Units of electricity.

Table 6.3: Projected Consumption of energy from Conventional sources in 2018-19.

Energy Source	Electricity(MU)	Petrol (MU)	Diesel (MU)	Kerosene (MU)	LPG (MU)	Total (MU)
Consumption	155	137	127	13	17	450

Table 6.4: Projected Consumption of energy from Conventional sources in 2023-24

Energy Source	Electricity(MU)	Petrol (MU)	Diesel (MU)	Kerosene (MU)	LPG (MU)	Total (MU)
Consumption	262	194	183	6	18	663

Table 6.5: Target Reduction of conventional Energy @10%

Year	Total (MU)
2016-17	45 MU
2021-22	66 MU

The target for the Solar city programme for Panaji City could be taken as the reduction in the demand of electricity equivalent by 45 MU by next five years through various supply and demand side measures in residential, commercial, Industrial and Municipal sectors. This would lead to a marked reduction in the Carbon footprint of the city and will propel it onto a sustainable path of growth in terms of energy. Various Renewable Energy (RE) and Energy Efficiency (EE) options through which this can be achieved are explained in detail in the subsequent chapters.

CCP will achieve 73% of total target by Renewable energy and balance 27% through energy efficiency sources. Total estimated targeted reduction of RE sources is 42 MU and reduction of EE measures is 15 MU by 2018-19.

7 Green Building & Energy Efficiency in Buildings

7.1 Introduction

Residential, public and commercial buildings consume a large amount of energy mostly for lighting, appliances, space heating and water heating. In order to improve energy efficiency and conserve energy through the concept of solar city existing buildings and new buildings must evolve to incorporate energy efficiency and energy conservation measures.

To encourage the best practices in Panaji, this chapter considers how energy efficiency is incorporated into building codes. Strategies to achieve energy efficient buildings according to international practice will be explained here for the main components of a building in order to achieve energy efficiency and conservation in the developing solar city of Panaji. Information on technologies and energy saving methods outlined in this chapter aim to assist CCP in going beyond basic energy efficient strategies and to provide more the tools for innovative design for new and retrofit buildings for Panaji.

As Panaji lies in the hot and humid climate, any energy efficient building system must be designed according to this climate. This should also be a major consideration when looking at various practices that are suitable to follow.

This chapter will explain in detail the various green and sustainable initiatives that can be incorporated during the construction and operation of any new construction as well as retrofitting of existing buildings planned in city of Panaji.

7.2 Building Energy Efficiency – Existing policy Framework

In India there exist the National Building codes 2005 (NBC 2005) and the new Energy conservation of buildings codes 2006 (ECBC 2006). The national building codes only consider regulations in building construction primarily for the purposes of regulating administration, health and safety, materials and construction requirements and building and plumbing services whereas the ECBC 2006 consider energy conservation and energy efficiency in buildings to provide minimum requirement for the energy efficient design and construction of buildings. The NBC 2005 refers to a wide variety of building type and ownership whereas ECBC 2005 only refers to commercial buildings and some building complexes.

The ECBC 2006 mainly considers administration and enforcement, the building envelope, HVAC, service hot water and pumping, lighting and electric power to

encourage conservation of energy. These are considered in new buildings and additions to existing buildings.

At present the energy conservation act 2001 empowers the state governments to adjust the codes according to local conditions. This encourages inconsistency in building practices across the country and can lead to huge deviations from the existing codes. There are currently state designated agencies for implementation of this code for example in Panaji, Department of Electricity Goa is the state designated agency for implementing the energy conservation act 2001 and hence ECBC 2006.The regulating authority is different for each state and is responsible for enforcing the adapted building codes for that state. Experts check the plans for new buildings or changes to existing buildings and permit the builder to carry out construction if the design meets the code requirements. The plans are rejected and sent for alteration if they do not meet the requirements. After the building is built it must again be certified as complete by the state designated agency before it is used.

The Bureau of Energy Efficiency is working on certifying Energy Auditing Agencies in order to evaluate buildings energy use, which will enable better regulation of energy conservation in buildings. In order to encourage green rating practices of buildings, IGBC has come up with LEED rating.

Points are given for different criterion at the site planning, building planning and construction, and the building operation and maintenance stages of the building life cycle as explained in action plan.

7.3 Green Building-An Understanding

Green Building, also known as green construction or sustainable building, is the practice of creating structures and using processes that are environmentally responsible and resource- efficient throughout a building's life-cycle.

Although new technologies are constantly being developed to complement current practices in creating greener structures, the common objective is that green buildings are designed to reduce the overall impact of the built environment on human health and the natural environment by:

- Efficiently using energy, water, and other resources
- Protecting occupant health and improving employee productivity
- Reducing waste, pollution and environmental degradation.

7.4 Need for a Green building

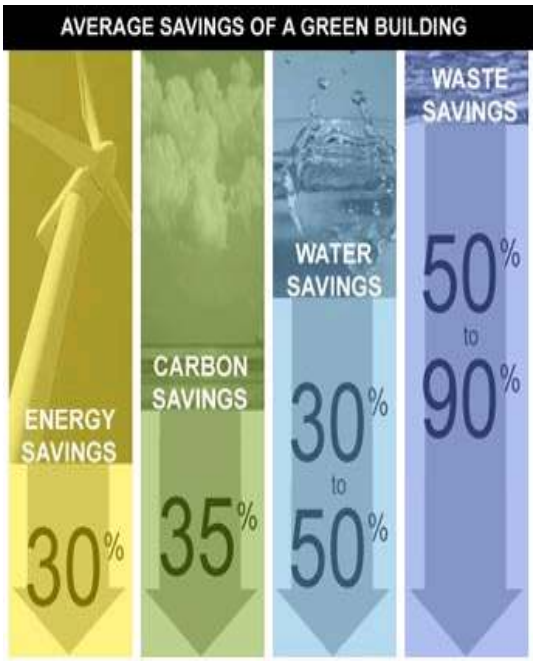
Traditional buildings consume large amounts of energy and other natural resources and generate harmful byproducts for the environment around them. In India buildings account for 30% of total energy consumption and generate 35% of green house gas emissions that harm air quality and contribute to global warming.

Thus Buildings have an enormous impact on the environment, human health, and the economy. The successful adoption of green building strategies can maximize both the economic and environmental performance of buildings.

7.5 Benefits and outcomes of a Green building

The major benefits of a Green building are as follows:

- ✓ Reduced energy consumption without sacrificing the comfort levels
- ✓ Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.
- ✓ Reduced air and water pollution (with direct health benefits)
- ✓ Reduced water consumption
- ✓ Limited waste generation due to recycling and reuse
- ✓ Reduced pollution loads
- ✓ Increased user productivity
- ✓ Enhanced image and marketability



Following are the outcomes of a Green building as researched on basis of existing Green buildings.

- There is 8-9 % decrease in operating costs
- The building value increases by around 7.5 %.
- The return on investment is around 6.6 %.
- There is around 3.5 % increase in occupancy in Green buildings.
- Reported increase of about 3.0 % in rent ration.

7.6 Rating system for Green buildings

In India, at present, there are predominantly two rating systems to certify buildings as green buildings, namely GRIHA and LEED-INDIA. These rating systems have a predefined set of criteria and there are points for each one of these criterion. The buildings are required to fulfill the defined criteria and achieve a certain number of points to be certified.

GRIHA Rating: GRIHA, an acronym for Green Rating for Integrated Habitat Assessment, is the National Rating System of India. It has been conceived by TERI and developed jointly with the MNRE Ministry of New and Renewable Energy, Government of India. It is a green building 'design evaluation system', and is suitable for all kinds of buildings in different climatic zones of the country.

It is a rating tool that helps people, assess the performance of their building against certain nationally acceptable benchmarks. It will evaluate the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'. The rating system, based on accepted energy and environmental principles, will seek to strike a balance between the established practices and emerging concepts, both national and international. The guidelines/criteria appraisal may be revised every three years to take into account the latest scientific developments during this period.

Going by the old adage 'what gets measured, gets managed', GRIHA attempts to quantify aspects such as energy consumption, waste generation, renewable energy adoption, etc. so as to manage, control and reduce the same to the best possible extent.

LEED India Rating: LEED-INDIA is the Indian counterpart of United States Green Building Council's LEED (Leadership in Energy and Environmental Design). It is led by the Indian Green Building Council (IGBC) in India.

The Leadership in Energy and Environmental Design (LEED-INDIA) Green Building Rating System is a nationally and internationally accepted benchmark for the design, construction and operation of high performance green buildings.

LEED-INDIA rating system provides a roadmap for measuring and documenting success for every building type and phase of a building lifecycle.

7.7 Procedure for certification

1. GRIHA Rating

All buildings, except for industrial complexes and housing colonies, which are in the design stage, are eligible for certification under the GRIHA system which also adopted by MNRE (Ministry of New and Renewable Energy). Buildings include offices, retail spaces, institutional buildings, hotels, hospital buildings, healthcare facilities, residences, and multi-family high-rise buildings.

Registration

- A project has to be registered with GRIHA through the GRIHA website (www.grihaindia.org) by filling in the registration form online.
- Registration should preferably be done at beginning of a project, as several issues need to be addressed at the pre-design stage.
- The registration process includes access to the essential information related to rating. If desired by the applicant, one-day training for the design team by GRIHA on the rating system is also included at a nominal additional cost.

During the training session, the following areas shall be covered:

- Overview of the green building design
- Building project and project-specific guidance system
- Documentation process
- Evaluation process

The key steps for the process of Certification for getting a building evaluated under GRIHA are:

1. Registration
2. Submission of documentation
3. Preliminary evaluation by TERI Technical team
4. Evaluation by panel of experts
5. Preliminary rating with comments sent to project team
6. Final submission of documents
7. Final evaluation by panel of experts
8. Approval of rating by advisory committee
9. Award of rating

Fees

The registration cum rating fee (subject to review and modification every year) w.e.f. from July 1 2008 is as follows:

Registration Cost and the fee for secretariat	Rs. 2,50,000 {Fixed Cost}
Evaluation fee for up to 5000 sq. m	Rs. 64,000
Evaluation fee for area > 5000 sq. m	Rs 64,000 + Rs3.75/sq.m for each sq. m over and above 5000 sq. m

This fee is to be paid upfront on registration of the project for GRIHA certification and is non-refundable.

The fee includes

- Cost of GRIHA documents and templates
- Third party evaluator fees
- One-day training workshop for all consultants involved in the project {In Delhi or Bangalore}
- GRIHA secretariat costs for documents collection, assimilation, valuation and submission.

MNRE Scheme on Energy efficient Solar / Green buildings:

- **Budget Allocation**: The total budget of Rs. 10.00 crore has been allocated for implementation of the scheme during the year 2013-14 and rest of the 12th Plan period. The Ministry aims to promote the green building principles & concept with emphasis on the renewable energy application in the green buildings among the stakeholders through a combination of promotional incentives and support majors in the country.

- **Financial Provisions:** The scheme provides for the financial incentives to carry out the following promotional activities to promote the construction of Green Buildings in the country.

- **Incentives for Capacity Building and Awareness Activities:** A financial support of up to Rs. 2.00 lakh for 1-2 days and Rs. 3.0 lakh for three days activity could be provided for organizing training programmes, workshops, conferences, seminars, publications, awareness campaigns, and orientation programmes etc. to the implementing agencies. However, for International Conferences/ exhibitions/ workshops the financial supports up to Rs. 5.0 lakh may be considered based on merit.

- **Awards to Urban Local bodies (ULBs):** The onetime cash award of Rs. 10 lakh along with a shield will be given to best 3 ULBs per year selected through competition for adopting and promoting the energy efficient solar/green buildings to be rated under the rating system in vogue i.e., GRIHA, LEED India etc.

- **Awards to the Green Building having maximum RE installations:** The cash award of Rs. 15 Lakh 10 Lakh and 5 Lakh along with a shield will be given to best 3 buildings per year that have the maximum installation of renewable energy systems and the net Zero energy based buildings in the country.

- **Incentives for Renewable Energy Projects installations:** The proposals on RE systems including SPV installations, SWH, waste to energy projects, biogas generation projects etc. or any other innovative RE related projects in the Energy Efficient Solar/ Green buildings may be considered under the Scheme as per available incentives under various MNRE's schemes.

2. LEED India Rating

LEED India certification provides independent, third-party verification that a building project meets the highest performance standards. The LEED India plaque awarded by the IGBC is recognition of the project achievement.

Registration:

The first step toward earning LEED-INDIA certification is project registration. Registering during the early phases of project design will ensure maximum potential for achieving certification. Registration is an important step that establishes contact with the IGBC and provides access to essential information, software tools and communications. Upon registration, project contacts receive LEED India templates and a Reference guide.

Once a project is registered, the project team begins to prepare documentation and calculations to satisfy the prerequisite and credit submittal requirements. It is helpful to have an IGBC Accredited Professional as the project contact and team member responsible for coordinating the LEED-INDIA process and requirements.

