Development of Thane Solar City

Draft Master Plan, May 2010

ICLEI Local Governments for Sustainability

ABBREVIATIONS AND ACRONYMS

AC:	Air-conditioner
BEE:	Bureau of Energy Efficiency
BIPV:	Building Integrated Photovoltaics
BMS:	Building Management System
BOOT:	Build, Operate, Own and Transfer
BOT:	Build, Operate and Transfer
CAGR:	Compound Annual Growth Rate
CDM:	Clean Development Mechanism
CDP:	City Development Plan
CERC:	Central Electricity Regulatory Commission
CFA:	Central Financial Assistance
CFL:	Compact Fluorescent Light
CHP:	Combined Heat and Power
CNG:	Compressed Natural Gas
CO_2:	Carbon Dioxide
CPWD:	Central Public Works Department
CSP:	Concentrating Solar Power
DG Sets:	Diesel Generator Sets
DISCOM:	Distribution Company
DSM:	Demand Side Management
DTS:	Decentralized Waste Water Treatment System
ECBC:	Energy Conservation Building Code
eCO_2:	Equivalent Carbon Dioxide
EE:	Energy Efficiency
ESCo:	Energy Service Company
FITM:	Feed in Tariff Mechanism
FTL:	Fluorescent Tube Light
GDP:	Gross Domestic Product
GHG:	Green House Gases
GLS:	Global Light Source
GRIHA:	Green Building Integrated Habitat Assessment
HH:	House Hold
HPSV:	High Pressure Sodium Vapour
Hrs/day:	Hours per Day
HVAC:	Heating, Ventilation and Air-conditioning
Hz:	Hertz
ICLEI SA:	International Council for Local Environmental Initiatives – South Asia
IEA:	International Energy Agency
IEO:	International Energy Outlook
IREDA:	Indian Renewable Energy Development Agency
ISES:	International Solar Energy Society
JnNURM:	Jawaharlal Nehru National Urban Renewal Mission
TMC:	Thane Municipal Corporation
Kg:	Kilogram
kHz:	Kilo Hertz
kL:	kilo litre
kL:	Kilo Litre
kT/yr:	Kilo Tonnes per Year
kW:	kilo Watt
kWe:	Kilo Watt Equivalent
kWh:	kilo watt-hour
kWp:	Kilo Watt Peak
L:	Litre
LED:	Light Emitting Diode
LEED:	Leadership in Energy and Environmental Design
LPD:	Litres per day
LPG:	Liquefied Petroleum Gas
m/s:	Metres per Second
M:	Metre
MNES:	Ministry of Non-conventional Energy Sources (now the MNRE)
MNRE:	Ministry of New and Renewable Energy
MSEDCL:	Maharashtra State Electricity Distribution Company
MSW:	Municipal Solid Waste
MT:	Metric Tonnes
MU:	million units
MW:	Mega Watt
MWe:	Mega Watt Equivalent
MWh:	Mega Watt-hour
MWp:	Mega Watt Peak
NGO:	Non-governmental Organization
O&M:	operations and Maintenance
PDD:	Project Design Document
PNG:	Piped Natural Gas
PPP:	Public-Private Partnership
R&D:	Research and Development
RE:	Renewable Energy
REC:	Renewable Energy Certificate
RET:	Renewable Energy Technology
SCADA:	Supervisory Control and Data Acquisition
SCMD:	Standard Cubic Meters per Day
SCP:	Solar Cities Project
SERC:	State Electricity Regulatory Commission
Sft:	Square Feet
SNA:	State Nodal Agency
SPV:	Solar Photo Voltaic
Sqm:	Square Metre
STP:	Sewage Treatment Plant
SWH:	Solar Water Heater
SWM:	Solid Waste Management
T/yr:	Tonnes per Year
T:	Tonne
$TeCO_2$:	Tonnes of Equivalent Carbon Dioxide
TERI:	The Energy and Resources Institute
ULB:	Urban Local Body
UNFCCC:	United Nations Framework Convention on Climate Change
W:	Watt
Wh:	Watt-hour
WTP:	Water Treatment Plant

ACKNOWLEDGEMENT

This Master Plan is an outcome of the Ministry of New and Renewable Energy's (MNRE's) Solar City Programme as part of the 11th Five year plan. Their initiatives have led to the collaboration of the Thane Municipal Corporation (TMC) with ICLEI-South Asia for the preparation of the Solar City Master Plan for Thane city, as part of this Programme. We gratefully acknowledge the support of Thane Municipal Corporation and Maharashtra Energy Development Agency (MEDA) for providing assistance in primary and secondary data collection in the initial phase of master plan preparation.

We would like to thank Secutech Automation (India) Pvt. Ltd Mumbai, for data collection and sample survey for Thane city. The report benefited enormously from peer review process by a gamut of experts from ICLEI South Asia and most importantly the Thane Municipal Corporation (TMC), Maharashtra Energy Development Agency (MEDA) and the stakeholders of Thane Solar City Programme. We acknowledge their contributions and suggestions which streamlined the structure and composition of the master plan.

Finally, the report would have not been possible without the generous support of Ministry of New & Renewable Energy, Government of India to Thane Municipal Corporation under the programme 'Development of Solar Cities'.

EXECUTIVE SUMMARY

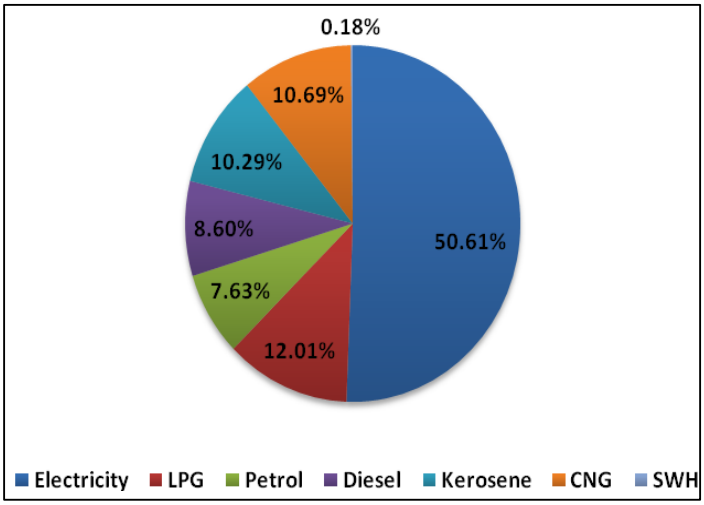
The "Development of Solar Cities" programme by the Ministry of New and Renewable Energy (MNRE), Government of India, is an immense opportunity for contributing towards a sustainable India in the coming years. This programme is a crucial step towards supporting Indian cities for the development of renewable energy and energy efficiency projects and curbing conventional energy demand by 10% in the next five years. This master plan is the outcome of the programme's objective to develop a road map for the city to envision and implement renewable energy and energy conservation strategies. The master plan approach is in tandem with the requirements of the MNRE guidelines.

The master plan begins with the introductory city profile which encapsulates the city's current energy demands and also the municipal corporation services which are intrinsic to the city's growing energy demand.

The 2nd chapter provides the *Current Energy Scenario of Thane*. Detailed analysis of the trend and pattern of electricity, petrol, diesel, kerosene and LPG consumption has been discussed and thoroughly analysed to base the strategy development of the city. The main sources of energy in the city are electricity, petrol, diesel, LPG and kerosene.

The 3rd Chapter *Energy Demand Forecast of Thane* estimates the future conventional energy demand interpolating the past data of energy consumption as well as population growth data. However other key aspects detrimental to energy demand like population growth and city economic growth has also been considered for ascertaining the city's future conventional energy demands.

Electricity has the largest share in the makeup, accounting for 50.61% of the energy supply, with LPG at 12.01%, petrol at 7.63%, diesel at 8.60%, kerosene at 10.29% and CNG at 10.69%. The present penetration of SWH in Thane is approximately 0.18%.



Goal for Year 2013:

Studying the historical growth in consumption levels and population growth projections until the year 2013, it has been assessed that the energy consumption in Thane in 2013 can be ascertained under the highest growth scenario as **2301 MU**.

This gives the city a 10% reduction goal of **230.1 MU**.

The success of renewable energy technology projects can only be assured with an accurate resource assessment and its potential in the city. Hence the 4th Chapter *Renewable energy and Energy Efficiency Strategies for TMC* begins with the resource availability and intensity of renewable energy resources like solar, wind, hydro- and geothermal in the city. This chapter is the most substantial part of the master plan as it delineates the specific strategies for the city. For ease of study the city has been divided into **residential,**

commercial, municipal and industrial sectors and both renewable energy and energy efficiency initiatives are enlisted within it. Case studies have been highlighted in the city which are 4-5 specific sites within the city where RE and EE technologies can be showcased.

A minimum of 5% of the energy reduction achieved is aimed to be met through renewable energy measures. The primary or the most feasible actions for which the techno-economics have been developed under renewable energy measures are solar water heater and solar home light systems. Considering the high upfront/ capital costs of solar equipments in India SWH has proved to be the least cost option compared to other solar equipments for TMC. As TMC is primarily an urban residential area, the potential for investment lies more in/from individual households.

The table below summarizes the year wise energy savings goal with RE and EE strategies in different sectors:

	Energy Savings target over 5 years period of implementation							
RE and EE Strategy for Thane City	**1st Year**	**2nd year Cumulative**	**3rd year Cumulative**	**4th year Cumulative**	**5th year Cumulative**	**Total Energy Savings (MU)**	**% of savings target to achieve**	**Emission reduction/ year**
RE for Residential Sector	10.33	25.83	46.49	72.31	103.30	103.30	44.90%	96654
RE for Commercial & Inst. Sector	0.74	1.85	3.33	5.18	7.39	7.39	3.21%	4977
RE for Industrial Sector	0.17	0.42	0.75	1.16	1.66	1.66	0.72%	1366
RE for Municipal Sector	0.17	14.68	20.15	32.12	32.63	32.63	14.18%	26435
Total for RE strategy	14.50	36.25	65.24	101.49	144.99	144.99	63.01%	129432
EE for Residential Sector	11.00	27.51	49.52	77.03	110.05	110.05	47.83%	89140
EE for Commercial Sector	2.59	6.47	11.65	18.12	25.89	25.89	11.25%	20971
EE for Industrial Sector	0.58	1.45	2.61	4.06	5.79	5.79	2.52%	4694
EE for Municipal Sector	2.62	6.55	11.79	18.34	26.21	26.21	11.39%	21226
Total for EE Strategy	16.79	41.99	75.57	117.56	167.94	167.94	72.99%	136032
RE and EE Combined Strategy	31.29	78.23	140.82	219.05	312.93	312.93		265464
	14%	34%	61%	95%	136%	136%		

The table below summarizes the total budget and year wise expenses for implementation of solar city development programme shared among MNRE, state/ city and private users.

	Year 1 (Crore)	**Year 2 (Crore)**	**Year 3 (Crore)**	**Year 4 (Crore)**	**Year 5 (Crore)**	**Total (Crore)**
State / City Share	14.36	21.54	28.72	35.89	43.07	143.58
MNRE Share	65.96	105.84	133.43	168.42	197.58	671.24
Private Share	90.69	145.33	184.72	234.25	272.06	927.06
Total Budget	171.01	272.71	346.88	438.57	512.72	1741.88

Guidebook for development of Solar City:

The "Guidebook for development of Solar City" is an integral part of the Master Plan. The guidebook provides generic information about general energy scenario, renewable energy scenario and energy efficiency initiatives in India, evolution of solar city concept, international solar city initiatives and local renewable network in its first two chapters. The third chapter describes the solar city programme in India and its objectives, targets and guidelines. Indicative renewable energy devices and energy efficiency measures are described in chapter 4 & 5. Financial models have been suggested in the 6th Chapter *Financial Schemes and Business Models* to enable the city to implement the strategies listed here. The implementation phase under this programme will be the key indicator to determine the level of success for this MNRE programme. The 6th Chapter cites numerous schemes available in India as well as various business models which can be emulated for successful implementation of RE & EE projects.

Not only financing but capacity building and awareness generation go hand in hand to ensure sustainability of the MNRE programme. All activities from developing a "Solar City Cell" to workshops and training have been discussed in the 7th Chapter *Implementation Strategy for Solar City Programme*.

8th Chapter *Risk Analysis* describes the risks involved in developing renewable energy projects in the Indian context and suggests mitigation methods for the cities. A generic approach has been taken to provide the preventive measures however risks are city-specific and requires intrinsic detailing for individual projects.

The master plan provides a framework to compare and analyze alternative strategies and policies, in order to facilitate Council's review and the decision-making process. Achieving significant reduction in energy consumption requires collective effort by all City departments, other government departments, businesses, industries and citizens. The City needs to become a bolder leader in its policies, planning, programs, advocacy and its own operations – there is a tremendous opportunity and need to demonstrate Community Leadership. The investigation showed that the biggest energy saving potential is in the residential sector and most significant RES potential is for solar energy projects. It is the responsibility of leaders in all tiers of government, commerce, industry and civil society to promote action towards more efficient and renewable energy use.