Credit Interpretations:

In some cases, project teams may encounter difficulties applying a LEED India prerequisite or credit to a specific project. In such cases, projects can apply for Credit Interpretation Request (CIR).

Certification Process:

The key steps for the process of Certification for getting a building evaluated under LEED India are:

1. Registration
2. Credit Interpretations
3. Certification and Documentation
4. Certification Award
5. Appeal

Fee Summary

The registration and rating fees for LEED rating is as follows:

Registration Fee			
IGBC Members	Rs.25,000		
Non Members	Rs.30,000		
Certification Fee			
	5,000 sq.m & below	**5,001 sq.m to 50,000 sq.m**	**50,001 sq.m & above**
	Fixed rate	**Based on sq.m**	**Fixed rate**
Founding Members	Rs. 2,90,000	Rs. 2,90,000 plus Rs. 5.30 per additional sq.m over & above 5,000 sq.m	Rs. 5,30,000
Annual members	Rs. 3,25,000	Rs. 3,25,000 plus Rs. 5.30 per additional sq.m over & above 5,000 sq.m	Rs. 5,65,000
Non-members	Rs. 3,35,000	Rs. 3,35,000 plus Rs. 5.30 per additional sq.m over & above 5,000 sq.m	Rs. 5,75,000

** Parking areas need not be considered as part of the built-up area*

** Fee is inclusive of service tax*

** Registration and Certification fee are non-refundable*

** Membership discounts can be availed only if the project owner is a member of IGBC.*

IGBC to recognize Government Green Buildings Demonstrating Global Leadership

To enable wider adoption of Green Building concepts by the government sector, IGBC would like to offer the following benefits to Government building projects, registering with IGBC, effective April 1, 2010.

- **Free Feasibility Study*:**

An exclusive feasibility study for the project team. This is a techno-economic study to help the project team to decide on the level of rating that can be aspired for, by verifying the projects compliance with the mandatory and other credit requirements. The study would enable incorporating energy & water saving measures by design. It is designed to provide strategic inputs & direction to achieve the rating. This service is offered free of cost. However, organizations are requested to reimburse the travel and accommodation for 2 professionals.

- **Free Training Programme on Green Buildings*:**

Training program on green buildings for the project team will facilitate information sharing on green buildings, rating systems and case studies. This also provides an insight into various facets of green building design and enlightens the participants to acquire knowledge on expectation of a green building, both during design and performance. This service is offered free of cost. However, organizations are requested to reimburse the travel and accommodation for 2 professionals.

Unique Benefits for Government Buildings achieving Platinum rating of IGBC

Achieving 'PLATINUM' rating under various rating programmes of IGBC is a challenging task. 'PLATINUM' rating signifies demonstration of global leadership in green building design and construction practices.

IGBC will refund 100% certification fee for the Government building project, on achieving the 'PLATINUM' rating of any IGBC rating system

Note:
**The above said incentives & services are offered for buildings constructed by Not-For-Profit governmental organizations*

7.7.1 Salient Features of Green Building

Green Building has the following advantages:

- **Minimum Air Conditioning Load:**

  Each tonne of refrigeration (TR) caters to more than 300 Sqft (Normal buildings in India require 150-200 Sqft / TR) of air conditioned area, despite higher fresh air intake. This is achieved through specially selected double glazing for each

orientation, and by ensuring that all external walls and exposed roofs are well insulated, thus minimizing the air conditioning load.

- **Lighting Power Density:**

  Energy efficient general lighting power density is less than 10 W / Sq.mt (Normal is 20 W/Sqmt), as per LED requirements.

- **Power Consumption:**

  Annual power consumption for Green Office building is generally less than 250 KWH / Sq.mt for normal 12 hours / day operation (Normal buildings are 400 KWH / Sq.mt.).

- **Excellent Indoor Air Quality:**

  Fresh air requirement is 3% higher than ASHRAE 62.1 - 2004, to improve the indoor air quality (IAQ). Therefore personnel working indoor are always subject to generous quantity of treated fresh air, which keeps them fresh and energetic even after extended working hours, thereby improving productivity. Fresh air is generally supplied on-demand basis monitored thru CO_2 level in return air.

- **Treated Fresh Air:**

  Treated fresh air is provided with heat recovery wheel (HRW) to minimize the air conditioning load by reducing the ambient air temperature before it passes through the cooling coil of the space AHUs.

- **Visible Light Transmittance:**

  Glass of window is specified for superior visible light transmittance allowing maximum harnessing of day-light (without adding glare on computer screen) thus reducing energy consumption through electrical light fixtures throughout the day.

- **Water Conservation:**

  It is achieved through Zero Discharge, that is, entire effluent is treated in Sewerage Treatment Plant (STP), and treated water is recycled as makeup for air conditioning and DG sets cooling towers, for flushing in WCs and urinals, and for gardening

- **Rain Water Harvesting System:**

  Rain water harvesting system with filtration is provided. This water can be used for cars / car parking washing and for general washing.

7.8 Demand Comparison: Conventional Vis a Vis Green Building

Table 7.1: Demand comparison of Conventional building vis-à-vis Green Building

Type of Loads	Conventional Building	Green Buildings *
Air-conditioning Cooling Load	150 SFT/TR	600 SFT/TR
Electrical Demand Load	10 WATT/SFT	4 WATT/SFT
Lighting Power Density office area	2 WATT/SFT	< 0.6 WATT/SFT
Lighting Power Density retail area	4 WATT/SFT	< 1 WATT/SFT
Lighting Power Density parking area	1 WATT/SFT	< 0.15 WATT/SFT
Potable Water Demand	45 Liters per day per person	20 Liters per day per person

** - As per the Green measures adopted*

Green buildings are scored by rating systems, such as the Leadership in Energy and Environmental Design (LEED) rating system developed by the Indian Green Building Council, U.S. Green Building Council, Green Globes from GBI and other locally developed rating systems.

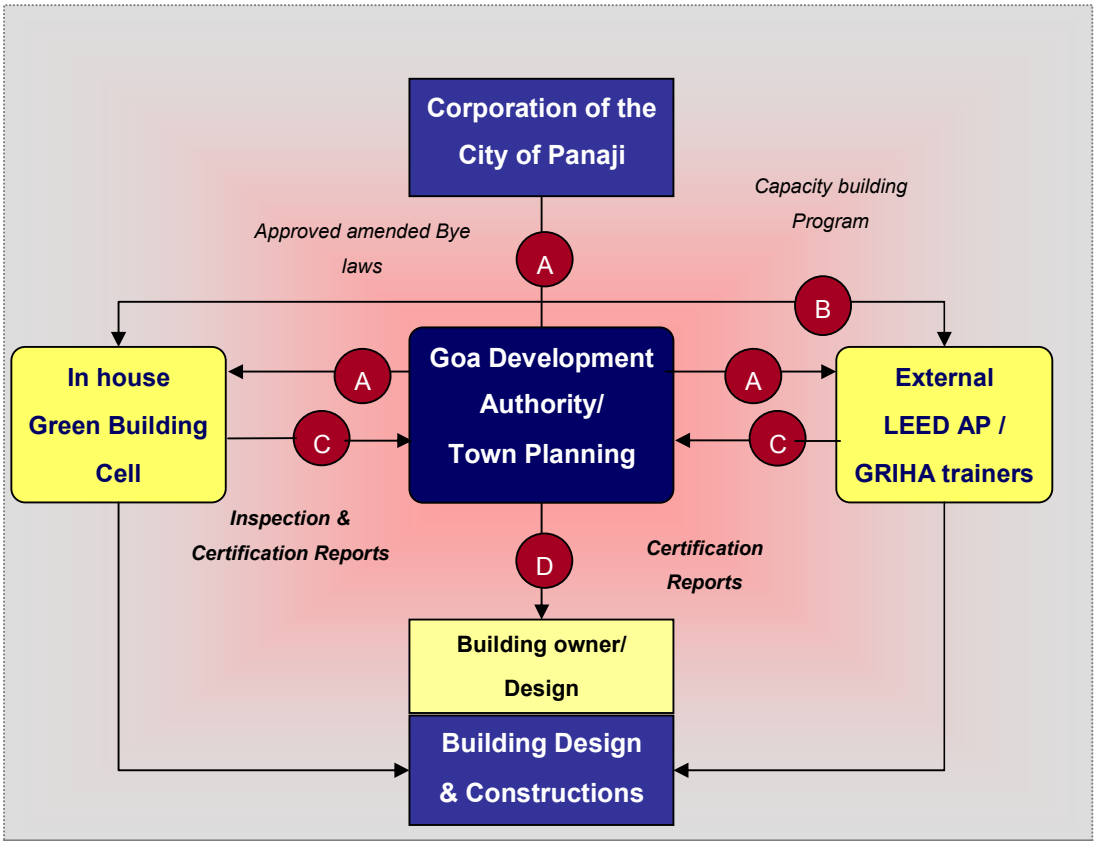
7.9 Green Building Implementation Framework Model for Corporation of the City of Panaji

In order to propagate the energy efficient/ green building in the jurisdiction of CCP, the construction of commercial, industrial and residential complexes/ townships can be made mandatory by CCP or can advocate some special financial incentives can be given by CCP such as property tax rebates or incentives in electricity bills etc.

For the effective implementation of sustainable construction as per the LEED/ GRIHA criteria CCP should set up a Green Building cell which can be a subset of the solar city cell, which will consist of members of town planning authority, PWD and CCP who will be trained on Green Building concept and also seek the help of LEED AP or GRIHA certified professionals.

This green building cell will be responsible for the approval of all plans in order to ensure that it is as per the criteria of LEED/ GRIHA which can also have a third party inspection from LEED AP/ GRIHA certified professionals who in turn will give the certification report to town planning department advising them on any changes to be made in plan if required or recommending approval. The model framework depicted in Figure below. CCP should conduct extensive training programme either

by GRIHA or IGBC (Indian Green Building Council) for all the local architects and people involved in civil construction in order to do effective capacity building on Green buildings with the help of MNRE.



Legend:

A: Approved / amended Building bye laws

B: Inspecting by Third Party

C: Inspection & Certification Report

D: Certification Report

7.10 Steps to be taken by CCP for effective implementation of Energy Efficiency in Buildings

- CCP may mandate solar water heating or Solar PV system mandatory for the Hotel industries and commercial establishments as technology being suitable in the climate of the proposed Solar City.
- **Note**: Government of Haryana Notification No.22/52/2005-06 Dated 29-07-2005 has made it mandatory to use solar water Heating System (SWHS) in all industries where hot water is required for processing, Hospitals & Nursing Homes including Government Hospitals, Hotels, Motels, Canteens, Housing Complexes set up by group Housing Societies/Housing Boards & all Residential Buildings (plot size 500 sq. yards & above)falling within Municipal Committees /

Corporations and HUDA sectors, All Government Buildings, Residential schools, Educational and training institutes, Tourism Complexes And Universities Etc. in the state.

- CCP can mandate the energy conservation measures considering the following example of Administration of Union Territory of Chandigarh. Detailed Notification is attached as an annexure.
- **Note:** In exercise of the powers conferred by Section 18 of the Energy Conservation Act, 2001 (52 of 2001), read with the Government of India, Ministry of Home Affairs Notification No.S.O. 593(E)/F.No. U-11030/1/2005-UTL dated the 24th April, 2006 Administrator of Union Territory of Chandigarh hereby issues the following directions for efficient use of energy and its conservation in the Union Territory of Chandigarh namely:
    - Mandatory use of Solar Water Heating Systems
    - Mandatory use of Compact Fluorescent Lamp (CFL) in Government Buildings/Government Aided Institutions/Boards/corporations.
    - Mandatory use of Energy Efficient Tube Light System/Retrofit Assembly in Government Buildings/Government Aided Institutions/Boards/ Corporations.
    - Mandatory use of Compact Fluorescent lamps (CFLs) and T-5 (28 watt) Tube Lights.
    - Promotion of Energy Efficient Building Design
    - Mandatory use of Energy Efficient Street Lights

8 Energy Planning

8.1 Renewable Energy Resource Assessment

Having arrived at baseline scenario, the next logical step is look for ways and means to address the issue of ever increasing energy demand. It is required to see how best the demand can be meeting in a sustainable manner. To meet the goal for Sustainable development, effective plan is required for meeting the energy requirement and at the same time minimizing the impact of such activities on the environment through emissions reduction. Under the national plan for climate change, India plans to install 20 GW of solar power by 2020. Also India has fifth largest capacity of wind power installed. Further, the Ministry for New and Renewable energy has taken many steps to encourage the installation of power plants based on renewable. But in order to assess the generation mix by these renewable, one needs to evaluate the resources for renewable energy available at that particular site. Currently Goa has less than 1% of installed capacity from Renewable Energy sources. The analysis of the potential of these renewable is presented in the following sections.

8.1.1 Biomass potential

In Corporation of the City of Panaji biomass power potential is too less to establish biomass based power plant. Biomass is used in the organic farming.

8.1.2 Solar Energy

Corporation of City of Panaji is having good potential for power generation through Solar PV. Good potential for use of solar energy in thermal applications is available for Panaji. List of implementable projects are shown in the table below.

Table 8.1: List of Projects Identified for CCP to implement solar Power Project

Sl. No.	Name of Project	Proposed Project size (KW)
1	Govt. Polytechnic Collage, Althino, Panaji, Goa	50
2	Dhempe Collage of Arts and Science, Miramar, Goa	50
3	National Institute of Ocean Graphy, Dona Pola, Panaji, Goa	50

4	Goa Dental Collage, Banbolin , Panaji, Goa	3
5	Goa Industries Development Corporation (GIDC) Patto, Panaji, Goa	25
6	Paryatan Bhavan (Goa Tourism), Patto, Panaji, Goa	50
7	Passport Office, Patto, Panaji, Goa	20
8	Kadamba Bus stand	100
9	The Municipal Garden	75
10	Francisco Luis Gomes Garden	50
11	Dona Paula	100
12	Miramar Beach	100
13	Kala Academy	25
14	Church of Our Lady of the Immaculate Conception	25
	Total	723

9 Renewable Energy Strategy

9.1 Residential Sector RE strategy

9.1.1 Solar Water Heaters

Assumptions:

- 200 LPD can replace 4.5 KW capacity Geyser
- Hot water requirement in one house hold for 4 months
- Average operations 1 hour per day from 10 liters geyser (1.5 KW)
    - = 4 X 30 X 1.5 X 1 = 180 Kwh / year.
- Number of household = 13400
- Emission Factor .81 tCO_2 / MWh.

Table 9.1: Target for SWH installation in Panaji

Single Household	Value	Units
Average size of domestic SWH	200	LPD
Collector Area	4	Sqmt
Total energy saved per year	180	KWh
Indicative Cost of Installation	35000	`
MNRE Subsidy at Rs 3000 per sq Mtr 3300 per sq mtr for ETC and FPC	10500	`
Cost of Energy Savings	1170	`
Emission Reduction per year	0.14	Tonnes
Payback Period	30	Years
Target for Entire City		
Total No of Households	13400	Nos
Residential Household using fossil fuel for water heating	70%	
Target to replace electric geyser by SWH in 5 years	60%	
Average size of domestic SWH	200	LPD
Number of SWH to be installed in 5 year plan	5628	Nos
Total collector area in sqm	22512	Sqmt
Total energy saved per year	1.01	MU
Indicative cost of installation	1969	`Lakhs
MNRE Subsidy at Rs 1100 per sq Mtr	590	`Lakhs

Cost of Energy Savings	25	`Lakhs
Payback Period	3	years
Emission Reduction per year	820	tonnes

Source for Subsidy & cost of system MNRE, Emission Factor CEA calculation

9.1.2 Solar PV for Home Inverters

Assumptions:

- Solar Insolation Level – 4.5 kWh/m^2/day
- Subsidy – 30%
- Emission Factor .81 tCO_2 / MWh.

Table 9.2: Solar PV for Home Invertors

	Value	Units
Capacity of solar PV system for Home Inverter	250	Wp
Indicative cost of incorporating Solar PV to home inverter	30000	`
Total Residential Household	13400	nos
Residential Household using inverter during load shedding	70%	%
Target to introduce solar charger for inverters in 5 years	60%	%
Number of solar invertors to be installed in 5 years plan	5628	Nos
Total PV capacity installed	1407	KWp
Energy generated by PV	1.98	MU
Cost of energy saved	49	`Lakhs
Indicative cost of installation	1688	`Lakhs
MNRE Subsidy	506	`Lakhs
Emission Reduction per year	1600	tonnes

Source: CCP, GEDA, MNRE & CEA for emission factor

9.1.3 Solar PV for replacement of DG sets

Assumptions:

- Solar Insolation Level – 4.5 kWh/m^2/day
- Subsidy – 30%
- Emission factor of Diesel 0.81 tco_2/Mwh

Table 9.3: Solar PV for Replacement of DG Sets

	Value	Units
Proposed Capacity of solar PV system	1	KWp
Indicative cost of solar power pack	1.2	`Lakhs
Total residential households	13400	nos
Residential households use generators during load shedding	10%	%
Target to introduce solar power packs in 5 years	50%	%
Number of solar power packs to be introduced in 5 years	670	nos
Total PV capacity installed	670	KWp
Energy generated by PV arrays per year	0.94	MU
Typical generator used	5-10	KW
Average fuel consumption per day for 4-6 hours of load shedding	6	litres
Amount of diesel saving for the entire city	1467	KL
Cost of Diesel saved	733	`Lakhs
Indicative cost of installation	804	`Lakhs
MNRE Subsidy	241	`Lakhs
Payback period	2	years
Emission reduction per year for replacement of diesel	762	tonnes

9.1.4 Area Requirement for installation of Solar PV and water heating system in residential sector

Sr. No.	Renewable Energy Strategy - Residential	Target Unit	Target Capacity	Area Requirement (SqM)
1	Installation of solar water heaters (200 LPD)	Nos	5628	22512
2	Use of Solar home inverter(250 Wp)	KWp	1407	21105
3	Use of PV for replacing DG sets	KWp	670	10050
4	Total Area required			53667

We have considered the area requirement for solar water heater is 4 SqM per 200 LPD systems as per and 15 SqM per KW for solar PV system as per MNRE guidelines. Considering the same total roof top area required for installation of Solar PV and water heating system is 53667 SqM.

9.1.5 Summary of RE strategy for Residential Sector

Table 9.4: Summary of RE Strategy for Residential Sector

Renewable Energy Strategy - Residential	Target Unit	Target Capacity	Investment (`lakhs)	MNRE Subsidy (`lakhs)	User Contribution (`Lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Installation of solar water heaters (200 LPD)	Sqmt	22512	1970	591	1379	1.01	821
Use of solar home lighting systems (74Wp)	Nos	402	64	32	32	0.63	151
Use of Solar home inverter(250 Wp)	KWp	1407	1688	507	1182	1.98	1600
Use of PV for replacing DG sets	KWp	670	804	241	563	0.94	762
Total			**4527**	**1371**	**3156**	**4.56**	**3333**

Source: Darashaw Analysis

9.2 Commercial Sector RE Strategy

9.2.1 Installation of Rooftop Solar PV in the Schools & Community Hall

Assumptions:

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- 55% of total Load considered for Roof Top Solar PV
- Daily insolation level taken: 4.5 kWh/m^2/day
- Emission Factor 0.81 t CO_2 / MWh
- Roof Top Solar PV System without Battery Backup

Table 9.5: Roof Top Solar PV System in Schools & Community Hall

Particulars	Total	Units
Primary School	98	nos
Middle School	48	nos
Secondary & Higher secondary School	41	nos
Higher Education institution	12	nos
Total connected load of Building	2893	KW
Tentative Potential for Roof Top in Buildings	1736	KW
Total Indicative Cost of Installation	1562	`Lakhs
Total Energy Generated	2.85	MU
MNRE Subsidy	469	` Lakhs
Cost of Energy Saved	185	` Lakhs
Emission Reduction per year	2309	tonnes

Source: CCP,GEDA, MNRE & CEA for emission factor

9.2.2 Installation of Rooftop Solar PV in the Health Centers & others commercial establishments

Assumptions:

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- Daily insolation level taken: 4.5 kWh/m^2/day
- Roof Top Solar PV System without Battery Backup
- Emission Factor 0.81 t CO_2 / MWh

Table 9.6: Roof Top Solar PV - Health Care Centers, Hotels, Resorts etc.

Particulars	Total	Units
Hospital	23	nos
Hotels	35	
Police station	1	
Health care Centre & Blood Bank	19	nos
Total Connected load of Heath Care Facilities	4794	KW
Tentative Potential for Roof Top in Health Care Facilities	2876	KW
Total Indicative Cost of Installation	2589	` Lakhs
Total Energy Generated	4.04	MU
MNRE Subsidy	776	` Lakhs
Cost of energy saved	262	` Lakhs
Emission Reduction per year	3271	tonnes

Source: CCP,GEDA, MNRE & CEA for emission factor

9.2.3 Installation of Rooftop Solar PV in the Banks

Assumptions:

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- Daily insolation level taken: 4.5 kWh/m2/day
- Emission Factor 0.81 t CO_2 / MWh
- Roof Top Solar PV System without Battery Backup

Table 9.7: Rooftop Solar in Banks

Particulars	Total	Unit
No of Schedule Bank	72	nos
No of Co-operative Bank	24	nos
Total Connected Load for Banks	901.0716	KW
Tentative Potential for Roof Top in Banks	720	KW
Total Indicative Cost of Installation	648	` akhs
Total Energy Generated	1.01	MU
MNRE Subsidy	194	` akhs
Cost of energy saved	30	` akhs
Emission Reduction per year	819	tonnes

Source: CCP,GEDA, MNRE & CEA

9.2.4 1 MW Community based Grid Connected Solar Power Plant

Assumptions:

- Cost of Roof Top SPV: Rs. 7.5 Crore Per MW
- Daily insolation level taken: 4.5 kW/m^2/day
- Total Operational Days 312
- Emission Factor 0.81 t CO_2 / MWh

Table 9.8: 1 MW Community Based Grid Connected Power Plant

Particulars	Value	Units
Capacity of Solar PV power plant	1	MW
Indicative cost of installation	15	` Crore
Total Energy Generated	1.40	MU
Cost of energy saved	42.12	` Lakhs
Emission Reduction per year	1137.24	tonnes

9.2.5 2 MW Municipal Solid Waste Power Plant on Public Private Partnership basis

Assumptions:

- 25-30 Tons of bio degradable waste required for generating 1 MW (25 MT/MW)

Table 9.9: 2 MW Grid Connected Municipal Solid Waste based Power Plant

	Value	Units
Total Solid Waste Generated by 2018-19	50	tonnes
Quantity of Refuse Derived Fuel	30	tonnes
Quantity required for 1 MW	28	tonnes
Tentative Potential	2	MW
Plant Load Factor	75%	%
Auxiliary Consumption	10%	%
Total Energy generated per year	13.14	MU
Total Energy exported to Grid	11.826	MU
Cost of Installation	1000.00	` Lakhs
MNRE Subsidy	300.00	` Lakhs
Emission Reduction per year	9579.06	tonnes

Source: CCP, GEDA and Darashaw Analysis

9.2.6 Solar water heater for Hotels, Resorts, Hospitals, Medical centers & Commercial centers.

Assumptions:

- Average size of SWH system = 2000 LPD
- Collective area for each SWH system = 40 SqM
- Operational days 365 / year for 12 hours each day
- Emission Factor .81 tCO_2 / MWh

Table 9.10: SWH for Hotels, Resorts, Hospitals, Medical centers etc.

SWH for Commercial Sector	Value	Units
Average size of domestic SWH	2000	LPD
Collector Area	60	Sqmt
Total energy saved per year	6570	KWh
Indicative Cost of Installation	300000	Lakh
MNRE Subsidy at Rs 1100 per sq Mtr	66000	`
Cost of Energy Savings	49275	`
Emission Reduction per year	5.42025	Tonnes
Payback Period	6	Years
Target for Entire City		
Total No of commercial establishments	65	Nos
Commercial consumers uses electric geyser	80%	
Target to replace electric geyser by SWH in 5 years	45%	
Average size of domestic SWH	2000	LPD
Number of SWH to be installed in 5 year plan	23	Nos
Total collector area in sqm	1404	Sqmt
Total energy saved per year	0.15	MU
Indicative cost of installation	70.2	`Lakhs
MNRE Subsidy at Rs 1100 per sq Mtr	15.44	`Lakhs
Cost of Energy Savings	11.53	`Lakhs
Payback Period	3	years
Emission Reduction per year	124.52778	tonnes

Source: CCP, GEDA, MNRE and Darashaw Analysis

9.2.7 Area Requirement for installation of Solar PV and water heating system in commercial sector

Renewable Energy Strategy - Commercial	Target Unit	Target Capacity	Area Requirement (SqM)
Rooftop Solar PV in Buildings of school and Community hall	KW	1736	26037
Rooftop Solar in Hotels, Hospitals and police stations	KW	2877	43153
Rooftop Solar in Banks	KW	721	10812
SWH for Commercial Sector	Sqmt	1404	1404
Solar PV Power Plant	KW	1000	15000
Root top area requirement (SqM)			96407

We have considered the area requirement for solar water heater is 4 SqM per 200 LPD systems as per and 15 SqM per KW for solar PV system as per MNRE guidelines. Considering the same total roof top area required for installation of Solar PV and water heating system is 96, 407 SqM.