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CHAPTER 1

1. INTRODUCTION

1.1. Thane City Profile

The city of Thane is one of Maharashtra's major industrial town and the district headquarters. The National Decennial Census 2001 pegged the population of the city at 12, 61,517. Thane is included in the Mumbai Metropolitan Region and is one of the 18 Urban Centers therein. Being the first urban Center on the periphery of the Greater Mumbai, the city occupies a unique position in the region. The city has been marked by rapid demographic growth and has witnessed ten fold multiplications in the last forty years. However owing to large industrial development and its proximity to the Greater Mumbai, Thane has demonstrated its will to rise to the challenge and exhibit marked improvement in generating increased revenues and convert then into better economic growth, improved services and expanded infrastructure. The geographical jurisdiction of the Thane city spreads over an area of 128.23 sq. km. The city is located at the mean sea level on the northern part of the Konkan region. The city is also known as Lake city because of the 35 lakes encompassing an area of about 40 Ha.

1.2. City Urban Services

The City of Thane forms an important urban agglomeration of Maharashtra State. Substantial portion of Maharashtra's state domestic product originates in urban areas. The productivity of urban areas largely depends upon the efficient urban land use and the efficiency of the urban infrastructure. For the sustained economic growth of the city, therefore efficient delivery of urban infrastructure services along with the expansion of services commensurate with the pace of urban population growth is of crucial importance. This has necessitated the Thane Municipal Corporation to undertake the preparation of VISION document for the city. The intent of vision for the city is to facilitate, promote the economic growth of the city with special emphasis on environment of the city. The Corporation has also focused on and aimed at improving the quality of life of the people, particularly the urban poor. Keeping a holistic approach the Corporation tried to prepare a realistic action plan.

1.2.1. Administrative Setup

The Corporation is under the administrative control of the Commissioner, and Additional Municipal Commissioner who is an IAS officer appointed by the State Government. In the Head office there are Administration, Engineering, Health, Accounts, Planning and Revenue wings headed by Senior Officers and at zonal level there are ward officer.

1.2.2. Public Health

TMC provides public health services through 24 dispensaries and primary health centers, 1 diagnostic center, prominent health department, 4 maternity homes, 1 paediatric hospital and 500 bed hospital. In addition it implements national health programmes such as polio vaccination, family planning and family welfare, vitamin and booster doses to children. The Corporation also runs medical college and nursing training institute.

1.2.3. Revenue

During the last two years, TMC has implemented accounting reforms backed by the budgeting reforms. The opening balance sheet as on April 01, 2004has been prepared and since April 01, 2005, TMC has been maintaining its accounts on double entry accrual based accounting system. On the other hand, TMC has implemented budgeting reforms by preparing the budget for the FY 2005-2006 with a view of targeting to arrive at a scientific basis by linking the nature of receipt or payment with functions / services or other budget control centers. TMC has prepared an outcome budget for the FY 2006-07 by adopting a logical framework to relate the outcome with the performance of various items. The total revenue income under budget 'A' & 'C' has increased at an average annual growth rate of 11.5% & 12.6% respectively through 1999-2004. Total capital expenditure grew at a CARG 38% as compared to the last decades 20.8%.The grants contribution to TMC's budgets have been miniscule and capital expenditure has essentially been funded from TMC's own surpluses and loans.TMC has posted a revenue surplus throughout the last decade. The strong revenue surplus over the decade is a measure of fiscal responsibility. TMC has refinanced most of its high cost loans in the FY 2003-04 and FY 2004-2005 which has enabled TMC to leverage the total amount of loans at a relatively lower cost. About 60% of TMC's expenditure is of fixed nature which as a proportion to the revenue receipts is about 40% which gives TMC a good deal of financial flexibility.

1.2.4. Town Planning

Town Planning department is headed by the Town Planning Officer (Executive Engineer - Planning). The main activities of this department are Building license, Layout Approval, Site Approval & Subdivision, Reconstitution of Site Approval, Renewal Of Building License, Request Of Survey and Extract, Request for Attested Copies, Appeals to Director of Town and Country Planning OR to the Government, and Regularization of unapproved / deviated constructions and development.

1.2.5. Education

TMC has been providing educational facilities at all levels. The Corporation runs 56 nurseries, 133 primary schools and 8 secondary schools. In addition, the Corporation also runs school for the handicapped. The school board of the Corporation manages the primary schools while the secondary education is delivered by the secondary education department of the Corporation.

1.3. Developing Thane as 'Solar City'

The Ministry of New and Renewable Energy (MNRE), Govt. of India has launched a Scheme on "Development of Solar Cities" under which a total of 60 cities/towns are proposed to be supported for development as "Solar/ Green Cities" during the 11th Plan period. The program aims at minimum 10% reduction in projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources. Out of this 5% will be from renewable energy source. MNRE has been providing financial support to Thane Municipal Corporation for preparing a Master Plan for developing Thane as a Solar City.

1.3.1. Preparation of Master Plan for 'Thane Solar City'

The master plan preparation process is divided into six steps:

(i) Preparing energy base-line for year 2008

Energy base-line for the city is a detailed documentation of the existing energy demand and supply scenario for the city. Among other things, it consists of sector-wise energy consumption matrix and energy supply-mix for the base year. The city is divided into four sectors vis. Residential, commercial/ Institutional, Industrial and Municipal sector.

(ii) Demand Forecasting for 2013/2018

This step involves predicting the energy demand for 5 year and 10 year periods. To estimate the demand, growth in energy use in different sectors has been established. These growth rates are established based on immediate past trends and future growth plans. Based on the past time-series data and information on growth plans, growth rate in energy demand for different sectors has been estimated. These growth rates are used for making future projection of energy demand in each sector for year 2013 (five year) and 2018 (10 year).

(iii) Sector wise strategies

This step involves carrying out techno-economic feasibility of different renewable energy and energy efficiency options for each sector based on techno-economic feasibility for such application to the concerned sectors. A renewable energy resources assessment has been done to identify the potential renewable energy sources for the city. This includes assessment of solar radiation, wind power density and availability, biomass resources and municipal/industrial wastes. A strategy has been prepared for use of techno economically feasible renewable energy technology options in each sector.

(iv) Year-wise goals of savings

Year wise goals have been set to achieve targeted energy savings through demand side management by energy conservation and energy efficiency measures in different sectors & supply side measures based on renewable energy applications.

(v) Action Plan

A five-year action plan has been prepared to achieve the set goals & expected GHG abatements. This includes establishment of solar city cell, capacity building and awareness generation.

(vi) Financial Outlay and sharing of fund

An indicative financial outlay has been prepared for implementation of the proposed five-year action plan and potential sources of funding from respective sources (both public and private) has been indicated.

CHAPTER 2

This chapter gives details of energy consumption for the Thane city for past 3-5 years. The consumption has been shown based on the energy sources such as electricity, LPG, petrol, diesel and kerosene. Further, sectoral break up (i.e. residential, commercial, industrial and municipal) of consumption for each fuel is also presented. The chapter also provides the findings of the primary sample survey, including monthly fuel consumptions, ownership of appliances and their usage, present usage of renewable energy, awareness and usage of energy efficient technologies etc.

2. ENERGY BASELINE STATUS OF THANE CITY

2.1. Overall Energy Status

2.1.1. Energy Consumption

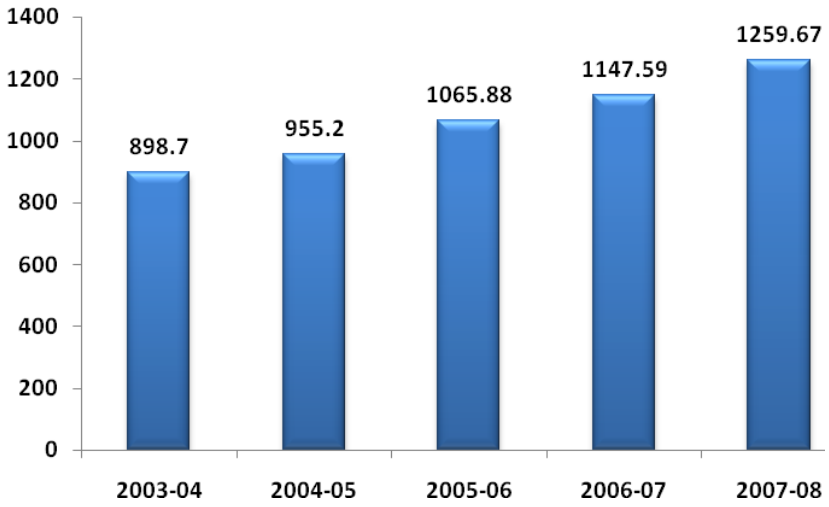
Based on the information gathered from survey, the energy supply scenario is presented here. The main sources of energy are electricity, petrol, diesel, LPG, CNG and kerosene.

(i) Electricity: Electricity distribution in the city is division based and there are 3 divisions (Thane Urban, Wagle Estate Division and Kalwa Division) in the Thane city. Based on the information available, sector wise electricity consumption data is compiled for last 5 years.

Table 1 : Electricity consumption in Thane City

Electricity Consumption (MU)						No. of Consumers
Year	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	
Residential	322.6	358.4	402.7	447.5	513.1	343904
Commercial	85.7	95.3	112.1	136.7	172.9	42156
Industrial	490.4	501.4	514.3	526.4	537.7	7270
Municipal	-	-	36.78	36.99	35.97	-
Total	**898.7**	**955.2**	**1065.88**	**1147.59**	**1259.67**	**393330**

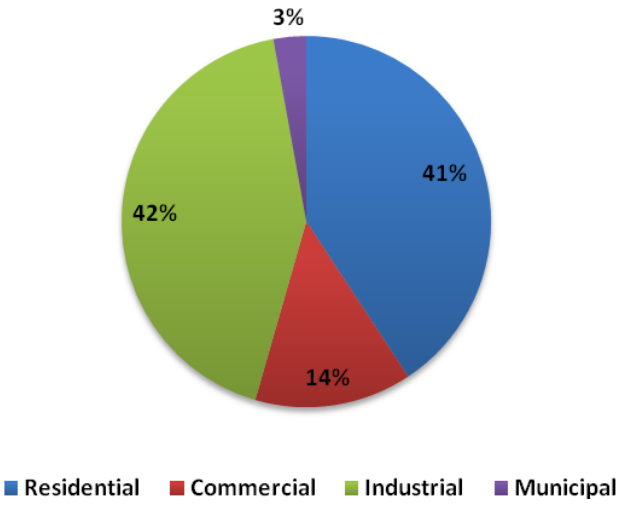
The maximum electricity consumption in Thane city is from Industrial Sector which consumes about 44% of the total electricity consumption in the city. The Sectoral Growth in last 5 years for residential, commercial and industrial sectors are 59.04%, 101.70% and 9.65% respectively. Overall, the electricity consumption has increased by 40.17% in 5 year.



Growth in Electricity Consumption

Figure 1 : Trend of Electricity Consumption in Thane city

Figure below gives the break up of electricity consumption for different sectors. Residential sector dominates (81%) in electricity consumption and hence should be targeted for Demand Side Measures (DSM). During last five years, the residential and commercial sectors have shown higher growth in electricty consumption as compared to the the municipal and industrial sectors.



Sector Wise Break-Up of Electricity Consumption

Figure 2 : Pattern of Electricity Consumption in Thane city

(ii) **LPG:** Based on the available data, LPG consumption is summarized in Table given below.

Table 2 : LPG Consumption Data in TMC

Sectors	**2005-06 (MT)**	**2006-07 (MT)**	**2007-08 (MT)**
Residential	19011	19170	19746
Commercial + Industrial	765	860	820
TOTAL	**19776**	**20030**	**20566**

(iii) **Petrol:** Based on the available data, petrol consumption is summarized in Table given below. Most of the consumption would be in transportation sector; however, sectoral break up of petrol consumption is not available.

Table 3 : Petrol Consumption Data in TMC

	2004-05	**2005-06**	**2006-07**	**2007-08**
TOTAL	4723.43	5466.70	11543.89	18828.67

(iv) **Diesel:** Based on the available data, diesel consumption is summarized in Table given below. Most of the consumption would be in transportation & industrial sector. There would also be some diesel consumption in residential sector for DG sets. However, sectoral break up of diesel consumption is not available.

Table 4 : Diesel Consumption Data in TMC

2005-06	**2006-07**	**2007-08**
11672.75	17123.46	20630.05

(v) **Kerosene:** Based on the available data, kerosene consumption is summarized in Table given below. Most of the consumption would be in industrial sector; however, it might include the supply to industries which are not falling under TMC area. Sectoral break up of kerosene consumption is not available.

Table 5 : Kerosene Consumption Data in TMC

Kerosene (kL)					
	2003-04	2004-05	2005-06	2006-07*	2007-08
Total	24997	27896	26912	26244	25468

(vi) PNG: Based on the available data, PNG consumption is summarized in Table given below. Most of the consumption would be in industrial sector; however, it might include the supply to industries which are not falling under TMC area. Sectoral break up of PNG consumption is not available.

(vii)

Table 6 : PNG consumption data in TMC

Type of users	2005-06	2006-07	2007-08
Consumption (scmd)	NA	2560	6150

(viii) CNG: Based on the available data, CNG consumption (in kgs.) is summarized in Table given below. Most of the consumption would be in transport sector. Sectoral break up of CNG consumption is not available.