9.2.8 Summary of RE strategy for Commercial Sector

Table 9.11: Summary of RE strategy for Commercial Sector

Renewable Energy Strategy - Commercial	Target Unit	Target Capacity	Investment (`lakhs)	MNRE Subsidy (`lakhs)	User Contribution (`Lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Rooftop Solar PV in Buildings of school and Community hall	KW	1736	1562	469	1094	2.85	2309
Rooftop Solar in Hotels, Hospitals and police stations	KW	2877	2589	777	1812	4.04	3272
Rooftop Solar in Banks	KW	721	649	195	454	1.01	820
SWH for Commercial Sector	Sqmt	1404	70	15	55	0.15	125
Solar PV Power Plant	MW	1	1500	0	1500	1.40	1137
Energy From Municipal Solid Waste	MW	2	1000	300	700	11.83	9579
Total			7370	1755	5615	21.29	17242

9.3 Municipal Sector RE Strategy

9.3.1 Installation of Rooftop Solar PV in the Government Buildings

Assumptions:

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- Solar insolation level taken: 4.5 kWh/m^2/day
- Roof Top Solar PV System without Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.12: Roof Top Solar PV System in Government Buildings

Sr. No.	Building Category	Total	Units
1	Block Level centers	4	nos
2	Utility Area	13	nos
3	Post Office	64	nos
4	Bus Stand	1	nos
5	Telegraph office	1	nos
6	Other Government Buildings	15	nos
7	Total connected load of Government Buildings	1346	KW
8	Tentative Potential for Roof Top in Govt Buildings	1211	KW
9	Total Indicative Cost of Installation	1090	`Lakhs
10	Total Energy Generated	1.70	MU
11	MNRE Subsidy	327	` Lakhs
12	Cost of Energy Saved	51	` Lakhs
13	Emission Reduction per year	1377	tonnes

Source: CCP,GEDA, MNRE and Darashaw Analysis

9.3.2 Installation of Rooftop Solar PV in the Market & Shopping Centers

Assumptions:

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- Daily insolation level taken: 4.5 kW/m^2/day
- Roof Top Solar PV System without Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.13: Roof Top Solar PV System in Market & Shopping Centre

Sr. NO.	Market Categories	Total	**Units**
1	Neighborhood centre	15	nos
2	Agriculture Cooperative Society	0	nos
3	Markets	4	nos
4	Total connected load of Markets	445	KW
5	Tentative Potential for Rooftop in Markets	400	KW
6	Total Indicative Cost of Installation	360	` Lakhs
7	Total Energy Generated	0.56	MU
8	MNRE Subsidy	108	` Lakhs
9	Cost of Energy Saved	16	` Lakhs
10	Emission Reduction per year	455	tonnes

Source: CCP,GEDA, MNRE & Darashaw Analysis

9.3.3 Replacement of conventional street light with solar street light.

Assumptions:

- Estimated Cost of Solar Street Light: Rs. 20, 000
- MNRE Subsidy: 30%
- Daily insolation level taken: 4.5 kW/m^2/day
- Roof Top Solar PV System without Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.14: Replacement of Conventional street lights with Solar Street Lights

Sr. NO.	**Particulars**	Value	Units
1	Target no of street lights	800	nos
2	Capacity of one solar PV Module	74	Wp
3	Indicative cost of one street light	20000	`
4	Total PV capacity installed	59.2	KW
5	Energy Generated by PV	0.08	MU
6	Cost of energy saved	6.23	` Lakhs
7	Indicative cost of installation	160	` Lakhs
8	MNRE Subsidy	48	` Lakhs
9	Emission Reduction per year	67	tonnes

Source: CCP,GEDA, MNRE and Darashaw Analysis

9.3.4 Installation of solar traffic light.

Assumptions:

- Estimated Cost of LED based Solar Traffic Light: Rs. 25, 000
- Daily insolation level taken: 4.5 kW/m^2/day
- Solar PV System without Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.15: Solar Traffic Lights

Particulars	Value	Units
Target no of street lights	800	nos
Capacity of one solar PV Module	74	Wp
Indicative cost of one street light	20000	`
Total PV capacity installed	59	KW
Energy Generated by PV	0.08	MU
Cost of energy saved	2.49	` Lakhs
Indicative cost of installation	160	` Lakhs
MNRE Subsidy	48	` Lakhs
Emission Reduction per year	67	tonnes

Source: PWD, CCP and GEDA

9.3.5 Installation of solar Advertising Hoardings.

Assumptions:

- Estimated Cost of LED based Solar Traffic Light: Rs. 25, 000
- Solar PV System with Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.16: RE system for Advertisement Hoardings

	Value	Units
Target no of traffic lights	50	nos
Capacity of one solar PV Module (2*74Wp)	148	Wp
Indicative cost of one traffic light	25000	`
Total PV capacity installed	7.4	KW
Energy Generated by PV	0.01	MU
Cost of energy saved	0.0000003	` Lakhs
Indicative cost of installation	12.5	` Lakhs
MNRE Subsidy	3.75	` Lakhs
Emission Reduction per year	8	tonnes

Source: PWD, CCP and GEDA

9.3.6 Installation of Sewerage Treatment based Biogas power plant

Assumptions:

- Estimated Water requirement Per Person: 120 lpcd
- Waste Water generated: 80% of total water used
- Biodegradable waster available for methanization: 40%
- Estimated Biogas Consumption Cubic Meter / Hour / 1 MW: 521 Cum
- Operational Days: 350

Table 9.17: Sewerage Treatment based biogas power plant

Particulars	Value	Units
Total projected Population in 2024	83843	nos
Total Water Requirement @ 120 lpcd	11.32	MLD
Total waste water generated	9	MLD
Total biodegradable waste available for biomethanation	3.62	TPD
Digester efficiency	65%	%
Biogas yield	0.8	cum/kg
Total biogas yield per day	1883	cum
Biogas consumption Cu mtr/hour/engine for @ 1MW	521	cum
Tentative capacity of bio-methanation plant	150	Kw
PLF	80%	%
Auxiliary consumption	10%	%
Total energy generated	1012218	Kwh
Electricity exported to grid	0.91	MU
Cost of Installation	50	` lakhs
MNRE Subsidy	15	lakhs
Emission Reduction per year	737	tonnes

Source: PWD, CCP and Darashaw Analysis

9.3.7 Summary of RE strategy for Municipal Sector

Table 9.18: Summary of RE strategy for Municipal Sector

Renewable Energy Strategy - Municipal	Target Unit	Target Capacity	Investment (`lakhs)	MNRE Subsidy (`lakhs)	User Contribution (`Lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Installation of 5 MW Solar PV Plant	MW	5	3500	0	3500	7.50	6525
Rooftop Solar PV in Building	KW	1211	1090	327	763	1.70	1378
Rooftop Solar PV in Markets	KW	401	360	108	252	0.56	455
Replacement of Conventional Street Lights with Solar Street Lights	Nos	800	160	48	112	0.08	67
Solar Traffic Lights	Nos	50	13	4	9	0.010	8
Sewerage treatment plant	Kw	151	50	15	35	0.91	738
Demonstration Projects	KW	723	1012	304	709	1.08	878
RE systems for Advertisement Hoardings	Nos	200	200	60	140	0.08	68
Total			**6385**	**866**	**5520**	**11.94**	**10118**

9.4 Industrial (Hotel) Sector RE Strategy

9.4.1 Installation of Solar Water Heating system for Heating or cooking

Table 9.19: Solar water Heting System 2000 LPD Capacity each

Single Industries	Value	Units
Average size of domestic SWH	2000	LPD
Collector Area	40	Sqmt
Total energy saved per year	16000	KWh
Indicative Cost of Installation	175000	
MNRE Subsidy at Rs 1100 per sq Mtr	52500	`
Cost of Energy Savings	72000	`
Emission Reduction per year	13	Tonnes
Payback Period	2	Years
Target for Entire City		
Total No of Households	50	Nos
Industrial consumers using fossil fuel for water heating	100%	
Target to replace electric geyser by SWH in 5 years	80%	
Average size of domestic SWH	2000	LPD
Number of SWH to be installed in 5 year plan	40	Nos
Total collector area in sqm	1600	Sqmt
Total energy saved per year	0.64	MU
Indicative cost of installation	70	`Lakhs
MNRE Subsidy at Rs 1100 per sq Mtr	21	`Lakhs
Cost of Energy Savings	29	`Lakhs
Payback Period	3	years
Emission Reduction per year	518	tonnes

Source: CCP, GEDA and Darashaw Analysis

9.4.2 Installation of Roof Top Solar PV System in High rise buildings having plot size more than 1000 SqM.

Assumptions

- Cost of Roof Top SPV: Rs. 0.9 Lakhs per KW
- MNRE Subsidy: 30%
- Daily insolation level taken: 4.5 kW/m^2/day
- Roof Top Solar PV System without Battery Backup
- Emission Factor: .81 tCO_2 / MWh

Table 9.20: Roof Top Solar PV System in High Rise Buildings having plot size more than 1000 Sq.M

Particulars	Value	Units
Total potential for Roof Top Solar PV system	4.725	MWp
Target to introduce solar Power Plant in 5 years	50%	%
Total PV capacity installed	2.4	MWp
Energy generated by PV arrays per year	3.32	MU
Cost of Diesel saved	590	`Lakhs
Indicative cost of installation	2126	`Lakhs
MNRE Subsidy	638	`Lakhs
Payback period	3	years
Emission reduction per year for replacement of diesel	2686	tonnes

Source: CCP, GEDA, Darashaw Analysis

10 Energy Efficiency Strategy

10.1 Energy Efficiency Strategies in Residential Sector

10.1.1 Replacement of CFL with LED

Assumptions:

- Estimated Cost of 15 W LED : Rs. 1800/-
- Hrs. of operation: 8
- Electricity Saving Per CFL: 10W

Table 10.1: Replacement of CFL with LED

Particulars	Value	Units
Total Residential Households	13400	nos
Households using CFL	100%	%
Target to replace CFL with LED	75%	%
Number of CFL to be replaced per households	4	nos
Total number of Incandescent bulb to be replaced	40200	nos
Indicative cost of installation	724	` Lakhs
Energy saved by replacing 25 W CFL with 15W LED	1	MU
Cost of electricity savings	29	` Lakhs
Payback period	25	years
Emission Reduction per year	951	tonnes

Source: CCP GEDA and Darashaw Analysis

10.1.2 Replacement of Conventional Ceiling fan with Energy Efficient Ceiling fans

Assumptions:

- Cost of 1 EE Ceiling Fan : Rs. 1500/-
- Hrs. of operation: 8
- Electricity saving Per Fan: 20 W

Table 10.2: Replacement of conventional ceiling fan with Energy Efficient fans

Particulars	Value	Units
Total residential households	13400	nos
Household using conventional fans	100%	%
Target to replace conventional fan by energy efficient fans	90%	%
Number of conventional fan to be replaced per household	2	nos
Total number of conventional fans to be replaced	24120	nos
Indicative cost of installation	362	` Lakhs
Energy saved by replacing conventional fans by EE fans	1	MU
Cost of electricity savings	35	` Lakhs
Payback period	7	years
Emission reduction per year	1141	tonnes

Source: CCP GEDA and Darashaw Analysis

10.1.3 .Replacement of Conventional AC with EE Star Rated AC

Assumptions:

- Cost of 1.5 T AC: Rs. 28000/-
- Normal energy Consumption per day: 9.45 kWh/day
- Hrs. of operation: 8
- Months of operation: 5
- Energy Saving per day: 1.75 kWh/day

Table 10.3: Replacement of conventional AC with EE star rated ACs

Particulars	Value	Units
Total Residential Households	13400	nos
Households using conventional ACs	45%	%
Target to replace Conventional ACs by EE star rated Acs	40%	%
Number of Conventional Acs to be replaced per household	1	nos
Total number of conventional ACs to be replaced	2412	nos
Indicative cost of installation	675	` lakhs
Energy saved by replacing conventional Acs by EE star rated Acs	0.63	MU
Cost of electricity savings	15	` lakhs
Payback period	15	years
Emission Reduction per year	512	tonnes

Source: CCP GEDA and Darashaw Analysis

10.1.4 .Summary of EE strategy for Residential Sector

Table 10.4: Summary of EE Strategy for Residential Sector

Energy Efficiency Strategy - Residential	Target Unit	Target Capacity	Investment (`lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Replacement of CFL with LED	nos	40200	30	1.17	951
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	24120	361	1.41	1141
Replacement of conventional airconditioners with EE star rated ACs	nos	2412	675	0.63	513
Total			**1066**	**3.22**	**2605**

Source: Darashaw Analysis

10.2 Commercial Sector EE Strategy

10.2.1 .Replacement of CFL with LED

Assumptions:

- Cost of each 15 W LED: Rs. 1800/-.
- Energy Saving per CFL: 10 W
- Hours of operation: 6 Hrs

Table 10.5: Replacement of CFL with LED

Particulars	Value	Units
Total Commercial Consumers	7469	nos
Consumers using CFL	95%	%
Target to replace CFL with LED	90%	%
Number of CFL to be replaced per consumer	15	nos
Total number of CFL to be replaced	95790	nos
Indicative cost of installation	1725	`Lakhs
Energy saved by replacing 25 W CFL with 15W LED	2.10	MU
Cost of electricity savings	63	`Lakhs
Payback period	27	years
Emission Reduction per year	1699	tonnes

Source: PWD, CCP & Darashaw Analysis

10.2.2 .Replacement of T12/T8 with T5 Tube Light

Assumptions:

- Cost of each T5 (28W) FTL: RS. 500/-
- Energy Saving per T5: 22W
- Hours of operation: 6 Hrs

Table 10.6: Replacement of T12 / T8 light by T5 Tube Light

Particulars	Value	Units
Total Commercial Consumers	7469	nos
Consumers using T8/T12 tube lights	95%	%
Target to replace T8/T12 by T5 tube lights	90%	%
No of tube lights to be replaced per consumer	15	nos
Total number of T8/T12 tube lights to be replaced	95790	nos
Indicative cost of installation	478	`Lakhs
Energy saved by replacing T8/T12 (with magnetic ballast) with T5 (with electronic ballast)	4.62	MU
Cost of electricity savings	138	`Lakhs
Pay back period	2	years
Emission Reduction per year	3738	tonnes

Source: PWD, CCP & Darashaw Analysis

10.2.3 .Replacement of conventional Ceiling fan with EE ceiling fan

Assumptions:

- Cost of each EE Ceiling Fan: RS. 1500/-
- Energy Saving per Fan: 20W
- Hours of operation: 8 Hrs

Table 10.7: Replacement of Conventional ceiling fan with Energy Efficient Fans

Particulars	Value	Units
Total Commercial Consumers	7469	nos
Consumers using conventional fans	95%	%
Target to replace conventional fan by energy efficient fans	80%	%
Number of conventional fan to be replaced per consumer	8	nos
Total number of conventional fans to be replaced	45412	nos
Indicative cost of installation	681	`Lakhs
Energy saved by replacing conventional fans by EE fans	2.65	MU
Cost of electricity savings	80	`Lakhs
Payback period	7	years
Emission reduction per year	2148	tonnes

Source: PWD, CCP & Darashaw Analysis

10.2.4 .Replacement of conventional AC with Star Rated AC

Assumptions:

- Cost of each 1.5 Ton AC: RS. 28000/-
- Normal Energy Consumption in conventional AC per day: 9.47kWh/day
- 3 Star AC Energy Consumption: 7.7 kWh/day
- Energy Saving per day: 1.75 kWh/day
- Hours of operation: 8 Hrs
- Months of operation: 5 months

Table 10.8: Replacement of Conventional air conditioners with EE star rated ACs

Particulars	Value	Units
Total Commercial Consumers	7469	nos
Consumers using conventional ACs	60%	%
Target to replace Conventional ACs by EE star rated Acs	80%	%
Number of Conventional Acs to be replaced per consumer	2	nos
Total number of conventional ACs to be replaced	3585	nos
Indicative cost of installation	1004	`lakhs
Energy saved by replacing conventional Acs by EE star rated Acs	0.94	MU
Cost of electricity savings	28	`lakhs
Payback period	15	years
Emission Reduction per year	762	tonnes

10.2.5 .Summary of EE strategy for Commercial Sector

Table 10.9: Summary of EE strategy for commercial sector

Energy Efficiency Strategy - Commercial	Target Unit	Target Capacity	Investment (`lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Replacement of CFL with LED	nos	95790	63	2.10	1699
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	45412	681	2.65	2148
Replacement of conventional air conditioners with EE star rated ACs	nos	3585.12	1004	0.94	762
Replacement of T12/T8 tube light by T5 tube light	nos	95790	479	4.62	3738
Total			2227	10.31	8348

10.3 Industrial (Hotel) Sector EE Strategy

10.3.1 .Replacement of T12 with 15 W LED

Assumptions:

- Cost of each 15 W LED: Rs. 1800/-.
- Energy Saving per T12: 25 W
- Hours of operation: 8 Hrs

Table 10.10: Replacement of T12 with 15 W LED in all the premises

Particulars	Value	Units
Total T12 installations in all the premises	105	nos
Consumers using Incandescent Bulbs	100%	%
Target to replace Incandescent Bulbs with CFL	100%	%
Number of lights to be replaced per consumer	2625	nos
Total number of Lights to be replaced	2625	nos
Indicative cost of installation	47	`Lakhs
Energy saved by replacing 40 W F12 with 15 W LED	0.19	MU
Cost of electricity savings	9	`Lakhs
Payback period	0.4	years
Emission Reduction per year	155	tonnes

Source: PWD, CCP and Darashaw Analysis

10.3.2 .Replacement of T12 / T8 by T5 Tube light

Assumptions:

- Cost of each T5 Tube Lights: Rs. 500/-.
- Energy Saving per T12: 22 W
- Hours of operation: 6 Hrs

Table 10.11: Replacement of T12 / T8 Tube Lights with T5 Tube Light

Particulars	Value	Units
Total Industrial Consumers	105	nos
Consumers using T8/T12 tube lights	90%	%
Target to replace T8/T12 by T5 tube lights	90%	%
No of tube lights to be replaced per consumer	25	nos
Total number of T8/T12 tube lights to be replaced	2126	nos
Indicative cost of installation	11	`Lakhs
Energy saved by replacing T8/T12 (with magnetic ballast) with T5 (with electronic ballast)	0.102	MU
Cost of electricity savings	5	Lakhs
Payback period	2	years
Emission Reduction per year	83	tonnes

Source: PWD, CCP and Darashaw Analysis

10.3.3 .Replacement of ceiling fan with EE ceiling fan

Assumptions:

- Cost of one 50 W Fan: Rs. 1500/-.
- Energy Saving per T12: 20 W
- Hours of operation: 8 Hrs

Table 10.12: Replacement of Conventional Ceiling fan with Energy Efficient Ceiling Fans

Particulars	*Value*	*Units*
Total Industrial Consumers	105	nos
Consumers using conventional fans	70%	%
Target to replace conventional fan by energy efficient fans	100%	%
Number of conventional fan to be replaced per industrial consumer	20	nos
Total number of conventional fans to be replaced	1470	nos
Indicative cost of installation	22	`Lakhs
Energy saved by replacing conventional fans by EE fans	0.086	MU
Cost of electricity savings	4	`Lakhs
Payback period	7	years
Emission reduction per year	70	tonnes

Source: PWD, CCP and Darashaw Analysis

10.3.4 .Replacement of conventional air conditioners with EE air conditioners

Assumptions:

- Cost of each 1.5 Ton AC: RS. 28000/-
- Normal Energy Consumption in conventional AC per day: 9.47kWh/day
- 3 Star AC Energy Consumption: 7.7 kWh/day
- Energy Saving per day: 1.75 kWh/day
- Hours of operation: 8 Hrs
- Months of operation: 8 months

Table 10.13: Replacement of Conventional air conditioners with EE air conditioners

Particulars	Value	Units
Total Industrial Consumers	105	nos
Consumers using conventional ACs	70%	%
Target to replace Conventional ACs by EE star rated Acs	100%	%
Number of Conventional Acs to be replaced per industrial consumer	4	nos
Total number of conventional ACs to be replaced	74	nos
Indicative cost of installation	31	`lakhs
Energy saved by replacing conventional Acs by EE star rated Acs	0.03	MU
Cost of electricity savings	1.39	`lakhs
Payback period	15	years
Emission Reduction per year	25	tonnes

Source: PWD, CCP and Darashaw Analysis

10.3.5 .Summary of EE strategy for Industrial (Hotel) sector.

Table 10.14: Summary of EE strategy for Industrial (IT) sector

Energy Efficiency Strategy - Industrial	Target Unit	Target Capacity	Investment (lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Replacement of T12 with 15W LED in all the premises	nos	2625	9	0.19	155
Replacement of T12/T8 tube light by T5 tube light	nos	2126	11	0.10	83
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	1470	22	0.09	70
Replacement of conventional airconditioners with EE star rated ACs	nos	73.50	31	0.03	25
Total			**72**	**0.41**	**333**

10.4 Municipal Sector EE Strategy

10.4.1 .Replacement of 40 W Tube Light with 15 W LED

Table 10.15: Replacement of 40 W Tube Light with 15 W LED

Sr. No.	Type of Fixture	Calculation	Unit	HPSV 400 W	LED 160 W
				[A]	[B]
1	Working Hours/Day	-	Hrs/Day/Fixture	12	12
2	Power Consumption	-	KW/Day/Fixture	0.65	0.18
3	Annual Power Consumption	[2] x 365	KW/Annum/Fixture	237	66
4	Power Saving	[A]-[B]	KW/Annum/Fixture	0	171
5	Total Nos of Fixtures		Nos	600	600
6	Total Power Saving	[4] x [5]	KW/Annum	0	102492
7	Monetary Saving	3x [6]	`/Annum	0	307476
8	Life of Lamp	-	Years	2	10
9	Cost of Lamp	-	`/lamp	4000	-
10	Replacement Cost	[5] x [9] x 12/ [8]	`/12 Yrs	13090909	
11	Cost of Fixture	-	`/Fixture	15000	40000
5	Total Cost of Fixtures	[5] x [11]	`	9000000	24000000
13	Maintenance Cost	-	%	10	1
14	Total Maintenance Cost	[12] x [13]/ 100	`/12 Yrs	900000	120000
15	Maintenance Cost	[14]/12	`/Yr	75000	10000
16	Salvage Value of HPSV Fixture @ 50%	[12A] x 0.5	`	-	4500000
17	Net Investment	[10] + [12] – [16]	`	22090909	19510000
18	Net Saving	[7] - [15]	`/Annum	-	297476
19	Payback Period	12 x [17]/ [18]	Month	-	787
20	Emission Reduction per year		tonnes		83

Source: PWD, Electricity Department & Darashaw Analysis

10.4.2 Replacement of 250 W HPSV with 100 W LED

Table 10.16: Replacement of 250 W HPSV with 100 W LED

Sr. No.	Type of Fixture	Calculation	Unit	HPSV 250 W	LED 100 W
				[A]	[B]
1	Working Hours/Day	-	Hrs/Day/Fixture	12	12
2	Power Consumption	-	KW/Day/Fixture	3	1
3	Annual Power Consumption	[2] x 365	KW/Annum/Fixture	1095	438
4	Power Saving	[A]-[B]	KW/Annum/Fixture	0	657
5	Total Nos of Fixtures		Nos	1318	1318
6	Total Power Saving	[4] x [5]	KW/Annum	0	865926
7	Monetary Saving	3x [6]	`/Annum	0	2597778
8	Life of Lamp	-	Years	2	12
9	Cost of Lamp	-	`/lamp	0	-
10	Replacement Cost	[5] x [9] x 12/ [8]	`/12 Yrs	0	
11	Cost of Fixture	-	`/Fixture	2800	13000
5	Total Cost of Fixtures	[5] x [11]	`	3690400	17134000
13	Maintenance Cost	-	%	10	1
14	Total Maintenance Cost	[12] x [13]/ 100	`/12 Yrs	369040	85670
15	Maintenance Cost	[14]/12	`/Yr	30753	7139
16	Salvage Value of HPSV Fixture @ 50%	[12A] x 0.5	`	-	0
17	Net Investment	[10] + [12] – [16]	`	3690400	17141139
18	Net Saving	[7] - [15]	`/Annum	-	2590639
19	Payback Period	12 x [17]/ [18]	Month	-	79
20	Emission Reduction per year		tonnes		701

10.4.3 .Replacement of 150 W HPSV with 70 W LED

Table 10.17: Replacement of 150 W HPSV with 70 W LED

Sr. No.	Type of Fixture	Calculation	Unit	HPSV 150 W	LED 70 W
				[A]	[B]
1	Working Hours/Day	-	Hrs/Day/Fixture	12	12
2	Power Consumption	-	KW/Day/Fixture	2	1
3	Annual Power Consumption	[2] x 365	KW/Annum/Fixture	657	307
4	Power Saving	[A]-[B], [A]-[C]	KW/Annum/Fixture	0	350
5	Total Nos of Fixtures		Nos	993	993
6	Total Power Saving	[4] x [5]	KW/Annum	0	347947
7	Monetary Saving	3x [6]	`/Annum	0	1043842
8	Life of Lamp	-	Years	2	12
9	Cost of Lamp	-	`/lamp	550	-
10	Replacement Cost	[5] x [9] x 12/ [8]	`/12 Yrs	2979000	
11	Cost of Fixture	-	`/Fixture	2500	6500
5	Total Cost of Fixtures	[5] x [11]	`	2482500	6454500
13	Maintenance Cost	-	%	10	1
14	Total Maintenance Cost	[12] x [13]/ 100	`/12 Yrs	248250	32273
15	Maintenance Cost	[14]/12	`/Yr	20688	2689
16	Salvage Value of HPSV Fixture @ 50%	[12A] x 0.5	`	-	1241250
17	Net Investment	[10] + [12] – [16]	`	5461500	5215939
18	Net Saving	[7] - [15]	`/Annum	-	1041152
19	Payback Period	12 x [17]/ [18]	Month	-	60
20	Emission Reduction per year		tonnes		282

10.4.4 .Electricity Saving by Design Efficiency in Water pumping system.