Table 7 : CNG Consumption data in TMC

Years	**2006-07**	**2007-08**
Consumption (scmd)	44600	73000

(ix) Briquette: Based on the available data, briquette consumption is summarized in Table given below. Most of the consumption would be in industrial sector. Sectoral break up of Briquette consumption is not available.

Table 8 : Briquette Consumption data in TMC

Year	**2005-06**	**2006-07**	**2007-08**
Briquette (MT)	13,000	20,000	21,000

2.1.2. Supply Side Energy Balance

Based on the available data for these 6 energy sources, the supply energy scenario for year 2007-08 is developed. It is assumed that the SWH penetration in the city is 1%, i.e. 1% of the households use SWH in the city. Other Renewables have very low penetration and are too small a percentage to be reflected here. The table and figure give contribution of these energy sources in the overall energy supply.

Table 9 : Supply of Energy in TMC, 2007-08

Source	**Consumption**	**Unit**	**Consumption (MU)**
Electricity	1224	MU	1259.67
LPG	20566.31	MT	299

Petrol	20630.05	kL	190
Diesel	18828.67	kL	214
Kerosene	25468	kL	256
CNG	73000	MT	266
SWH	3439	No.	4.39
		Total	**2489.06**

From this analysis, it is very clear that the electricity is the major source of energy consumed by the city and needs attention for effective and optimal use through energy efficiency measures, DSM and application of renewable energy resources.

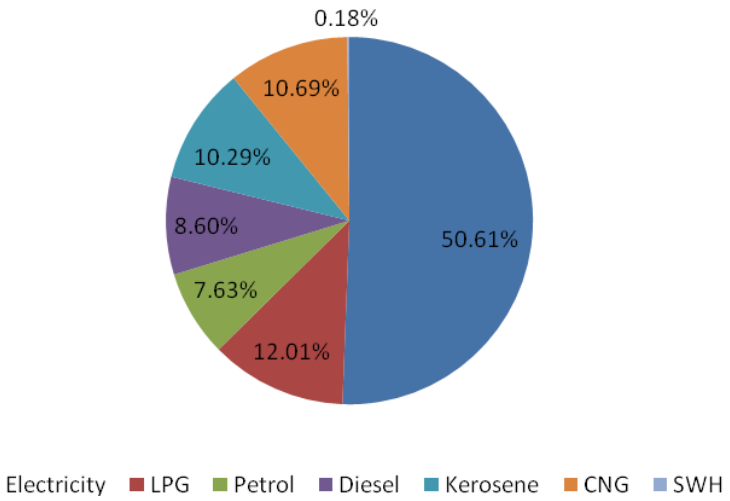


Figure 3 : Shares of Fuels in Supply Side Energy Balance

The above mentioned pie-chart gives the break up in percentage for supply side energy balance for the 2007-08.

2.2. Residential Sector

2.2.1. Energy consumption

Residential sector dominates the overall energy consumption. Energy usage pattern for this sector is shown in Table below.

Table 10 : Residential Sector Energy Consumption

	2004-05	2005-06	2006-07	2007-08
Electricity (MU)	358.4	402.7	447.5	513.1
LPG (MT)	18541.25	19011.47	19170.26	19745.87
Kerosene (kL)	27896	26912	26244	25468

Energy balance for the sector for the year 2007-08

Table 11 : Energy Balance for Residential Sector

Source	Consumption	Consumption (MU)
Electricity	513.05 MU	513.05 MU
LPG	19745.87 MT	287.05 MU
Kerosene	25468 kL	256.08 MU
	Total	**1056.18 MU**

Electricity is the main source of energy in residential sector as it contributes 49% of the total whereas LPG contributes 27% and kerosene 24%.

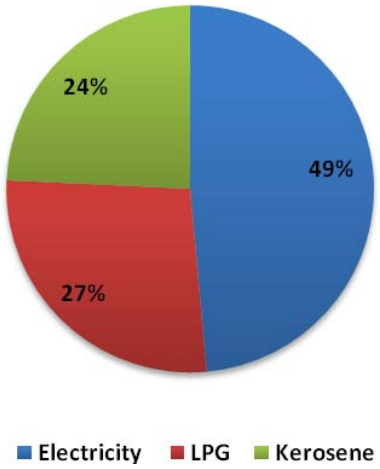


Figure 4 : Supply Balance in residential sector

2.2.2. Results of sample survey

It should be noted that numbers given in the summary are specific to the surveyed households only.

In order to understand the end uses of energy, and consumer behavior patterns consumer survey has been conducted. The survey questionnaire has been developed to gather information such as monthly fuel consumption, ownership of appliances and their usage, present usage of renewable energy, awareness and usage of energy efficient technologies, etc. The survey data has been analyzed and the summary has been shown below.

Household classification and general details

Household class: Based on the monthly electricity consumption households have been classified under 4 categories.

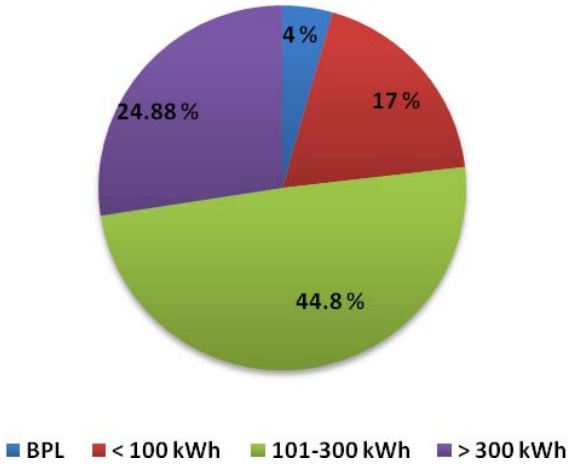


Figure 5 : Household Classification

Building type:

1. Bungalow / independent house -7%
2. Housing Scheme -12%
3. Apartment building / Flat -73%
4. Slum pocket -8%
5. Other -0%

- Family size: Less than 5 – 80%, 5-10 – 17%, >10-3%
- House area varies from 150 to 2500 ft^2 and the average size is 627 ft^2 per household.

Fuel usage:

- Primary fuel used for cooking:
  1. LPG/PNG - 97%
  2. Kerosene - 1%
  3. Fuel wood - 0%
  4. Electricity - 1.5%
  5. Others - 0.5% (total is more than 100 due to multiple fuel usage)

- Primary fuel used for water heating
  1. LPG/PNG - 36%
  2. Kerosene -2%
  3. Fuel wood -1%
  4. Electricity -60%
  5. Other -1% (total is more than 100 due to multiple fuel usage)

- **Ownership of household appliances:**
- Electric appliance summary:

Table 12 : Electric Appliance Ownership

Type of Appliances	% of surveyed hh owning the appliance	Average number of appliances per surveyed hh
Electric Fan	100	3.73
Air Conditioner	43.8	0.64
Desert cooler	1.5	0.01
Television	97.5	1.12
Refrigerator	91.5	0.94
Geyser	74.6	0.94
Immersion heater	1.0	0.01
Room heater	0	0.00
Electric Water Pump	2	0.02
Any other	93	2.32

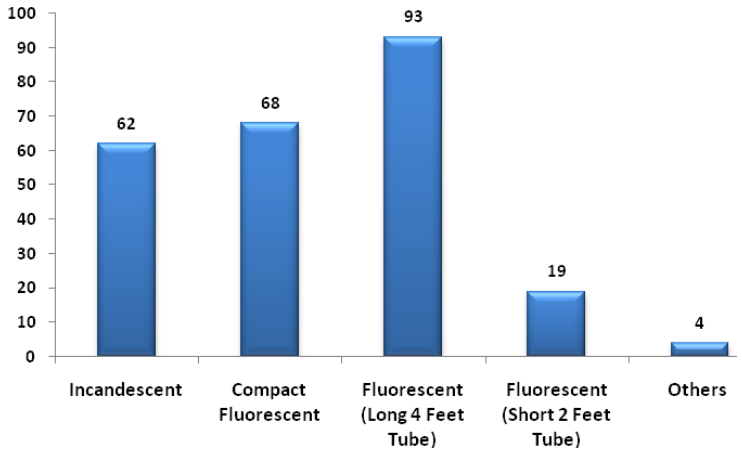


Figure 6 : Lighting Inventory and Usage

Awareness of EE & RE technologies amongst masses:

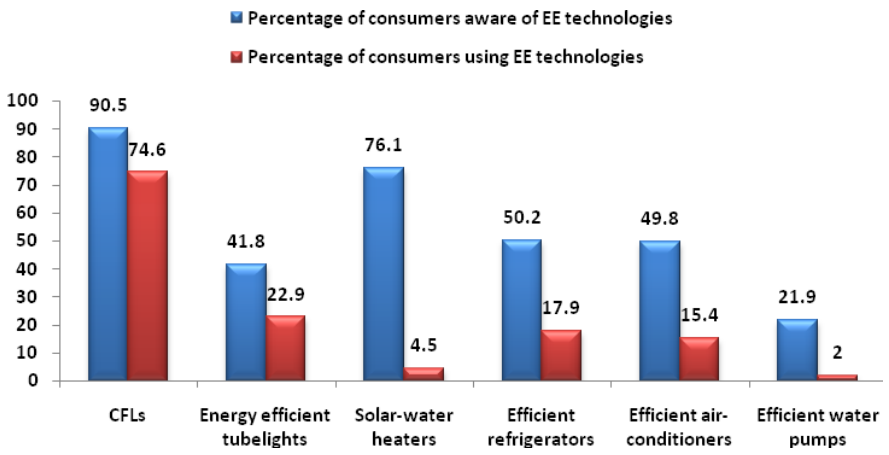


Figure 7 : Awareness and Usage of RE & EE Technologies

2.3. Commercial Sector

2.3.1. Energy Consumption

Electricity is the main source of energy in commercial sector. Commercial sector energy usage pattern is shown in Table below. The main sources are electricity.

Table 13 : Commercial Sector Energy Usage

Source	2004-05	2005-06	2006-07	2007-08
Electricity (MU)	95.3	112.1	136.7	172.9
LPG (MT)	585.66	765.04	860.34	820.439

Table 14 : Energy Balance for the Sector in 2007-08

Source	Consumption	Unit	Consumption	Unit
Electricity	172.9	MU	172.9	MU
LPG	820.439	MT	11.93	MU
		Total	**184.83**	**MU**

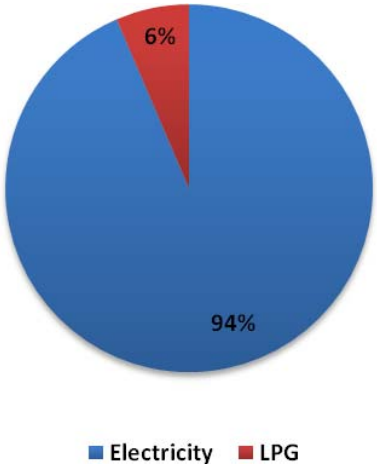


Figure 8 : Supply Balance in Commercial Sector

Electricity is the main source of energy in commercial sector.

2.3.2. Results of sample survey

Similar to the residential sector, a survey questionnaire has been prepared for commercial sector to understand the energy usage. The summary of the survey is given below. The data shown below are specific to the surveyed consumers only.

- **Consumer classification (kWh/month)**

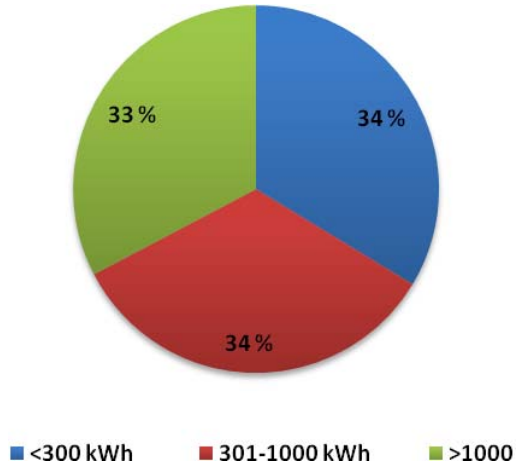


Figure 9 : Break Up by Consumer Category

2.3.3. Details of commercial establishments in the city

Table 15 : Summary of commercial establishment/ institutes in Thane

Educational Institutes	
Primary Schools/ Nursery	308
Intermediate & High schools	35
Universities/ colleges/ Technical Institutes	22
Hospitals	
Small hospitals and nursing homes with less than 50 beds	442
Hospitals with more than 100 beds	13
Hotels	
3 Star category hotels with less than 100 guest rooms	3
Budget hotels / lodge	23
Restaurants	
Large Restaurants	47
Medium Restaurants	149
Small Restaurants	409
Food Cart	320

2.3.4. Results of sample survey

Similar to the residential sector, a survey questionnaire has been prepared for commercial sector to understand the energy usage. The summary of the survey is given below. T**he data shown below are specific to the surveyed consumers only.**

- **Consumer classification (kWh/month)**

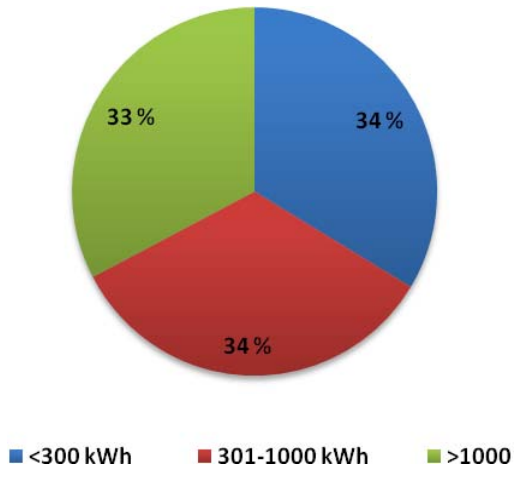


Figure 10 : Break Up by Consumer Category

Table 16 : Summary of sample survey in commercial sector

	% of consumer having
Air Conditioners. (incl. central plant)	62.5
Refrigerators/Freezers/Cool room	29.1
Cooking equipment	11.3
Water heating equipment	8.8
Laundry Equipment	1.3
Office Equipment (photocopiers, fax)	18.8
Computers	55.0
Electrical motors for air compressors	0.0
Lathe Machines	1.3
Other major electrical equipment (specify)	36.3

- **Fuel used:**
  1. Electricity - 100%
  2. LPG - 7.5%
  3. Diesel - 0.0%
  4. Other - 3.8% (total is more than 100 due to multiple fuel usage)

- **Average monthly fuel consumption**
  1. Electricity consumption varies from 30 to 10284 kWh and the average consumption is 1405 per consumer.
  2. LPG consumption is 2.8 cylinders per consumer (considering 80 consumers).
  3. Diesel consumption is NIL.