Table 10.18: Improvement in Design Efficiency

Particulars	Value	Units
Annual Energy consumption	0.007	MU
Annual Energy Cost	0.23	Lakhs
Estimated Investment	1.70	lakhs
Tentative Energy Savings	12%	%
Total Annual Savings	936	Kwh
Annual Monetary Savings	2808	Rs.
Emission Reduction	1	tonnes

10.4.5 .Electricity saving by installation of Variable frequency Drives (VFD) in Water pumping system.

Table 10.19: Improvement in Design Efficiency

Particulars	Value	Units
Annual Energy consumption	0.007	MU
Annual Energy Cost	0.23	Lakhs
Estimated investment	6	Lakhs
Tentative Energy Savings	8%	%
Total Annual Savings	624	Kwh
Annual Monetary Savings	1873	Rs.
Emission Reduction	1	tonnes

10.4.6 .Summary of EE strategy Municipal Sector

Table 10.20: Summary of EE strategy Municipal Sector

Energy Efficiency Strategy - Municipal	Target Unit	Target Capacity	Investment (`lakhs)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Replacement of Tube Lights of 40W with LED lights of 15 W	nos	600	195	0.10	83
Replacement of High Pressure Sodium Vapor Lamps of 250W with LED lights of 100 W	nos	1318	171	0.87	701
Replacement of High Pressure Sodium Vapor Lamps of 150 W with LED lights of 70 W	nos	993	52	0.35	282
Improvement of Design Efficiency in Pumping System	MU	0.00	0	0.00	0
Variable Speed Drivers	MU	0.00	0	0.00	0
Total			**419**	**1.32**	**1066**

Source: CCP, PWD and Darashaw Analysis

11 Budget & Action Plan

To meet the growing energy needs of Panaji, optimizing energy conservation and resource efficiency is needed which would thus reduce per capita electricity demand. This would minimize the need for new generation and reduce GHG emissions. It would enable a cleaner environment with reduced green house gases and other pollutants, thereby addressing the environmental concerns.

As matter of priority, in order to develop Panaji as a solar city, the principal government agencies should be committed to:

- Discussing critical energy issues jointly through open meetings and ongoing informal communication.
- Sharing of information and analyses to minimize duplication, maximize a common understanding and ensure a broad basis for decision making.
- Continuing progress in meeting the environmental goals and standards, including minimizing the energy sectors impact on local and global environment.

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 Panaji in order to develop it as a solar city. These targets are based on the detailed analysis and renewable resource potential assessment.

The short term targets for energy conservation are based on the energy conservation options identified and also with the recommendation for detailed energy audit. To achieve the medium and long term targets the key implementation points of the proposed Integrated Development Plan to make Panaji a solar city is summarized below.

11.1 Implementation Plan

- For implementation of the projects under the solar city scheme, an empowered committee may be set up which may work in coordination with the Solar city cell under the chairmanship of CCP.
- The solar city cell may take advantage of the programmes like JNNURM for implementation of the master plan.
- The solar city cell may also take advantage of the grant in aid being provided by the BEE to design a few pilot energy efficient buildings in the city, in accordance with ECBC. The possibility of availing incentives provided by central government for IGBC/GRIHA rated buildings may also be explored.
- The solar city cell/CCP may work proactively:

  - To get ECBC notification immediately.
  - To ensure that building byelaws are changed in accordance with it.
  - To ensure that all upcoming non residential buildings are brought under the ambit of ECBC and incorporate the relevant green building elements.
  - To ensure that the major new commercial complexes are IGBC/GRIHA certified.
- CCP may distribute quality LED lights to its residents at concessional prices or on easy payment terms which could be registered as CDM project, which can act as a revenue generator to CCP and also help in energy conservation.
- CCP may initiate a dialogue with the electricity department for introducing rebate on electricity tariff for domestic consumers who employ solar devices.
- CCP may also give property tax rebates to residents, commercial establishment who install solar water heating systems and rain water harvesting systems.
- To begin with CCP can go in for the detailed Energy audit of the whole area under township and take up various projects; street lighting, optimization of water pumping system etc. on priority basis through ESCO mode. The draft EOI, RFP documents for the same are attached in Annexure.
- CCP may initiate on priority basis the tender for Roof top Solar PV for CCP office building and other buildings.
- Utilizing various MNRE schemes CCP may initiate installation of solar based LED traffic lights, solar street lights, building integrated solar PV, and other relevant solar products on priority basis.
- CCP may launch adequate and suitable campaign on solar city covering all media resources – including print, radio and television.
- In order to spearhead the campaign activities and to demonstrate the same to public, CCP can construct an energy park and avail benefits of Scheme (Format attached in Annexure) which will act as an inviting place to provide public education about issues of sustainable energy and also demonstrate working models and benefits of various RE/EE devices along with Akshay Urja Shops.
- Setting up of solar powered, LED display boards at the strategic locations of the city which would not only display the fact that Panaji is a solar city but also display pollution levels, temperature updates, and messages useful to general public can taken up on public private partnership basis.

- CCP along with GEDA can organize a series of training programmes on Green Buildings for Town Planners, architects, HVAC and lighting consultants and engineers involved in the building sector.
- CCP in close coordination with BEE may initiate the creation of database of energy auditors who can then be engaged by house owners / builders/developers for obtaining the energy audit and implementing EC measures. Such residents could be given rebates / subsidies.
- CCP may initiate working closely with local traders and manufacturers to initiate the propagation energy efficient appliances.

11.2 Annual Energy Saving Target

The target of reduction was set as to achieve a 10% reduction in the demand for the baseline year by the end of five year period. Now since this turns out to be 45 million Units of electricity equivalent. This has to be achieved through a combination of RE and EE measures. The action plan sets a goal of total savings of 45 MU with the savings due to RE is 42 MU and due to EE is 15 MU. Therefore, it can be seen that 73 % of the reduction is achieved through suggested RE measures and 27 % of the reduction is achieved through EE measures.

Table 11.1: Year wise Energy Saving Target

RE & EE Strategy for CCP	Energy Saving Target over 5 years period of implementation (MU per year)					% of savings target to achieve	Emission reduction
	1st Year	2nd Year Cumulative	3rd Year Cumulative	4th Year Cumulative	5th Year Cumulative		
RE for Residential Sector	0	1	2	3	5	10%	3333
RE for commercial Sector	2	5	10	15	21	47%	17242
RE for Municipal sector	2	4	6	9	12	27%	10606
RE for Industrial sector	0	1	2	3	4	9%	3205
Total RE Strategy	**5**	**12**	**20**	**30**	**42**	93%	**31180**
EE for Residential Sector	0	1	1	2	3	7%	2605
EE for Commercial Sector	1.03	2.58	4.64	7.21	10.31	22%	8348
EE for institutional sector	0.04	0.103	0.18	0.29	0.41	0.91%	333
EE for Municipal sector	0.13	0.33	0.59	0.92	1.32	3%	1299
Total for EE strategy	**2**	**4**	**7**	**11**	**15.25**	**34%**	**12584**
RE & EE Combined Strategy	6	15	27	41	57	127%	43765

11.3 Annual Budget Allocation

The total indicative budget of solar city is estimated as Rs 243 crore which will be invested over a five year period. Indicative Budget for Renewable Energy and Energy efficiency is Rs. 205 Crore and Rs. 38 Crore respectively. The year wise budget allocation is shown in the table 11.2 and table 11.3 below.

11.3.1 .Indicative Budget for Renewable Energy

Table 11.2: Year wise budget Allocation for RE projects

Activities	Total Budget (lakhs)	Year 1	Year2	Year 3	Year 4	Year 5
		10%	15%	20%	25%	30%
Renewable Energy Strategy - Residential						
Installation of solar water heaters (200 LPD)	1970	197	295	394	492	591
Use of solar home lighting systems (74Wp)	64	6	10	13	16	19
Use of Solar home inverter(250 Wp)	1688	169	253	338	422	507
Use of PV for replacing DG sets	804	80	121	161	201	241
Sub Total	4527	453	679	905	1132	1358
Renewable Energy -Commercial						
Rooftop Solar PV in Buildings of school and Community hall	1562	156	234	312	391	469
Rooftop Solar in Hotels, Hospitals and police stations	2589	259	388	518	647	777
Rooftop Solar in Banks	649	65	97	130	162	195
SWH for Commercial Sector	70	7	11	14	18	21
Solar PV Power Plant	1500	150	225	300	375	450
Energy From Municipal Solid Waste	1000	100	150	200	250	300

Sub Total	7370	737	1106	1474	1843	2211
Renewable Energy Municipal						
Installation of 5 MW Solar PV Plant	3500	350	525	700	875	1050
Rooftop Solar PV in Building	1090	109	164	218	273	327
Rooftop Solar PV in Markets	360	36	54	72	90	108
Replacement of Conventional Street Lights with Solar Street Lights	160	16	24	32	40	48
Solar Traffic Lights	13	1	2	3	3	4
Sewerage treatment plant	50	0	0	0	0	50
Demonstration Projects	1012	101	152	202	253	304
RE systems for Advertisement Hoardings	200	20	30	40	50	60
Sub Total	6385	634	950	1267	1584	1951
Renewable Energy Strategy - Industrial						
SWH installation in Industrial sector of New Kolkata Town City	70	7	11	14	18	21
Roof Top Solar PV System in High Rise Residential, corporate institutional and IT sector	2126	213	319	425	532	638
Sub Total	2196	220	329	439	549	659
Grand Total	20479	2043	3064	4086	5107	6179

11.3.2 .Indicative Budget for Energy Efficiency

Table 11.3: Year wise budget Allocation for EE projects

Energy Efficiency Strategy - Residential						
Particulars	Investment (Lakhs Rs.)	Year 1	Year2	Year 3	Year 4	Year 5
Replacement of CFL with LED	29	3	4	6	7	9
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	362	36	54	72	90	109
Replacement of conventional air conditioners with EE star rated ACs	675	68	101	135	169	203
Total	1067	107	160	213	267	320

Energy Efficiency Strategy - Commercial						
Particulars	Investment (Lakhs Rs.)	Year 1	Year2	Year 3	Year 4	Year 5
Replacement of CFL with LED	62.93	6.29	9	13	16	19
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	681.17	68	102	136	170	204
Replacement of conventional air conditioners with EE star rated ACs	1003.83	100	151	201	251	301
Replacement of T12/T8 tube light by T5 tube light	478.95	48	72	96	120	144
Energy Efficiency in Green Buildings	0.00	0	0	0	0	0
Total	2226.89	223	334	445	557	668
Energy Efficiency Industrial						

Particulars	Investment (Lakhs Rs.)	Year 1	Year2	Year 3	Year 4	Year 5
Replacement of T12 with 15W LED in all the premises	8.62	0.86	1.29	1.72	2.16	2.59
Replacement of T12/T8 tube light by T5 tube light	10.63	1.06	1.59	2.13	2.66	3.19
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	22.05	2.21	3.31	4.41	5.51	6.62
Replacement of conventional air conditioners with EE star rated ACs	30.87	3.09	4.63	6.17	7.72	9.26
Total	72.17	7.22	10.83	14.43	18.04	21.65
Energy Efficiency Strategy - Municipal						
Particulars	Investment (Lakhs Rs.)	Year 1	Year2	Year 3	Year 4	Year 5
Replacement of Tube Lights of 40W with LED lights of 15 W	195	20	29	39	49	59
Replacement of High Pressure Sodium Vapor Lamps of 250W with LED lights of 100 W	171	17	26	34	43	51
Replacement of High Pressure Sodium Vapor Lamps of 150 W with LED lights of 70 W	52	5	8	10	13	16
Improvement of Design Efficiency in Pumping System	0	0	0	0	0	0
Variable Speed Drivers	0	0	0	0	0	0
Sub Total	419	42	63	84	105	126
Grand Total	3784	378	568	757	946	1135

- The total budget will be shared by CCP/ state Government, MNRE and private share in the proportion shown in the figure below.

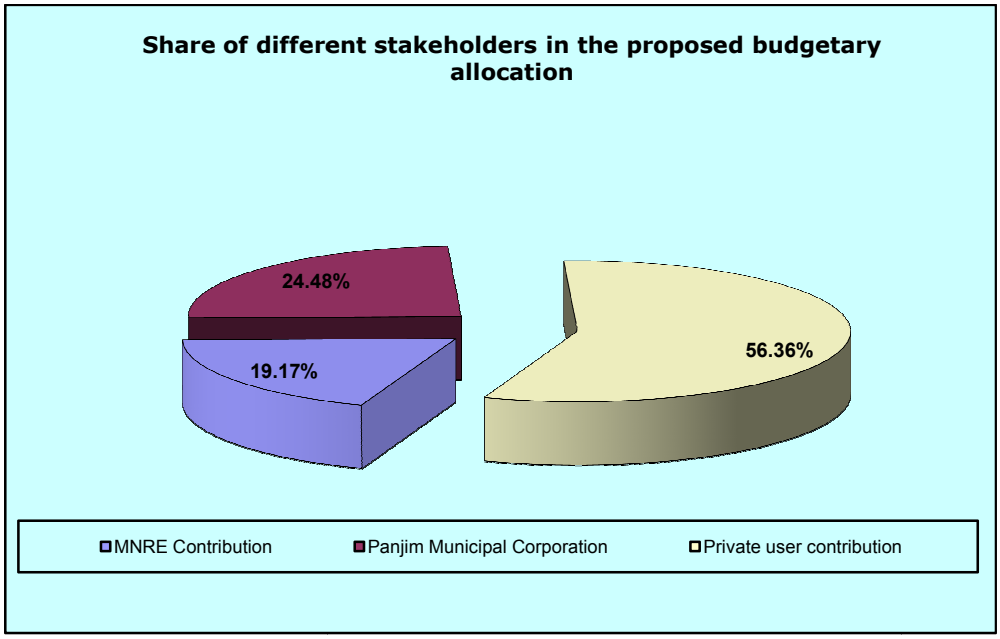


Table 11.4: Budget Contribution

MNRE Contribution	Total (Lakhs)	Year 1	Year2	Year 3	Year 4	Year 5
Renewable Energy Strategy - Residential	1371	137	206	274	343	411
Renewable Energy - Commercial	1755	176	263	351	439	527
Renewable Energy Municipal	866	87	130	173	216	260
Renewable Energy Strategy - Industrial	659	66	99	132	165	198
19.17%	**4651**	**399**	**599**	**798**	**998**	**1198**
State /City Contribution						
Renewable Energy Municipal	5520	552	828	1104	1380	1656
Energy Efficiency Strategy - Municipal	419	42	63	84	105	126
24.48%	**5938**	**594**	**891**	**1188**	**1485**	**1782**

Private User Contribution						
Renewable Energy Strategy - Residential	3156	316	473	631	789	947
Renewable Energy Strategy - Commercial	5615	561	842	1123	1404	1684
Energy Efficiency Strategy - Residential	1067	107	160	213	267	320
Energy Efficiency Strategy - Commercial	2227	223	334	445	557	668
Renewable Energy-Industrial	1537	154	231	307	384	461
Energy Efficiency Industrial	72	7	11	14	18	22
56.36%	**13674**	**1367**	**2051**	**2735**	**3418**	**4102**
Grand Total	**24263**	**2360**	**3541**	**4721**	**5901**	**7081**

11.4 Action Plan

The table shown in **Annex** shows the detailed year wise action plan and targets of various strategies (RE & EE). He year wise target has been distributed in such a way that initial years target is less and it gradually increases till 5th year as the awareness level of the citizens also increase.

11.5 Capacity Building and Awareness Generation

In order to inculcate the energy conservation techniques in the common architecture, it is essential that all the practitioners be properly trained in energy efficient or Green Architecture. CCP may organize a series of training programmes for the planners, architects, electrical, HVAC and lighting consultants and engineers involved in the building sector. These courses, tailor made to suit different levels, would have to be imparted to all the professionals, in public as well as in private sector – on a regular basis.

Specific training programmes need to be designed for front line workers and technicians and also for those in supervisory role, for effective monitoring of energy demand.

Entire members of solar city cell should be trained on RE and EE by MNRE and BEE respectively on various PPP models and in terms of selection of appropriate private party.

Public awareness and education being central to successful changeover to solar city, it is imperative for CCP to engage the public through sustained awareness campaigns and communicate the benefits of energy conservation and renewable energy to different user groups, including local elected representatives.

A key component of the awareness campaign would be to capture school children's attention towards energy efficiency and clean future. Thus the campaign for the school children will include the following elements:

- Inter School essay and drawing competitions.
- Inter School quizzes.
- Workshops and seminars.
- Exhibitions and demonstrations.
- Field Trips.

CCP can also initiate awareness campaigns along with electricity departments to generate a public response on energy conservation like door to door campaign, newsletters etc.

11.5.1 Capacity Building for Green Buildings

Target Groups	**Subgroups**	**Types of Awareness/training Required**
Government Agencies	1. CCP 2. PWD 3. Department of Electricity 4. GEDA	Training on Guidelines and regulations to achieve energy efficiency in the built environment of CCP *Awareness Generation Activities:* 1. National environmental initiatives viz., GRIHA, ECBC etc 2. Audit all govt. buildings and retrofit

Building Professionals and Professional Bodies	Architects Engineers Planners Builders	Training on Guidelines and regulations that are incorporated into the building bye laws to achieve energy efficiency in the built environment of CCP. *Awareness Generation Activities:* 1. Incentives for building professionals and builders 2. Latest products in the market 3. National environmental initiatives viz., GRIHA, ECBC etc 4. Labeled appliances/products 5. Annual meets to have a segment on energy efficiency in buildings
Civil Society	General public	Training on simple techniques upon energy conservation, electricity saving and practices on green building construction Awareness generation activities: 1. Through Website 2. Hoardings and billboards 3. Print media/posters/education leaflets 4. Eco Cell free personalized consultations interface with general public 5. Print & electronic media (TV, Radio) initiatives to sensitize public to the need of energy efficient buildings
	Resident welfare associations	Training on simple techniques upon energy conservation, electricity saving and practices on green building construction *Awareness generation activities:* 1. Energy efficient construction measures, energy saving – provide checklist for display in residential areas 2. Locality related development measures 3. National energy conservation initiatives viz.,

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Annexure 1- Action plan for Utilization of Funds

Solar City Scheme based Activities and Fund Utilization Plan												
			Time Line (Funds Requirement at the beginning of Each Half Year Period)									
Sr.No.	Acitvity Heads	Budgetted Amount	6 Months	12 Months	18 Months	24 Month	30 Month	36 Month	42 Month	48 Month	54 Month	60 Months
A.	**Setting-up Solar Cell & Its Functioning**	**1000000**										
a1.	Setting-up Office Infrastructure	200000	200000	0	0	0	0	0	0	0	0	0
a2.	EE/RE/CDM Awareness through Technology Interpretation Center	300000	0	300000	0	0	0	0	0	0	0	0
a3.	Capacity Building for Solar City Committee Members	300000	200000	100000	0	0	0	0	0	0	0	0
a4.	Case Study Tour Solar City Committee Members	200000	200000	0	0	0	0	0	0	0	0	0
B.	**Promotional & Awareness Activities**	**2000000**										
B1.	**Stakeholders Consultations:**	**1200000**										
a.	Workshop for Capacity Building for PPP in RE; ESCO in EE & Carbon Financing for Municipal Employees; Government Departments; State Nodal Agencies	400000	100000	100000	100000	100000	0	0	0	0	0	0
b.	Workshop on EE/RE involving Resident Welfare Association; NGOs	200000	100000	100000	0	0	0	0	0	0	0	0
c.	Capacity Building on EE/RE/Carbon Financing for Industrial Association	200000	100000	100000	0	0	0	0	0	0	0	0
d.	Capacity Building on EE/RE/Carbon Financing for Trade & Commerce Associations	200000	100000	100000	0	0	0	0	0	0	0	0
e.	Workshop on Green Buildings Ratings for Association of Engineers, Architects, Developers /Builders	200000	100000	100000	0	0	0	0	0	0	0	0
B2.	**Media & Publicity:**	**800000**										
a.	Print Media based Awareness Campaign	250000	50000	100000	50000	50000	0	0	0	0	0	0
b.	Radio based Awareness Campaign	150000	50000	50000	50000	0	0	0	0	0	0	0
c.	Cable T.V based Awareness Campaign	150000	50000	50000	50000	0	0	0	0	0	0	0
d.	Promotional Campaign for Schools & Colleges	250000	100000	50000	50000	50000	0	0	0	0	0	0

Solar City Scheme based Activities and Fund Utilization Plan												
			Time Line (Funds Requirement at the beginning of Each Half Year Period)									
Sr.No.	Acitvity Heads	Budgetted Amount, in	6 Months	12 Months	18 Months	24 Months	30 Months	36 Months	42 Months	48 Months	54 Months	60 Months
C.	**Preparation of Solar City Master Plan**	**1000000**										
c1.	Preparation & Submission of Primary & Secondary Sectorwise Survey Report with Inception Note & Stakeholders Consultation Report	100000	100000	0	0	0	0	0	0	0	0	0
c2.	Preparation & Submission of 3 Concept Papers on Priority Sectors	200000.00	200000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c3.	Preparation & Presentation of Draft Master Plan to Solar Cell Members	200000.00	200000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c4.	Preparation of Capital Investment Plan and Financial Operating Plan	300000.00	300000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c5.	Preparation & Presentation of Final Master Plan Report to Solar Cell Members	100000.00	100000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
c6.	Submission of Final Report to SNA & MNRE after incorporating further suggestions/modifications	100000.00	0.00	100000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
D.	**Monitoring of Implementation**	**1000000**										
d1.	Preparation of 6 monthly Master Plan Progress Report, Progress Review Meetings & Fund Utilization Report	100000.00	25000.00	25000.00	25000.00	25000.00	0.00	0.00	0.00	0.00	0.00	0.00
d2.	Preparation of NIT, Bid Documents & delivering Bid Process Management Services for Priority Energy Efficiancy (EE), Renewable Energy (RE) & Clean Development Mechanism (CDM) Projects	600000.00	200000.00	200000.00	200000.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
d3.	Presenting Municipal Projects for Approvals & Sanctioning of CFAs/Subsidies as per MNRE, BEE & other Government Schemes	300000.00	0.00	0.00	150000.00	########	0.00	0.00	0.00	0.00	0.00	0.00
	Column Total in Rs.	***5000000***	***2475000***	***1475000***	***675000***	***375000***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***	***0.00***

Annexure 2- Summary of RE Strategies

Renewable Energy Strategy - Residential	Target Unit	Target Capacity	Investment (Lakhs Rs.)	MNRE Subsidy (Lakhs Rs.)	User Contribution (Lakhs Rs.)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Installation of solar water heaters (200 LPD)	Sqmt	22512	1969.80	590.94	1378.86	1.01	820.56
Use of solar home lighting systems (74Wp)	Nos	402	64.32	32.16	32.16	0.63	150.51
Use of Solar home inverter(250 Wp)	KWp	1407	1688.40	506.52	1181.88	1.98	1600.10
Use of PV for replacing DG sets	KWp	670	804.00	241.20	562.80	0.94	761.95
Total			**4526.52**	**1370.82**	**3155.70**	**4.56**	**3333.12**
Renewable Energy -Commercial							
Rooftop Solar PV in Buildings of school and Community hall	KW	1735.80	1562.22	468.67	1093.55	2.85	2309.35
Rooftop Solar in Hotels, Hospitals and police stations	KW	2876.87	2589.19	776.76	1812.43	4.04	3271.70
Rooftop Solar in Banks	KW	720.86	648.77	194.63	454.14	1.01	819.79
SWH for Commercial Sector	Sqmt	1404.00	70.20	15.44	54.76	0.15	124.53
Solar PV Power Plant	MW	1.00	1500.00	0.00	1500.00	1.40	1137.24
Energy From Municipal Solid Waste	MW	2.00	1000.00	300.00	700.00	11.83	9579.06

Total			**7370.38**	**1755.50**	**5614.88**	**21.286**	**17241.66**
Renewable Energy Municipal							
Installation of 5 MW Solar PV Plant	MW	5.00	3500.00	0.00	3500.00	7.50	6525.00
Rooftop Solar PV in Building	KW	1211.40	1090.26	327.08	763.18	1.70	1377.65
Rooftop Solar PV in Markets	KW	400.50	360.45	108.14	252.32	0.56	455.46
Replacement of Conventional Street Lights with Solar Street Lights	Nos	800.00	160.00	48.00	112.00	0.08	67.32
Solar Traffic Lights	Nos	50.00	12.50	3.75	8.75	0.01	8.42
Sewerage treatment plant	Kw	150.63	50.00	15.00	35.00	0.91	737.91
Demonstration Projects	KW	723.00	1012.20	303.66	708.54	1.08	878.45
RE systems for Advertisement Hoardings	Nos	200.00	200.00	60.00	140.00	0.08	68.23
Total			**6385.41**	**865.62**	**5519.79**	**11.94**	**10118.44**
Renewable Energy Strategy - Industrial							
SWH installation in Industrial sector of New Kolkata Town City	Sqmt	1600.00	70.00	21.00	49.00	0.64	518.40
Roof Top Solar PV System in High Rise Residential, corporate institutional and IT sector	MWp	2.36	2126.25	637.88	1488.38	3.32	2686.73
Total			2196.25	658.88	1537.38	**3.96**	3205.13

Annexure 3- Summary of EE Strategies

Energy Efficiency Strategy - Residential	Target Unit	Target Capacity	Investment (Lakhs Rs.)	Energy Saved per year (MU)	Emission Reduction (Tonnes)
Replacement of CFL with LED	nos	40200.00	29.35	1.17	950.81
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	24120.00	361.80	1.41	1140.97
Replacement of conventional air conditioners with EE star rated ACs	nos	2412.00	675.36	0.63	512.85
Total			1066.51	3.22	2604.63
Energy Efficiency Strategy - Commercial					
Replacement of CFL with LED	nos	95790	62.93	2.10	1699.22
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	45412	681.17	2.65	2148.15
Replacement of conventional air conditioners with EE star rated ACs	nos	3585	1003.83	0.94	762.29
Replacement of T12/T8 tube light by T5 tube light	nos	95790	479	5	3738
Total			2226.89	10.31	8347.93