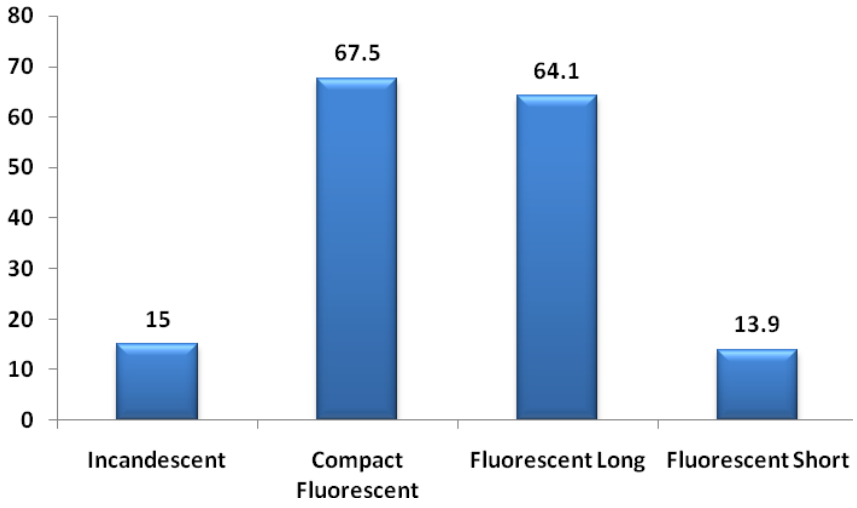


Figure 11 : Lighting technologies used by the consumers

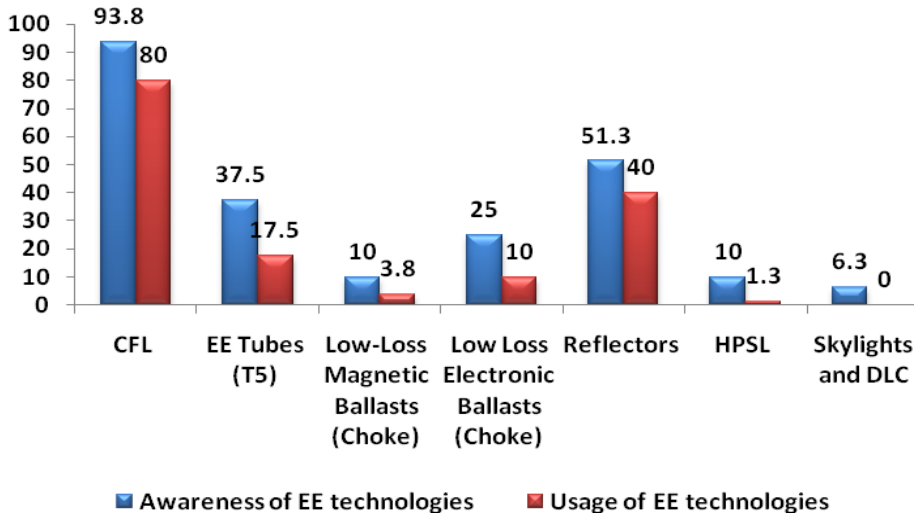


Figure 12 : Uses and awareness of energy efficient technologies in the city

2.4. Industrial Sector

Industrial sector consumed 42% of total electricity in the year 2007-08, thus is a major consumer of electricity in the city. Below mentioned tables show the consumption of electricity in different years.

2.4.1. Energy consumption

Table 17 : Industrial Sector Energy Consumption

	2005-06	2006-07	2007-08	2008-09
Electricity (MU)	501.4	514.3	526.4	537.7

Table 18 : Energy Balance for Industrial Sector

Source	Consumption	Unit	Consumption	Unit
Electricity	537.7	MU	537.7	MU

2.5. Municipal Sector

The major energy end-uses under the Municipal sector include street lights and water supply. Energy consumption data for these two segments is shown in the Table below. Energy consumption for the Govt. buildings and facilities is considered to be falling under commercial sector.

Table 19 : Overall Municipal Sector Energy Consumption (kWh)

Electricity Consumption	2004-2005	2005-2006	2006-2007
Streetlights	15991189	15024096	14995240
Treatment Plant	930000	912000	964000
Water Supply	19456518	21054122	20010398

Total	**36377707**	**36990218**	**35969638**

Table 20 : Street Light Energy Consumption (kWh)

Ward Committee	Street Lights	Consumption (kWh)
Kalwa	2390	1106978
Kopari	2145	1038774
Majiwada	4480	2061766
Mumbra	4282	1264110
Naupada	4534	2542766
Rayaladevi	3035	1263648
Uthalsar	3727	2676547
Vartaknagar	2405	1659339
Wagle	3079	1246262
Traffic Signal	135050	135050
Total	**165127**	**14860190**

Table 21 : Energy Consumption in Sewage Treatment Plant (kWh)

	2004-05	2005-06	2006-07	2007-08
Treatment Plant	1060000	930000	912000	964000

2.6. City Wide Green House Gas Inventory

2.6.1. City level Emissions

The city's inventory was conducted by compiling the best available data on energy consumption. The ICLEI SA study reveals that all activities in Thane city contribute[1] to 1252120.10TeCO_2 in 2007-08. The Per capita emission for Thane city is 1.04 T/ Year in 2007-08. The corporation level emission is about 2.33 % to the total city level emissions. The GHG emission has gone up by 20.81% in last three years, which is raising serious environmental sustainability concern and also energy security in near future. As per the study, the total electricity consumption has gone up by 18.18% in last three years.

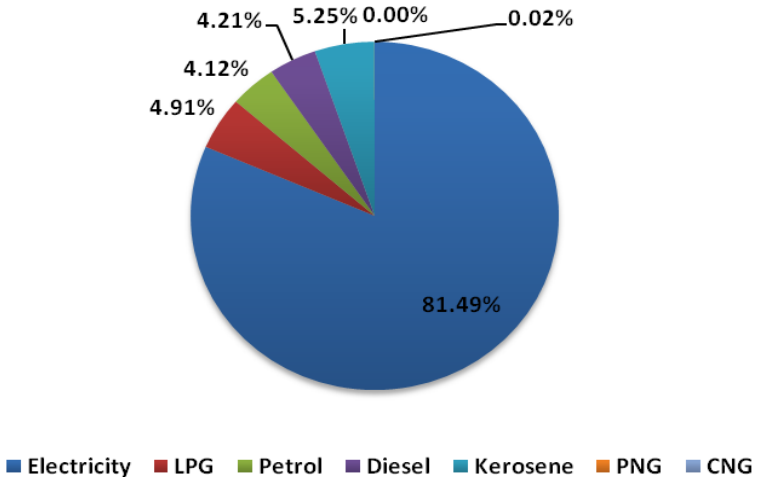


Figure 13 : Share of GHG Emissions by Sector

Above fig summarizes the city GHG emission by source. The electricity consumption accounts for 81% of the City's total carbon emissions. The diesel consumption produces 4.21% of the City's total carbon emissions. The LPG consumption in the city accounts for 4.91% of total emission and the Petrol & kerosene has another 4.12% & 5.25% respectively.

2.6.2. Government Emissions

Greenhouse gas emissions from City of Thane government operations totaled 29135.41 metric tons of CO_2e in the year 2007-08, which is approximately 2.71% of the City's total emissions. Figure presents the distribution of greenhouse gas emissions from City government by sector. Buildings account for 14% of the City government's CO_2e emissions. The City's water supply system represents 48 % of the City government's CO_2e emissions. Electricity used to power streetlights represented 36% of the emissions and the rest 2% is due to Sewage treatment Plant.

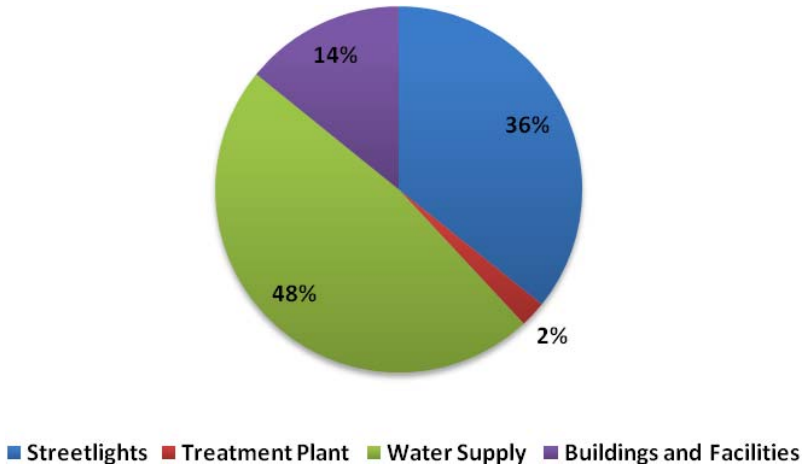


Figure 14 : Share of GHG emission in Government sector

CHAPTER 3

This chapter forecasts the future consumption of Thane based on baseline energy consumption, past data and population growth. The forecasts figures gives us a clear view of the future conventional energy demands in the city based on which the strategies have been developed and substantiated.

3. ENERGY DEMAND FORECAST FOR THANE

There are two scenario for which the projections have been done. First is based on the population growth and the second is based on the time-series data on energy use during last five years.

3.1. Forecasting Based on Population Growth

Population projection for Thane Municipal Area has been done in city development plan (CDP) under JNNURM scheme annual Growth rate is found to be 6.75% to 7.25 % per annum.

Table 22 : Population Projection till 2041

Year	**2005**	**2031**	**2041**
Population	15,44,390	33,66,556	41,73,305

Forecasting for the year 2013/2018

The projections for fuel consumption have been done assuming that they fuel consumption will grow at the same rate as population. The table given below summarizes projections for year 2013 and 2018.

Table 23 : Population projection for the year 2013 and 2018

	2008	**2013**	**2018**
Thane Municipal Area	1726062	2048460	2400276

Table 24 : Energy Consumption Projection

Year	**2008**	**2013**	**2018**
Population	1726062	2048460	2400276
Electricity consumption (MU)	1260	1495	1752
LPG (kg)	20566306	24407732	28599670
Petrol (KL)	204500	242697	284379
Diesel (KL)	650700	772239	904869
Kerosene (KL)	25468	30225	35416
CNG (scmd)	73000	86635	101514

In terms of energy (million kWh) the future projections would be:

Table 25 : Energy Consumption Projection for TMC

Sources	2008	2013	2018
Electricity (MU)	1260	1459	1702
LPG (MU)	299	355	416
Petrol (MU)	190	226	265
Diesel (MU)	214	254	298
Kerosene (MU)	256	304	356
CNG (MU)	266	316	371

Table 26 : Energy Consumption Projection for TMC (MU)

Sources	2008	2013	2018
Electricity (MU)	1260	1459	1702
LPG (MU)	299	355	416
Kerosene (MU)	256	304	356
Total	**1815**	**2128**	**2474**

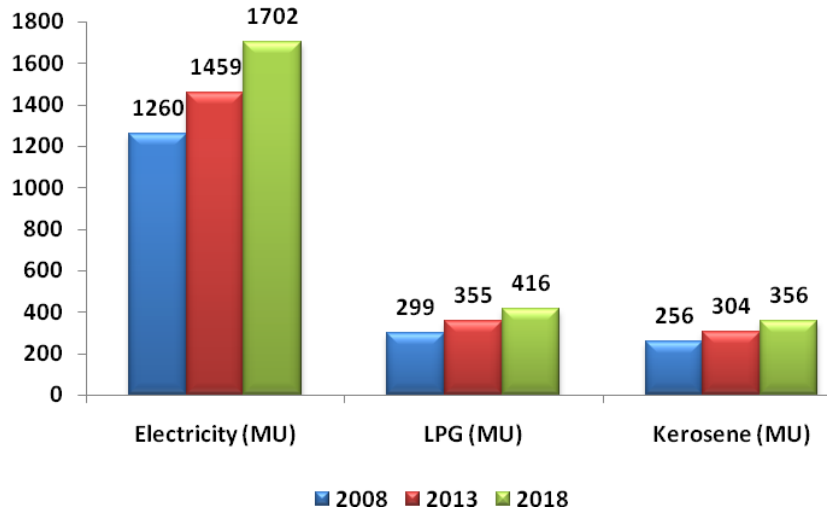


Figure 15 : Forecasting for Energy Consumption (MU) based on population growth

3.2. Forecasting Based on Past Data

The table given below gives the projected values for the year 2013 and 2018. **Based on the past data, a linear growth has been considered and the projection has been done**.