Energy Efficiency Industrial					
Replacement of T12 with 15W LED in all the premises	nos	2625	8.623125	0.191625	155
Replacement of T12/T8 tube light by T5 tube light	nos	2126	10.63	0.10	83
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	1470	22.05	0.085848	70
Replacement of conventional air conditioners with EE star rated ACs	nos	73.5	30.87	0.03087	25
Total			72.17	0.41	333
Energy Efficiency Strategy - Municipal					
Replacement of Tube Lights of 40W with LED lights of 15 W	nos	600	195.10	0.10	83.02
Replacement of High Pressure Sodium Vapor Lamps of 250W with LED lights of 100 W	nos	1318	171.41	0.87	701.40
Replacement of High Pressure Sodium Vapor Lamps of 150 W with LED lights of 70 W	nos	993	52.16	0.35	281.84
Improvement of Design Efficiency in Pumping System	MU	0.00	0.00	0.00	0.00
Variable Speed Drivers	MU	0.00	0.00	0.00	0.00
Total			418.67	1.32	1066.26

Annexure 4- Year wise Action Plan for Solar City Project

Activities	Unit for capacity targeted	1st Year	10 %	Target	2nd Year	15 %	Target	3rd Year	20 %	Target	4th Year	25 %	Target	5th Year	30 %	Target	Aggregrate in 5 years			44.966
		Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	Capacity Targeted	Savings (MU)	Emission Reduction (Tonnes)	% of target
Renewable Energy Strategies																				
Renewable Energy Strategy-Residential																				
Installation of solar water heaters (200 LPD)	Sqmt	2251	0.101	82	3377	0.15	123.08	4502	0.20	164.11	5628	0.25	205.14	6754	0.30	246.17	22512	1.013	820.56	2.25 %
Use of solar home lighting systems (74Wp)	Nos	40	0.063	15.05	60	0.09	22.58	80	0.13	30.10	101	0.16	37.63	121	0.19	45.15	402	0.630	150.51	1.40 %
Use of Solar home inverter(250 Wp)	KWp	141	0.198	160.01	211	0.30	240.01	281	0.40	320.02	352	0.49	400.02	422	0.59	480.03	1407	1.975	1600.10	4.39 %
Use of PV for replacing DG sets	KWp	67	0.094	76.20	101	0.14	114.29	134	0.19	152.39	168	0.24	190.49	201	0.28	228.59	670	0.941	761.95	2.09 %
Total for Residential Sector			**0.46**	**333.31**		**0.68**	**499.97**		**0.91**	**666.62**		**1.14**	**833.28**		**1.37**	**999.94**		**4.560**	**3333.12**	**10.14%**
RE Strategy for Commercial Sector																				

Rooftop Solar PV in Buildings of school and Community hall	KW	173.58	0.285	230.935	260.37	0.428	346.403	347.16	0.57	461.87	433.95	0.71	577.34	520.74	0.86	692.81	1735.80	2.851	2309.35	6.34%
Rooftop Solar in Hotels, Hospitals and police stations	KW	287.69	0.404	327.170	431.53	0.606	490.754	575.37	0.81	654.34	719.22	1.01	817.92	863.06	1.21	981.51	2876.87	4.039	3271.70	8.98%
Rooftop Solar in Banks	KW	72.09	0.101	81.979	108.13	0.152	122.968	144.17	0.20	163.96	180.21	0.25	204.95	216.26	0.30	245.94	720.86	1.012	819.79	2.25%
SWH for Commercial Sector	Sqmt	140.40	0.015	12.453	210.60	0.023	18.679	280.80	0.03	24.91	351.00	0.04	31.13	421.20	0.05	37.36	1404.00	0.154	124.53	0.34%
Solar PV Power Plant	MW	0.10	0.140	113.724	0.15	0.211	170.586	0.20	0.28	227.45	0.25	0.35	284.31	0.30	0.42	341.17	1.00	1.404	1137.24	3.12%
Energy From Municipal Solid Waste	MW	0.20	1.183	957.906	0.30	1.774	1436.859	0.40	2.37	1915.81	0.50	2.96	2394.77	0.60	3.55	2873.72	2.00	11.826	9579.06	26.30%
Total for Commercial Sector			**2.129**	**1724.166**		**3.193**	**2586.250**		**4.257**	**3448.333**		**5.322**	**4310.416**		**6.386**	**5172.499**		**21.286**	**17241.663**	**47.34%**
RE Strategy for Municipal Sector																				
Installation of 5 MW Solar PV Plant	MW	1.000	1.500	1305.000	1.000	1.500	1426.800	1.000	1.500	1426.800	1.000	1.500	1426.800	1.000	1.500	1426.800	5.000	7.500	7012.200	16.679%
Rooftop Solar PV in Building	KW	121.140	0.170	137.765	181.710	0.255	206.648	242.280	0.340	275.531	302.850	0.425	344.413	363.420	0.510	413.296	1211.400	1.701	1377.653	3.782%
Rooftop Solar PV in Markets	KW	40.050	0.056	45.546	60.075	0.084	68.320	80.100	0.112	91.093	100.125	0.141	113.866	120.150	0.169	136.639	400.500	0.562	455.465	1.251%

Replacement of Conventional Street Lights with Solar Street Lights	Nos	80.000	0.008	6.732	120.000	0.012	10.099	160.000	0.017	13.465	200.000	0.021	16.831	240.000	0.025	20.197	800.000	0.083	67.325	0.185 %
Solar Traffic Lights	Nos	5.000	0.001	0.842	7.500	0.002	1.262	10.000	0.002	1.683	12.500	0.003	2.104	15.000	0.003	2.525	50.000	0.010	8.416	0.023 %
Sewerage treatment plant	Kw	15.063	0.091	73.791	22.594	0.137	110.686	30.126	0.182	147.581	37.657	0.228	184.477	45.188	0.273	221.372	150.628	0.911	737.907	2.026 %
Demonstration Projects	KW	72.300	0.108	87.845	108.450	0.163	131.767	144.600	0.217	175.689	180.750	0.271	219.611	216.900	0.325	263.534	723.000	1.085	878.445	2.412 %
RE systems for Advertisement Hoardings	Nos	20.000	0.008	6.823	30.000	0.013	10.235	40.000	0.017	13.647	50.000	0.021	17.059	60.000	0.025	20.470	200.000	0.084	68.234	0.187 %
Total			**1.944**	**1664.344**	**531.329**	**2.165**	**1965.817**	**708.106**	**2.387**	**2145.489**	**884.882**	**2.609**	**2325.161**	**1061.658**	**2.831**	**2504.833**	**3540.528**	**11.936**	10605.644	**26.545%**
RE Strategy for Industrial (Hotel) sector																				
SWH installation in Industrial sector of Panaji	**Sqmt**	160.000	0.064	51.840	240.000	0.096	77.760	320.000	0.128	103.680	400.000	0.160	129.600	480.000	0.192	155.520	1600.000	0.64	518.400	1.423 %
Roof Top Solar PV System in High Rise Residential, corporate institutional and Hotel sector	**MWp**	0.236	0.332	268.673	0.354	0.498	403.009	0.473	0.663	537.346	0.591	0.829	671.682	0.709	0.995	806.019	2.363	3.32	2686.730	7.377 %
Total			**0.39**	**320.5**		**0.59**	**480.7**		**0.79**	**641.0**		**0.98**	**801.2**		**1.18**	**961.5**		**3.95**	**3205.**	**8.80**

			6	**13**		**4**	**69**		**1**	**26**		**9**	**82**		**7**	**39**		**7**	**130**	**0%**
Energy Efficiency Strategies																				
EE Strategy for Residential Sector																				
Replacement of CFL with LED	nos	4020	0.117	95.08	6030	0.176	142.62	8040	0.235	190.16	10050	0.293	237.70	12060	0.352	285.24	40200	1.174	950.81	2.61 %
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	nos	2412	0.141	114.10	3618	0.211	171.15	4824	0.282	228.19	6030	0.352	285.24	7236	0.423	342.29	24120	1.409	1140.97	3.13 %
Replacement of conventional aircconditioners with EE star rated ACs	nos	241	0.063	51.29	362	0.095	76.93	482	0.127	102.57	603	0.158	128.21	724	0.190	153.86	2412	0.633	512.85	1.41 %
Total for Residential Sector			**0.32**	**260.46**		**0.48**	**390.70**		**0.64**	**520.93**		**0.80**	**651.16**		**0.96**	**781.39**		**3.216**	**2604.63**	**7.15 %**
EE Strategy for Commercial Sector																				
Replacement of CFL with LED	nos	9579	0.210	169.92	14368	0.315	254.88	19158	0.420	339.84	23947	0.524	424.80	28737	0.629	509.77	95790	2.098	1699.22	4.67 %
Replacement of conventional ceiling	nos	4541	0.265	214.81	6812	0.398	322.22	9082	0.530	429.63	11353	0.663	537.04	13623	0.796	644.44	45412	2.652	2148.15	5.90 %

fan with Energy Efficient ceiling fans																			
Replacement of conventional air conditioners with EE star rated ACs	nos	359	0.094	76.23	538	0.141	114.34	717	0.188	152.46	896	0.235	190.57	1076	0.282	228.69	3585	0.941	762.29	2.09%
Replacement of T12/T8 tube light by T5 tube light	nos	9579	0.462	373.83	14368	0.692	560.74	19158	0.923	747.66	23947	1.154	934.57	28737	1.385	1121.48	95790	4.615	3738.28	10.26%
Energy Efficiency in Green Buildings	Nos	0	0.000	0.00	0	0.000	0.00	0	0.000	0.00	0	0.000	0.00	0	0.000	0.00	0	0.000	0.00	0.00%
Total for Commercial Sector			**1.03**	**834.79**	**36086.47**	**1.55**	**1252.19**	**48115.30**	**2.06**	**1669.59**	**60144.12**	**2.58**	**2086.98**	**72172.95**	**3.09**	**2504.38**	**240576.49**	**10.31**	**8347.93**	**22.92%**
EE Strategy for Industrial (Hotel)																				
Replacement of T12 with 15W LED in all the premises		263	0.0192	16	394	0.0287	23	525	0.0383	31	656	0.0479	39	788	0.0575	47	2625	0.192	155.22	0.43%
Replacement of T12/T8 tube light by T5 tube light		213	0.0102	8	319	0.0154	12	425	0.0205	17	532	0.0256	21	638	0.0307	25	2126	0.102	82.98	0.2278%

Replacement of conventional ceiling fan with Energy Efficient ceiling fans		147	0.0086	7	221	0.0129	10	294	0.0172	14	368	0.0215	17	441	0.0258	21	1470	0.086	69.54	0.1909%
Replacement of conventional air conditioners with EE star rated ACs		7	0.0031	2.50	11	0.0046	3.75	15	0.0062	5.00	18	0.0077	6.25	22	0.0093	7.50	74	0.031	25.00	0.0687%
Total			**0.04**	**33.27**	**944.21**	**0.06**	**49.91**	**1258.95**	**0.08**	**66.55**	**1573.69**	**0.10**	**83.18**	**1888.43**	**0.12**	**99.82**	**6294.75**	**0.41**	**332.74**	**0.91%**
EE strategy for Municipal Sector																				
Replacement of Tube Lights of 40W with LED lights of 15 W	nos	60	0.01	8.30	90	0.02	12.45	120	0.02	120.00	150	0.03	150.00	180	0.03	24.91	600	0.102	316	0.23%
Replacement of High Pressure Sodium Vapor Lamps of 250W with LED lights of 100 W	nos	132	0.09	70.14	198	0.13	105.21	264	0.17	140.28	330	0.22	175.35	395	0.26	210.42	1318	0.866	701	1.93%
Replacement of High Pressure Sodium Vapor	nos	99	0.03	28.18	149	0.05	42.28	199	0.07	56.37	248	0.09	70.46	298	0.10	84.55	993	0.348	282	0.77%

Lamps of 150 W with LED lights of 70 W																			
Improvement of Design Efficiency in Pumping System	MU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00 %
Variable Speed Drivers	MU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0	0.00 %
Total			**0.13**	**106.63**	**436.65**	**0.20**	**159.94**	**582.20**	**0.26**	**316.65**	**727.75**	**0.33**	**395.81**	**873.30**	**0.39**	**319.88**	**2911.00**	**1.32**	**1299**	**2.93 %**
																		56.99	**Sum Total**	**126.74%**

Annexure 6- Initiative taken by CCP

Annexure 7- List of Solar City members

Annexure 8- List of Stakeholder committee members

Annexure 9- Solar City Approval Letter from MNRE

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