Table 27 : Table Showing Energy Consumption Projection for TMC

	Available data					*Projected data*	
Year	**2003-04**	**2004-05**	**2005-06**	**2006-07**	**2007-08**	**2013**	**2018**
Electricity (MU)	899	955	1066	1148	1260	1705	2163
LPG (kg)	18451644	19126908	19776525	20030595	20566306	23183502	25750007
Petrol (Lit)	-	13435519	11672746	17123458	20630047	33287735	46804883
Diesel (Lit)	1182000	4723429	5466701	11543892	18828670	37828601	58885502
Kerosene (KL)	24997	27896	26912	26244	25468	25806	25451

In terms of energy (million kWh) the future projections would be:

Table 28 : Energy Consumption Forecast for TMC (MU)

Year	**2008**	**2013**	**2018**
Electricity consumption	1260	1705	2163
LPG	299	337	375
Kerosene	256	259	256
Total	**1815**	**2301**	**2794**

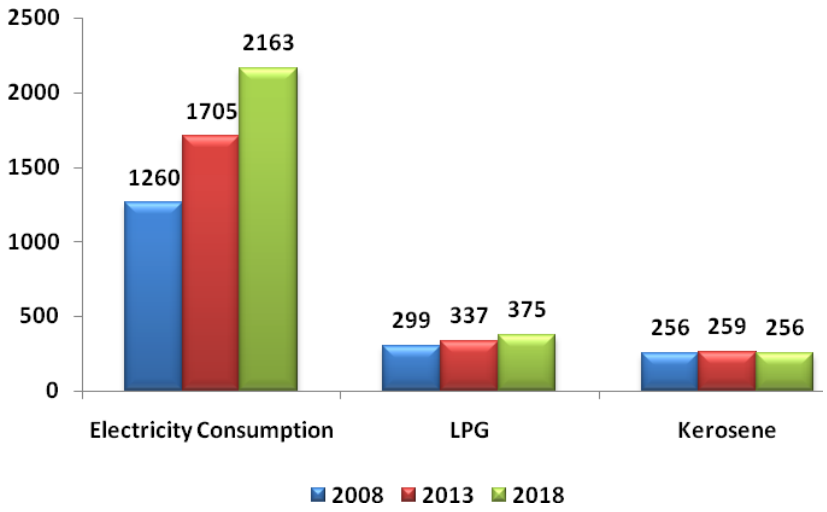


Figure 16 : Forecasting of Energy Consumption (MU) based on historical data

3.3. Forecasting Based on National Average of 25 Cities Data

The table given below gives the projected values for the year 2013 and 2018. **Based on the 25 cities' past data from ICLEI South Asia's Road Map of 54 South-East Asian Cities Emission report ,** a linear growth has been considered and the projection has been done**.**

Table 29 : Forecasting Of Energy Consumption for TMC – 2 (Based On 25 Cities' Data)

Energy Sources	Available data			projections based on 25 cities data	
Year	**2005-06**	**2006-07**	**2007-08**	**2013**	**2018**
Electricity consumption (MU)	1066	1148	1260	1738	2217
LPG (MT)	299	337	375	517	660
Kerosene (kL)	256	259	256	353	450

In terms of energy (million kWh) the future projections would be:

Table 30 : Forecasting of Energy Consumption

Energy Sources	2008	2013	2018
Electricity consumption	1260	1738	2217
LPG	375	517	660
Kerosene	256	353	450
Total	**1891**	**2608**	**3327**

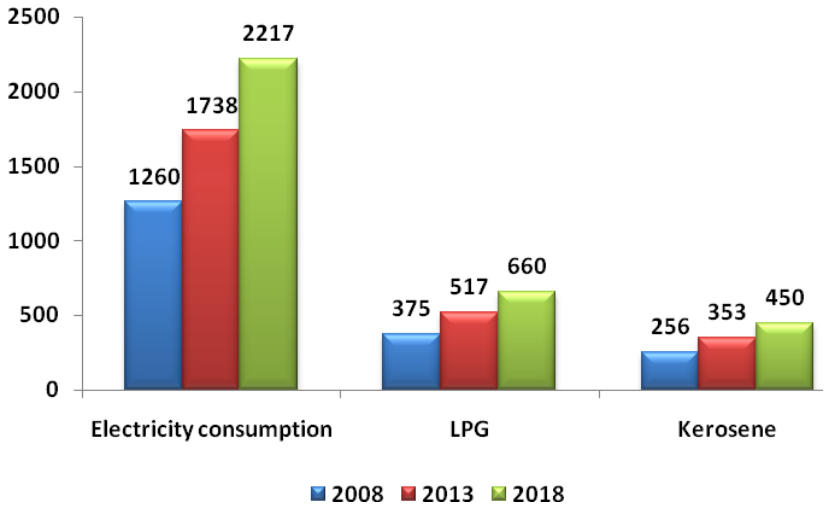


Figure 17 : Forecasting of Energy Consumption (MU) based on 25 cities' energy consumption data

3.4. Goal for the year 2013

Since, transportation sector is not included in this study and petrol and diesel consumption data is not available for different sectors, the energy usage for electricity, LPG and Kerosene is considered for defining the energy target. Based on this data, the targeted reduction in energy consumption (10% of the total based on past data projection) for the year 2013 would be **230.1 MUs**.

Table 31 : Forecasting of Energy Consumption for TMC

Energy Sources	Based on population growth (MU)	Based on past data (MU)	Based on 25 cities' data (MU)
Electricity (MU)	1459	1705	1738
LPG (MU)	355	337	517
Kerosene (MU)	304	259	353
Total (MU)	**2118**	**2301**	**2638**

CHAPTER 4

This chapter delves into renewable energy resource assessment and strategy for introducing different Renewable Energy Technologies in residential, commercial, industrial and municipal sector of Thane city. Renewable energy resource availability and potential is a key criterion for suitable renewable energy technology installations and success. The chapter later develops the strategies for Thane city based on the renewable energy available in the city and the baseline energy consumption and future energy demands of the city.

4. RENEWABLE ENERGY STRATEGIES FOR THANE

The main objective of this chapter is to identify available renewable energy resources in Thane city and carry out techno-economic feasibility of different renewable energy options for residential, commercial, industrial and municipal sector and making a priority listing of the options.

A renewable energy resources assessment has been done to identify the potential renewable energy sources for the Thane city. This includes assessment of solar radiation, wind power density and availability, biomass resources and municipal/industrial wastes etc. The strategy has been prepared for each sector identifying most techno economically viable renewable energy options considering wide range of potential consumers in the particular sector. An implementation target for development of solar city project in 5 years period has been set with an objective to meet at least 5% energy consumption from renewable energy on completion of the solar city project in Thane.

For the residential sector, potential for introducing the following renewable energy devices has been worked out based on present energy use pattern of the residents, economic level, availability of such products and economic feasibility.

(i) Solar Water Heaters
(ii) Solar Cookers
(iii) Solar Lanterns
(iv) Solar Home System
(v) Solar PV system for Home Inverters
(vi) PV for replacement of DG/ Kerosene Generator sets
(vii) Renewable Energy Systems for Residential Housing Complexes

Commercial and Institutional Sector has been divided in to four broad categories as below and these categories again sub divided into further categories based on their capacity and functional differences.

(i) RE Strategy for Hotels – budget hotels
(ii) RE Strategy for Restaurants – Large, medium, small, food cart
(iii) RE Strategy for Hospitals – 250-1000 bedded, 100-250 bedded, 50-100 bedded, Dispensaries/

dental clinic/ microsurgery

(iv) RE Strategy for Educational Institutes – Primary, intermediate, colleges, engineering colleges, medical colleges, Computer Institute, Polytechnics, ITI

On the spot assessment have been carried out visiting each of these sub categories to identify present energy demand, energy and fuel used, load shedding occurs, standby power supply provision, space available for installation of solar arrays and collectors etc. Based on the site visit and energy demand assessment, preliminary design/sizing of appropriate renewable energy devices have been worked out for each category establishment. An indicative budgetary financial implication, energy savings, payback period and GHG emission reduction has been estimated for each renewable energy option that has been suggested.

Industrial sector is broadly divided into five categories. Suitable renewable energy technologies have been prepared for each of the category.

(i) Electrical Equipment
(ii) Chemical Manufacturing
(iii) Rayon
(iv) Dyes
(v) Textile based cottage industry

Municipal Sector is divided into seven categories and options for appropriate renewable energy options have been recommended based on the assessment made on each category of the sector.

(i) Buildings - Municipality building and other Office Buildings
(ii) Markets – General markets, vegetable markets
(iii) Parks – Municipality Parks
(iv) Outdoor lighting Road safety- Street light, monuments, road blinkers,
(v) Municipal Solid Waste
(vi) Sewage Treatment Plant

4.1. Renewable Energy Resource Assessment

A preliminary assessment has been done for solar, wind and biomass resources and energy recovery potential from municipal solid waste and sewage treatment plant. While biomass data is for entire Thane district, there is no hydro potential in the city.

4.1.1. Solar Radiation

Thane (Latitude 27.18 N, Longitude 78.02 E) receives good amount of solar radiation as the average annual solar radiation for Thane is presented in the below table.

Table 32 : Monthly Averaged Insolation Incident on a Horizontal Surface (kWh/M^2/Day)

Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual

NASA SSE Satellite	4.97	5.66	6.4	6.72	6.56	4.62	3.54	3.49	4.3	5.18	4.94	4.58	**5.08**
MNRE Solar	4.60	5.41	6.18	6.62	6.49	4.86	3.74	4.03	4.54	5.00	4.61	4.29	**5.07**

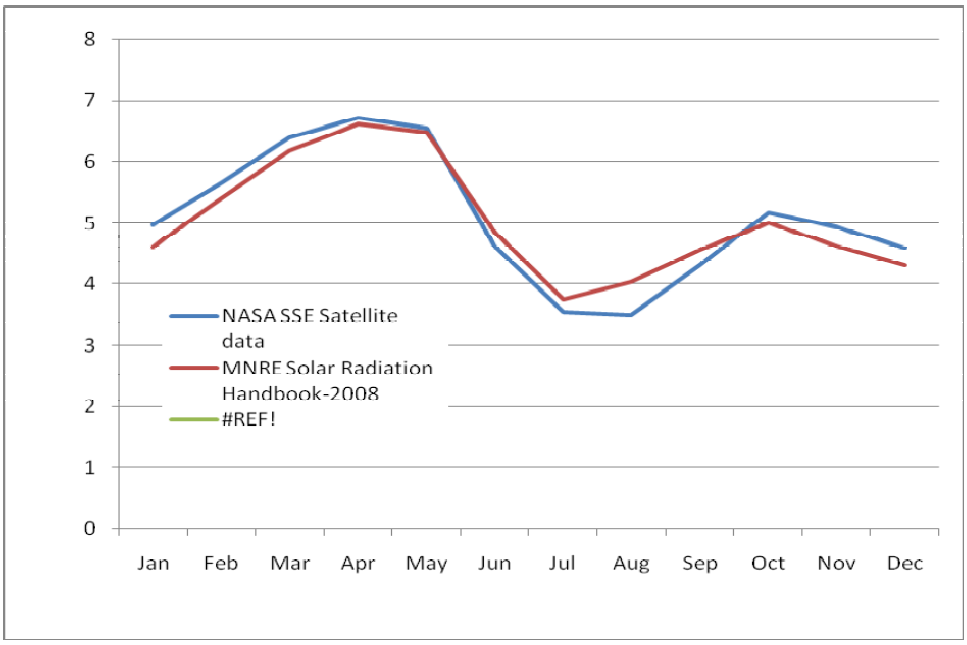


Figure 18 : Annual Solar Radiation profile in Thane

4.1.2. Wind Energy

Wind data[18] for Thane is presented in the table below. Generally, average annual wind speeds of at least 4.0-4.5 m/s are needed for a wind turbine to produce enough electricity to be cost-effective. From the wind data, there seems to be less potential for wind energy in Thane. Detailed Study is required for assessment of energy generation potential from wind resource

Table 33 : Monthly averaged wind speed above earth surface for terrain similar to airports (m/s)

Height	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
10m	3.03	3.68	4.03	4.44	4.48	4.46	5.09	4.61	3.2	2.75	2.69	2.73	**3.76**
50m	3.84	4.66	5.09	5.62	5.67	5.64	6.46	5.84	4.05	3.48	3.41	3.45	**4.77**

4.1.3. Biomass Resource

Biomass resource for Thane is not available separately. However, the data is available at district level and presented below in the Table. Major agricultural products of the district are Paddy, Nagli, Pulses, Oilseeds, Spices and Flowers. Though the potential of power generation for biomass is estimated to be 93MWe for the entire district, apparently there is no potential of power generation from biomass within the Thane city.

Table 34 : Biomass Resource

District	Area (kHa)	Crop Production (kT/Yr)	Biomass Generation (kT/Yr)	Biomass Surplus (kT/Yr)	Power Potential (MWe)	Biomass Class
Thane	149.7	356.5	591	105.4	12.5	Agro
Thane	593	NA	854	577.2	80.8	Forest & wasteland

4.1.4. Small Hydro Power

As per MNRE, there are 26 sites identified for small hydro power projects up to 25 MW in Thane district. The table gives the details of these sites.

Table 35 : Small Hydro Power Projects

Name of Project	Category of Proj *	Name of river/ canal	Capacity in kW	Head in m	Discharge in m3/sec	Remarks	Annual Rainfall
Barvi	ROR	Bharvi	3000	22.6		Site Identified	2497.5
Bhatsa Canal fall	CB	Bhatsa c	500	2.35	26.6	Site Identified	2497.5
Bhatsa LBC	CB	Bhatsa c	500	48.36	1.34	Site Identified	2497.5
Deharjee LBC	CB	Deharjee	1000	31.56	3.91	Site Identified	2497.5
Deharjee RBC	CB	Deharjee	75	31.56	0.31	Site Identified	2497.5
Devkup LBC	CB	Nallah	100	39.76	0.33	Site Identified	2497.5
Dhamani LBC	ROR		300	30			
Dhamani RBC	CB	Dhamni	600	25	2.06	Site Identified	2497.5
Domihir LBC	ROR		375	30			
Domihira RBC	CB	Nallah	175	25.5	0.85	Site Identified	2497.5
Gonda RBC	CB	Nallah	70	12.12	0.63	Site Identified	2497.5
Hatipata LBC	ROR		200	30			
Hattipada RBC	CB	Nallah	400	24.9	2.06	Site Identified	2497.5
Jamburde RBC	CB	Nallah	50	15	0.38	Site Identified	2497.5
Kharade RBC	CB	Vaitarna Nallah	50	15.51	0.26	Site Identified	2497.5
Mez RBC	CB	Nallah	50	12	0.63	Site Identified	2497.5
Monbuli RBC	CB	Mohhuli NAllah	75	8.67	0.05	DPrv.R ready	2497.5
Nevade RBC	CB	Nallah	50	11.2	4.5	Site Identified	2497.5
Nimbapur RBC	CB	Nallah	50	13.2	0.46	Site Identified	2497.5
Pimpurna RBC	ROR	Nallah	50	9	4	Site Identified	2497.5
Sai RBC	ROR		50	30			
Sasungar RBC	CB	Nallah	50	36	0.21	Site Identified	2497.5

Sherova RBC	CB	Nallah	50	11	0.43	Site Identified	2497.5
Tilher RBC	CB	Nallah	50	10.7	0.64	Site Identified	2497.5
Uparale RBC	CB	Tilwari	50	7.4	0.18	Site Identified	2497.5
Vashikhare RBC	CB	Nallah	50	20.33	0.3	Site Identified	2497.5

4.1.5. Waste generation

Waste generation data for Thane Municipal area for the last 5 year is presented in the table given below.

Table 36 : Solid Waste Generation Data

Year	Solid waste Generation (MT/day)	Waste Composition				
		Paper Products	Food	Plant debris	Wood / Textiles	% Other Waste (inorganic)
2002-2003	500	39.5	300	35	10	115.5
2003-2004	520	41.08	312	36.4	10.4	120.12
2004-2005	540	42.66	324	37.8	10.8	124.74
2005-2006	560	44.24	336	39.2	11.2	129.36
2006-2007	580	45.82	348	40.6	11.6	133.98
2007-2008	600	47.4	360	42	12	138.6

4.1.6. Liquid Waste from Sewage Treatment Plant

Thane has two Sewage Treatment Plants. The city has a STP of 54 MLD capacity.

4.2. RE Strategy for Residential sector

With projected population of 20.48 lakh (2013), the residential sector is the second highest energy consumer in the Thane city. The residential sector consumes 41% of total electricity consumption of 1259.67 MU in Thane city. The sector consumed 1056.18 MU of energy, which includes primarily electricity and LPG and kerosene. Electricity is the major fraction (49%) of energy consumed by the residential sector. Use of renewable system to cater a part of energy demand in residential sector can substantially reduce fossil fuel consumption and green house gas emission. Different renewable energy options have been proposed based on technology available and economic feasibility. Only those renewable energy devices are recommended which are technically proven, commercially available and attractive in terms of financial benefit from energy savings.

(i) Installation of Solar Water Heating System

The target in 5 years for introduction of SWHs is set at 10% of residential consumers who are already using electric geysers for their daily hot water requirement. Introduction of solar water heating system could save up to 40.1 MU energy per year. Cost implication and energy savings potential is presented in the table below.

Table 37 : Target for SWHs installation in Thane City

		Unit
Average size of domestic SWH (2 sqm collector area)	100/125	LPD
Total energy saved per year	1575	kWh
Indicative cost of installation	20000	INR
MNRE subsidy @1100.00 per m2	2200	INR
Cost of energy savings	5512.5	INR
Payback period	3	years

		Unit
Total Residential household	343904	Nos.
Residential household using geysers	74%	
Target to replace electric gyser by SWH in 5 years	10%	
Average size of domestic SWH (2 sqm collector area)	100/125	LPD
Number of SWH to be installed in 5 years plan	25449	Nos.
Total collector area in sqm	50898	Sqm
Total energy saved per year	40.1	MU
Indicative cost of installation	5089.78	Lakh
MNRE subsidy @Rs.1100.00 per sqm	559.88	Lakh
Cost of energy savings	1402.87	Lakh
Payback period	3	years
Emission reduction per year	32466	Tonnes

(ii) Use of Solar cookers (Box and dish type)

Both box type solar cooker and dish type solar cooker can be promoted in the urban areas. Box type solar cooker is an ideal device for domestic cooking during most of the year, except for the monsoon season and cloudy days. It however can not be used for frying or chapatti making. It is durable and simple to operate. On the other hand, dish type solar cooker can be used for indoor cooking. The stagnation temperature at the bottom of the cooking pot could be over 300^{o}C depending upon the weather conditions. The temperatures attained with this cooker are sufficient for roasting, frying and boiling. Regular use of a box type solar cooker may save 3-4 LPG cylinders per year. The use of solar cooker to its full capacity may result in savings up to 10 LPG cylinders per year at small establishments. Setting a target of 5% residential consumer to adopt solar

cooker (75% box type and 25% dish type) in the 5 years period, a total of 0.48 million kg of LPG could be saved by reducing 1680 tonnes of GHG from Thane City (considering specific emission from LPG as 0.24 kg CO2 per kWh).

Table 38 : Target for introducing solar cooker in Thane City

		Unit
Total Residential household	343904	Nos.
Household having facility to install a solar cooker	40%	
Target for introducting of solar cooker in 5 years	5%	
Number of Solar Cooker to be installed in 5 years plan	6878	Nos.
Average savings of LPG domestic cylinder per year per solar cooker (14kg)	5	Nos.
Total LPG saved per year	481466	kg
Total energy saved per year	7.00	MU
Indicative cost of installation (75% box type & 25% SK-14)	180.55	Lakh
MNRE subsidy for solar cooker @30%	54.16	Lakh
Cost of energy savings	120.37	Lakh
Payback period	1.05	years
Emission reduction per year	1680	Tonnes

(iii) Solar lanterns to replace kerosene lamps

Solar lantern has the average capacity of providing three hours of continuous light from a single charge per day, and can work as source of light for poor families without electricity. Kerosene is the main source of burning light in poor families in Thane particularly during load shedding hours and survey results reveal that 14% of population use kerosene lanterns during load shedding to illuminate their houses. Average consumption of kerosene per household is 3 litres per month. Assuming a household uses 3-4 lanterns, consumption of one lantern will be about 3 litres per month. Targeting 10% of population to replace at least one kerosene lantern with solar lantern out of 2% of total population who uses kerosene lamps a 0.02 million litres of kerosene could be saved reducing 63 tonnes of GHG per year. Detailed techno commercial is provided in the table below.

Table 39 : Target for introducing solar lanterns in Thane City

		Unit
Capacity of residential Solar Home System	10	Wp
Number lights per Solar Home System	1	Nos.
Number of Kerosene lamp replaced by SL	1	Nos.

Consumption of kerosene per lanterns/month	3	Litres
Cost of kerosene per litre in the market	20	INR
Cost of kerosene per year per household	720	INR
Indicative cost of installing a SL	3000	INR
MNRE subsidy @50%	1500	INR
Payback period when replacing the kerosene lamps	2.1	years

		Unit
Total Residential household	343904.00	Nos.
Residential household use kerosene lamps	2%	
Target to replace kerosene lamp in 5 years	10%	
Number of SL to be installed in 5 years plan	688	Nos.
Total kerosene lamp replaced	688	Nos.
Indicative cost of installation	20.63	Lakh
Kerosene saved	24761	Litres
Savings in terms of Electricity	0.25	MU
Cost of kerosene savings	4.95	Lakh
MNRE subsidy @50%	10.32	Lakh
Payback period	2.1	years
Emission reduction per year	63	Tonnes

(iv) Use Solar Home Systems (SHS)

A Solar Home System is a fixed indoor lighting system and consists of solar PV module, battery and balance of systems. Capacity of such system could be of 18Wp, 37Wp and 74Wp for different configuration. The luminaries used in the above systems comprise compact fluorescent lamp (CFL) of 7 W / 9 W / 11 W capacity respectively. The fan is of DC type with less than 20 W rating. One Battery of 12 V, 40 / 75 Ah capacity is also provided with SPV modules of 37Wp / 74Wp as required. The system will work for about 4 hours daily, if charged regularly. The Solar Home Lighting systems have been proposed to replace kerosene lamps used by 2% population in Thane Municipality area during load shedding hours. A 74Wp Solar Home System can replace 3-4 kerosene lamps with 4-5 hours backup hence replacing entire need of kerosene, which is estimated at an average of 3 litres per month per household. Assuming 10% replacement in the planned 5 years period an estimated amount of 0.11 million litres of kerosene could be saved reducing 275 tonnes of GHG emission from the city. The potential of kerosene replacement with Solar Home Systems and financial implication thereon is indicated in the table below.

Table 40 : Target for introducing solar home system in Thane City

		Unit
Capacity of residential Solar Home System	74	Wp
Number lights per Solar Home System	4	Nos.
Number of Kerosene lamp replaced by SHS	4	Nos.

Consumption of kerosene per household/month (survey result)	13	Litres
Cost of kerosene per litre in the market	20	INR
Cost of kerosene per year per household	3144	INR
Indicative cost of installing a SHS	16000	INR
MNRE subsidy @50%	8000	INR
Payback period when replacing the kerosene lamps	2.5	years

		Unit
Total Residential household	343904	Nos.
Residential household use kerosene lamps	2%	
Target to replace kerosene lamp in 5 years	10%	
Number of SHS to be installed in 5 years plan	688	Nos.
Total kerosene lamp replaced	2751	Nos.
Indicative cost of installation	110.05	Lakh
Kerosene saved	108	KL
Savings in terms of Electricity	1	MU
Cost of kerosene savings	22	Lakh
MNRE Subsidy @50%	55	Lakh
Payback period	2.5	years
Emission reduction per year	275	Tonnes

(v) Using Solar PV for Home Inverters

Use of solar panels to charge Home Inverter system could be an attractive option as standby power supply system during load shedding hours. The power supply situation in Thane is very poor. About 4-5 hours load shedding occurs per day in most of the places of Thane city. About 52% of residential consumer use inverters during load shedding hours. Assuming that 15% of HH who are already using inverters will adopt the 250 Wp solar PV systems to charge their inverter battery, an aggregate of 6.71 MWp solar PV systems could be installed in the residential buildings, which will generate 10 MU green energy per year and reduce the load demand and emission by 8148 tonnes per year. It is assumed that MNRE will provide 50% subsidy for these system. The potential of energy savings, green house gas emission reduction and budgetary financial implication is indicated in the table below.

Table 41 : Target for introducing Solar PV for Home Inverters in Thane City

		Unit
Capacity of solar PV system for Home Inverter	250	Wp
Indicative cost of incorporating Solar PV to Home Inverter	30000	INR
Total Residential household	343904	Nos.
Residential household use Inverter during load shedding	52%	
Target to introduce solar charger for inverter in 5 years	15%	
Number of solar inverter to be installed in 5 years plan	26825	Nos.

Total PV capacity installed	6706	kWp
Energy genereted by PV arrays per year	10	MU
Cost of energy saved	352	Lakh
Indicative cost of installation	8047	Lakh
MNRE subsidy @50%	4024	Lakh
Payback period	11	years
Emission reduction per year	8148	Tonnes

(vi) Using Solar PV for replacement of DG/ Kerosene Generator sets

Due to poor power supply situation, about 27% of resident of Thane use typically 5-10kW DG/ kerosene generator sets during the load shedding hours. Solar PV power packs can be used to replace those polluting generator sets with high operating cost. A 1000 Wp solar PV power pack has been considered for an average household in Thane. For 5-year framework 10 % households have been taken into consideration for replacement of DG /kerosene sets with solar PV systems with a target to save 11.14 million litres of diesel per year reduce GHG in the tune of 28302 tonnes per year.

Table 42 : Target for replacement of diesel generator sets with PV Power Pack in Thane City

		Unit
Capacity of solar PV system	1	kWp
Indicative cost of incorporating Solar power pack	2.00	Lakh
Total Residential household	343904	Nos.
Residential household use generators during load shedding	27%	
Target to introduce solarpower pack in 5 years	10%	
Number of solar power pack to be installed in 5 years plan	9285	Nos.
Total PV capacity installed	9285	kWp
Energy genereted by PV arrays per year	13.93	MU
Typical generator set used	5-10	kW
Averagel fuel consumption per day for 4-6 hours load shedding	6	litres
Amount of diesel saved per year for entire city	11142	KL
Cost of Diesel saved	4457.00	Lakh
Indicative cost of installation	18570.816	Lakh
MNRE subsidy @50%, subject to maximum of Rs.1.00 Lakh per kWp	9285.408	Lakh
Payback period	2.08	years
Emission reduction per year for replacement of diesel	28302	Tonnes

(vii) RE systems for residential Apartments/ housing complexes

Thane has more than 8000 registered residential apartment building societies in the city with average number of 20 families in each societies. Solar water heaters and solar PV power plants are considered to be most viable renewable energy devices for the existing and well as new residential complexes.

Table 43 : RE system for residential apartments

Number of target residential apartment buildings in the city	8000	
% of residential apartment to incoporate RE system	10%	
Number of residential apartment to incorporate RE system	800	
Average number of Residence in each building	20	
Solar Water Heater System		
Average size of Solar water heaters	2000	LPD
Total capacity of SWH to be installed in 5 years plan	1600000	LPD
Total collector area in sqm	32000	Sqm
Total energy saved per year	18.9	MU
Indicative cost of installation	1600.00	Lakh
MNRE subsidy @Rs.1900.00 per sqm	608.00	Lakh
Beneficiary/ State/ TMC share	992.00	Lakh
Cost of energy savings	661.50	Lakh
Payback period	1.50	years
Emission reduction per year	16000	Tonnes
Solar PV Power Plant for Back up power		
Capacity of solar PV system for single apartment of 20 Residence	10	kWp
Indicative cost of incorporating Solar PV to Home Inverter	12	Lakh
Total capacity of PV systems for targeted apartments for 5 years	8000	kWp
Energy genereted by PV arrays per year	12.00	MU
Cost of energy saved	420	Lakh
Indicative cost of installation	96000	Lakh
MNRE subsidy @50%	48000	Lakh
Beneficiary/ State/ TMC share	48000	Lakh
Payback period	114	years
Emission reduction per year	9720	Tonnes

(viii) Summary of RE strategy for Residential Sector

Implementation of renewable energy projects as proposed above will save 103.30 MU energy per year, which will reduce GHG of 96654 tonnes per year. When achieved the target, residential sector strategy will meet 44.90% of total target for energy savings for the city as per mandate of development of solar city. The entire target could be achieved with a total investment of about Rs.1296.19 cr in the 5 years period where

contribution from MNRE will be about Rs.625.97 cr with existing schemes and balance fund could be met from users, state or other funding agencies. It is recommended that promotion of solar water heaters in residential sector should be given higher priority, as energy savings from solar water heaters is the highest.

Table 44 : Summary of RE Strategy for Residential sector in Thane City

RE Strategy for residential sector	Potential Users	Target Users	Target Capacity	Units of Target	Investment (Lakh)	MNRE subsidy (Lakh)	Beneficiary's contribution (Lakh)	Amount of Energy Saved (MU)	Emissions Reductions (Tonnes)
Installation of Solar water Heaters	254489	25449	25449	Nos.	5089.78	559.88	4529.90	40.08	32466
Use of solar cookers	137561.6	6878	6878	Nos.	180.55	54.16	126.38	7.00	1680
Use of Solar Lantern	6878.08	688	688	Nos.	20.63	10.32	10.32	0.25	63
Use of Solar Home Lighting System	6878.08	688	688	Nos.	110.05	55.02	55.02	1.09	275
Use of Solar Home inverter	178830.08	26825	26825	Nos.	8047.35	4023.68	4023.68	10.06	8148
Use of PV for replacing DG sets	92854.08	9285	9285	Nos.	18570.82	9285.41	9285.41	13.93	28302
Residential Apartment Building	NA	8000	1600000	LPD	1600.00	608.00	992.00	18.90	16000
Residential Apartment Building	NA	8000	8000	kWp	96000.00	48000.00	48000.00	12.00	9720
					129619.18	**62596.47**	**67022.71**	**103.30**	**96654**

4.3. RE Strategy for Commercial and Institutional Sector

The commercial sector also has a substantial part in energy consumption in Thane city. The sector consumes about 14% of total electricity consumed in the city with its 365 educational institutes, 455 medical service facilities, 28 hotels and 925 odd restaurants. Different strategies are prepared for different categories of consumers based on type and quantum of energy consumed and availability of resource and space to generate renewable energy in their premises. While preparing the strategy, only techno economically viable and commercially available renewable energy options are considered.

4.3.1. RE Strategy for Hotels

Thane city does not have much of the big hotels. The city has some 3 star hotels, budget hotels and other commercial accommodations facilities. Some case studies are made to assess renewable energy and energy conservation measures in hotels. Major energy requirement such as hot water and electricity during load shedding hours could be met by solar energy. Solar thermal system can be used to generate hot water or steam for cooking. Solar PV power plant can be used to reduce or eliminate use of diesel generators which are being used during load shedding hours. Apart from that hotels also generate bio waste which can be

used to produce biogas through bio-methanation process. Solar pumps and solar garden lights can be used for sprinkling water and beautification.

(i) Renewable Energy Systems for a 3 star Hotels

A case study has been prepared for a 3 star hotel in Thane. The tables below give us the energy appliances utilized by a typical budget hotel in Thane. Based on the energy baseline scenario specific renewable energy systems have been proposed which can help in energy saving at the case study site. The occupancy of the hotel has been taken to be 50% for the calculations mentioned below.

Table 45 : Case Study of 3 star hotel

Location of the Hotel	Thane	
No of rooms	40	Nos.
Roof Area available	300	sqm
Common Area	100	sqm
Average Load Shedding	3	Hours/day
Monthly LPG consumption for cooking	180	kg
Standby Power Supply System:		
Diesel Generator 1 (off peak load)	90	KVA
Average consumption of diesel per hour	18	liters/ hour
Diesel Generator 2 (peak load)	120	KVA
Average consumption of diesel per hour	28	Liters/hour

Electrical Energy Demand:

Electrical Appliances	No.s	Operating Hours	Watt/ unit	Load (kW)	Energy consumption /day at 100% occupancy (kWh)	Energy consumption /day at 50% occupancy (kWh)	Utilization /year	Energy Consumption per year
Guest Rooms								
Ceiling Fans	40	12	60	2.4	28.80	14.40	365	5256
Air Conditioner	40	10	1500	60	600.00	300.00	300	90000
Electric Geyser	40	2	1500	60	120.00	60.00	300	18000
Television	40	10	100	4	40.00	20.00	365	7300
Refrigerator	40	8	150	6	48.00	24.00	365	8760
Incandescent (light Bulb)	40	10	40	1.6	16.00	8.00	365	2920
Compact Fluorescent	80	6	20	1.6	9.60	4.80	365	1752
Fluorescent (Long, 4 Feet Tube)	40	10	40	1.6	16.00	8.00	365	2920
Common area and other								

facilities								
Celing fans	30	12	60	1.8	21.60	21.60	365	7884
Airconditioner	8	10	1500	12	120.00	120.00	300	36000
Compact Fluorescent	40	6	20	0.8	4.80	4.80	365	1752
Fluorescent (Long, 4 Feet Tube)	20	10	40	0.8	8.00	8.00	365	2920
Incandescent (lLight Bulb)	20	10	60	1.2	12.00	12.00	365	4380
Refrigerators/ Freezer	5	8	560	2.8	22.40	22.40	365	8176
Television	1	8	100	0.1	0.80	0.80	365	292
Water pump	5	4	1500	7.5	30.00	30.00	365	10950
Fluorescent (Long, 2 Feet Tube)	8	12	20	0.16	1.92	1.92	365	701
Computers	2	24	100	0.2	4.80	4.80	365	1752
Printers	1	3	100	0.1	0.30	0.30	365	110
Microwave Oven	1	2	1800	1.8	3.60	3.60	365	1314
				166	**1109.00**	**669.00**		**213138**

The renewable energy systems proposed for the 3 star hotel in Thane are enlisted in the tables below. The techno –economics of installing the RE systems has also been provided.

Solar Water Heating system to replace geysers and preheating of water for cooking:	5000	LPD (60 sqm collector area)
Approximate area required for installaton	150	sqm
Indicative cost of the system	500000	INR
MNRE subsidy @1400.00 per m2	210000	INR
Energy savings per day average	175	kWh
Savings of electricity per year	39375	kWh
Savings of LPG per year	15969	kWh
	1098.45	kg
	91.54	kg/month
Annual cost savings from saving electricity	196875	INR
Annual cost savings from saving LPG	43938	INR
Total savings	240813	INR
Payback period	1.20	years
Emission reduction	45	tonnes
Rooftop PV system for diesel abetment	50	kWp
Approximate area required	50	sqm
Indicative cost of the system with 1 day battery backup	11250000	INR
MNRE Subsidy @Rs.75 per Wp	3750000	INR
Approximate Annual energy generation	75000	kWh

Fraction of DG power replaced	99%	
Amount of diesel saved per year	24985	litres
Cost savings from diesel per year	999405	INR
Annual O&M Cost of DG sets	150000	INR
Payback period	7	years
Emission reduction	61	
Biogas system		
Organic Waste from kitchen and other services per day	70	kg
Biogas plant recommended	5	CuM
Investment	0.75	Lakh
MNRE subsidy @50%	0.38	Lakh
User's share	0.38	Lakh
LPG saved per year	730	kg
Energy in terms of MU savings per year	0.01	MU
Cost savings per year	0.29	Lakh
Payback period	1.28	Years
Emission Reduction per year	0.445	Tonnes

(ii) Another case study has been prepared taking a budget hotel in Thane city. The tables below give us the energy appliances utilized by a typical budget hotel in Thane. Based on the energy baseline scenario specific renewable energy systems have been proposed which can help in energy saving at the case study site. The occupancy of the hotel has been taken to be 50% for the calculations mentioned below.

Table 46 : Case Study of Budget Hotel cum Bar & Restaurant

Location of the Hotel	**Thane**	
No of rooms	16	Nos.
Roof Area available	150	sqm
Shadow free open space at ground	15	sqm
Average Load Shedding	4	Hours/day
Monthly LPG consumption for cooking	1620	kg
Standby Power Supply System:		
Diesel Generator 1 (off peak load)	82.5	KVA
Average consumption of diesel per hour	16	liters/ hour
Diesel Generator 2 (peak load)	50	KVA
Average consumption of diesel per hour	12	Liters/hour

Electrical Energy Demand:

Electrical Appliances	**No**	**Operating Hours**	**Wattage of the device (in**	**Load (kW)**	**Energy consumption /day at 100%**	**Energy consumption /day at 50%**	**Annual average energy consumption at 50%**	**Percentage sharing of different**

			watt)		occupancy (kWh)	occupancy (kWh)	occupancy	equipments
Guest Rooms								
Ceiling Fans (throughout the year)	16	12	60	0.96	11.52	5.76	2102.40	1.02%
Air Conditioner (throughout the year)	16	10	1800	28.8	288.00	144.00	52560.00	25.44%
Electric Geyser (throughout the year)	16	2	1750	28	56.00	28.00	10220.00	4.95%
Television	16	10	100	1.6	16.00	8.00	2920.00	1.41%
Incandescent (light Bulb)	16	10	60	0.96	9.60	4.80	1752.00	0.85%
Compact Fluorescent	32	6	15	0.48	2.88	1.44	525.60	0.25%
Fluorescent (Long, 4 Feet Tube)	16	10	55	0.88	8.80	4.40	1606.00	0.78%
Common area and other facilities								
Celing fans	14	12	60	0.84	10.08	10.08	2721.60	1.32%
Airconditioner	16	10	1800	28.8	288.00	288.00	77760.00	37.64%
Compact Fluorescent	168	6	15	2.52	15.12	15.12	5518.80	2.67%
Fluorescent (Long, 4 Feet Tube)	4	10	55	0.22	2.20	2.20	803.00	0.39%
Incandescent (lLight Bulb)	4	10	60	0.24	2.40	2.40	876.00	0.42%
Refrigerators/ Freezer	4	8	560	2.24	17.92	17.92	6540.80	3.17%
Television	1	8	100	0.1	0.80	0.80	292.00	0.14%
Water pump	2	4	3750	7.5	30.00	30.00	10950.00	5.30%
Computers	1	24	100	0.1	2.40	2.40	876.00	0.42%
Printer	1	10	100	0.1	1.00	1.00	365.00	0.18%
Total energy consumption				**104**	**763.00**	**566.00**	**206590.00**	**100%**

Recommended Renewable Energy System

Solar Water Heating system to replace geysers and preheating of water for cooking:	2400	LPD (48 sqm collector area)
Approximate area required for installaton	72	sqm
Indicative cost of the system	240000	INR
MNRE subsidy @1400.00 per m2	100800	INR
Energy savings per day average	84	kWh
Considering 300 days use of geyser (using 75% of water) and 12 months of hot water for cooking (using 25% of water) savings per year will be	26565	kWh
Savings of electricity per year	18900	kWh
Savings of LPG per year	7665	kWh
	527.26	kg
	43.94	kg/month
Annual cost savings from saving electricity	94500	INR
Annual cost savings from saving LPG	21090	INR
Total savings	115590	INR

Payback period	1	years
Emission reduction	22	tones
Rooftop PV system for diesel abetment	30	kWp
Approximate area required	30	sqm
Indicative cost of the system with 1 day battery backup	7500000	INR
MNRE Subsidy @Rs.1.00lakh per kWp	3000000	INR
Approximate annual energy generation	45000	kWh
Fraction of DG power replaced	71%	
Amount of diesel saved per year	14462	litres
Cost savings from diesel per year	578491	INR
Annual O&M Cost of DG sets	100000	INR
Payback period	7	years
Emission reduction	36	tonnes
Biogas system		
Organic Waste from kitchen and other services per day	30	kg
Biogas plant recommended	3	CuM
Investment	0.5	Lakh
MNRE subsidy @50%	0.25	Lakh
User's share	0.25	Lakh
LPG saved per year	438	kg
Energy in terms of MU savings per year	0.006367425	MU
Cost savings per year	0.1752	Lakh
Payback period	1.426940639	Years
Emission Reduction per year	0.267	Tonnes

(iii) Summary of RE strategy for Hotels

Introduction of RE system in 25% of hotels in Thane city as described in the table below will save 0.42 MU of energy per year and reduce GHG emission by 352.57 tonnes. Introduction of solar water heater system should be given prime importance in the hotels.

Table 47 : Summary of RE strategies for hotels

		RE System Proposed				
Hotels	**Numbers**	**SWH/SC system**	**PV system**	**Biogas/ Biomass system (cum)**	**Energy Savings (MU)**	**Total Emission reduction**
Three star hotel	5	25000	250	25	0.67	557.23
Budget hotels / lodge	23	55200	230	230	1.00	853.07
Aggregate	28	80200	480	255	1.67	1410.30
Targeting 25% implementation	7	20050	120	64	0.42	352.57
Investment (Lakh INR)		20.05	270.00	6.38		
MNRE subsidy @Rs.1400.00 per sqm		5.61	120.00	3.19		

Beneficiary/state/TMC contribution		14.44	150.00	3.19		

4.3.2. Renewable Energy Systems for Restaurants

Thane has a number of restaurants and eateries. The city has more than 900 restaurants and which are categorised as large restaurant, medium restaurants/Dhabas and small restaurants. Solar water heaters can easily be introduced in these restaurants to meet their hot water demand for cooking and utensil cleaning. Since all the restaurants are using DG sets as standby power supply source during load shedding, PV power plant will be an attractive and profitable option for the restaurants.

Cart food is very popular in Thane. There are hundreds of food cart which use kerosene or gas operated lights for illumination. Solar Lanterns will be a profitable and attractive option for these food cart operators.

(i) RE strategy for Restaurants

Restaurants have been separately taken up for case studies as innumerable such establishments are found across India which are huge energy guzzlers. Thane city also has innumerable restaurants of which one restaurant has been chosen as a case study site.

Table 48 : Case Study of Restaurant

Location of the Restaurant	**Thane**	
Roof Area available	150	sqm
Connected load	50	kW
Average Load Shedding	4	Hours/day
Monthly LPG consumption for cooking	2700	kg
Organic waste generated	100-120	Kg/day
Standby Power Supply:		
Diesel Generator	65	KVA
Average consumption of diesel per year	11.52	kL

Electrical Energy Demand:

Electrical Appliances	**Nos.**	**Operating Hours**	**Load (W)**	**Total Load (kW0**	**Energy consumption /day (kWh)**	**Use per year**	**Energy Consumption per year (kWh)**
Ceiling Fans (12 months)	5	12	60	0.30	3.60	365.00	1314
Air Conditioner (12 months)	4	10	2000	8.00	80.00	365.00	29200
Micro oven	5	6	1000	5.00	30.00	365.00	10950
Milk Chiller	1	8	740	0.74	5.92	365.00	2161
Deep Freezer	1	8	560	0.56	4.48	365.00	1635
Compact Fluorescent	123	12	20	2.46	29.52	365.00	10775
Air conditioner for cold room	2	10	1500	3.00	30.00	365.00	10950
Television	3	8	100	0.30	2.40	365.00	876
Water pump 1	2	4	1500	3.00	12.00	365.00	4380
Water pump 2	1	4	1000	1.00	4.00	365.00	1460

Computers	12	24	100	1.20	28.80	365.00	10512
Printer	1	3	100	0.10	0.30	365.00	110
OTG	1	4	800	0.80	3.20	365.00	1168
Total				**26.46**			**85490**

Based on the portfolio of energy consumption in the restaurant following renewable energy systems have been recommended to save energy. The techno economics of installing the PV system is provided below.

Solar Water Heating system to replace LPG for preheating of water for cooking:	1000	LPD
Approximate area required for installation	30	sqm
Indicative cost of the system	150000	INR
MNRE subsidy @1400.00 per m^2	42000	INR
Energy savings per day average	35	kWh
Savings of LPG per year	12775	kWh
	878.76	kg
Annual cost savings from saving LPG	35150	INR
Payback period	3.07	years
Emission reduction	8	tonnes
Rooftop PV system for diesel abetment	20	kWp
Approximate area required	20	sqm
Indicative cost of the system with 1 day battery backup	4500000	INR
MNRE Subsidy @Rs.75.00 per Wp	1500000	INR
Approximate annual energy generation	30000	kWh
Fraction of DG power replaced	40%	
Amount of diesel saved per year	4552	litres
Cost savings from diesel per year	182086	INR
Annual O&M Cost of DG sets	50000	INR
Payback period	13	years
Emission reduction	24	tonnes
Biogas system		
Organic Waste from kitchen and other services per day	100-120	kg
Biogas plant recommended	10	CuM
Investment	0.5	Lakh
MNRE subsidy @50%	0.25	Lakh
User's share	0.25	Lakh
LPG saved per year	1460	kg
Energy in terms of MU savings per year	0.02	MU
Cost savings per year	0.58	Lakh
Payback period	0.43	Years
Emission Reduction per year	0.89	Tonnes

(ii) Summary of RE strategy for Restaurants

Introduction of RE system in 25% of restaurants in Thane city as described in the table below will save 2.01 MU of energy per year and reduce GHG emission by 1631.12 tonnes. Introduction of solar water heater system should be given prime importance followed by biogas system and solar PV system for diesel abatement.

Table 49 : Summary of RE strategy for Restaurants

		RE System Proposed				
Restaurants	**Numbers**	**SWH/SC system**	**PV system**	**Biogas/ Biomass system (cum)**	**Energy Savings (MU)**	**Total Emission reduction**
Large Restaurants	47	235000	1175	470	4.54	3825.33
Medium Restaurants/ Dhabas	149	149000	74.50	745	1.88	1647.20
Small Restaurants	409	81800	102.25	1227	1.13	1051.95
Food Cart	320	0	0.02	0.00	0.48	0.02
Aggregate	925	465800	1352	2442	8.02	6524.50
Target for 5 years 25%	231	116450	338	611	2.01	1631.12
Total investment (Lakh INR)		116.45	760	61.05		
MNRE subsidy (Lakh INR) @1400		33	338	30.53		
Beneficiary's contribution (Lakh INR)		84	422	30.53		

* Replacing kerosene by using 2 lanterns in one cart

4.3.3. Renewable Energy Systems for Hospitals

The Thane city has apprx. 455 health care facilities, which includes 442 hospitals having less than 50 beds each and 13 hospitals having more than 100 beds each. Apart from that the city has other health care facilities like dispensaries, dental clinic, microsurgery, day care centre and pathological laboratories.

To portray the energy consumption scenario in these facilities a 100 and 50 bed Hospitals have been chosen in Thane city. Detailed energy consumption data have been collected and specific recommendations for renewable energy systems have been made. An average occupancy of 75% has been considered for making all calculations.

(i) Renewable Energy Systems for 100 bedded Hospital

A 100 bedded Hospital has been chosen as the case study site for a 100 bed hospital in Thane. The general details and the energy consumption pattern of the hospital are mentioned in the tables below.

Table 50 : Case Study of 100 bedded hospital

Location of the Hospital	**Thane**	
No of beds	100	Nos.

Roof Area available	400	sqm
Connected Load	145	KVA
Average Load Shedding	2	Hours/day
Average electricity bills per month	1.25	Lakh
Average occupancy	75%	
Standby Power Supply:		
Diesel Generator 1 (off peak load)	75	KVA
Diesel Generator 2 (peak load)	125	KVA
Diesel Generator 3 (peak load)	275	KVA
Average consumption of diesel per day	51	Liters/ day

Electrical Appliances	Nos	Operating Hours	Watt / unit	Load (kW)	Energy consumption /day at 100% occupancy (kWh)	Energy consumption /day at 75% occupancy (kWh)	Utilization /year	Energy Consumption per year
Ceiling Fans	140	12	60	8.4	100.80	75.60	270	20412
Air conditioner	24	10	1000	24	240.00	180.00	270	48600
Air Conditioner	30	10	1800	54	540.00	405.00	150	60750
Electric Geyser	30	4	1500	45	180.00	135.00	120	16200
Fluorescent (Long, 4 Feet Tube)	300	10	40	12	120.00	90.00	365	32850
Water pump	2	4	8820	17.64	70.56	70.56	365	25754
Computers	6	24	100	0.6	14.40	14.40	365	5256
Printer	2	3	100	0.2	0.60	0.60	365	219
Auto clave	2	2	5000	10	20.00	20.00	365	7300
				172	**1286.00**	**991.00**		**217341**

Based on the energy demand in this building the following renewable energy systems have been recommended for the 100 bedded hospitals.

Solar Water Heating system to replace gysers and preheating of water for cooking:	10000	LPD (200 sqm collector area)
Approximate area required for installaton	300	sqm
Indicative cost of the system	1000000	INR
MNRE subsidy @1400.00 per m2	420000	INR
Energy savings per day average	525	kWh
Electricity savings per year	118125	kWh
Annual cost savings from saving electricity	590625	INR
Payback period	0.98	years
Emission reduction	96	tonnes

Rooftop PV system for diesel abetment	30	kWp
Approximate area required	30	sqm
Indicative cost of the system with 1 day battery backup	6789474	INR
MNRE Subsidy @Rs.75 per Wp	2263158	INR
Approximate annual energy generation	45263	kWh
Fraction of DG power replaced	90%	
Amount of diesel saved per year	16768	litres
Cost savings from diesel per year	670705	INR
Annual O&M Cost of DG sets	150000	INR
Payback period	6	years
Emission reduction	37	tonnes

(ii) Renewable Energy Systems for 50 bedded Hospital

A 50 bedded Hospital has been chosen as the case study site in Thane. It is one of the primary medical facilities in Thane. The energy baseline scenario of the Hospital reveals huge energy consumption on daily basis, supplemented by a high capacity diesel generators with back-up of 125 KVA and 75 KVA each. An average occupancy of 75% has been taken to provide the calculations given below.

Table 51 : Case Study for 50 bed hospital

Location of the Hospital	**Thane**	
No of beds	50	Nos.
Roof Area available	250	sqm
Connected Load	150	KVA
Average Load Shedding	4	Hours/day
Average electricity bills per month	1.00	Lakh
Average occupancy	75%	
Standby Power Supply:		
Diesel Generator 1	75	KVA
Diesel Generator 2	125	KVA
Average consumption of diesel per day	80	Liters/ day

Electrical Energy Demand:

Electrical Appliances	**No. s**	**Operating Hours**	**Watt / unit**	**Load (kW)**	**Energy consumption /day at 100% occupancy (kWh)**	**Energy consumption /day at 75% occupancy (kWh)**	**Utilization /year**	**Energy Consumption per year**
Ceiling Fans	70	12	60	4.2	50.40	37.80	270	10206

Air Conditioner	20	10	1800	36	360.00	270.00	150	40500
Electric Geyser	30	4	1750	52.5	210.00	157.50	120	18900
Fluorescent (Long, 4 Feet Tube)	200	10	55	11	110.00	82.50	365	30113
Water pump	2	4	8820	17.64	70.56	70.56	365	25754
Computers	6	24	100	0.6	14.40	14.40	365	5256
Printer	2	3	100	0.2	0.60	0.60	365	219
Auto clave	2	2	5000	10	20.00	20.00	365	7300
				132	**836.00**	**653.00**		**138248**

Recommended Renewable Energy Systems

The energy consumption baseline assessment of eth 50 bedded hospital in Thane, lead to the recommendation of Solar water heater to address the daily hot water requirement and PV systems for diesel abatement.

Solar Water Heating system to replace geysers and preheating of water for cooking:	5000	LPD (100 sqm collector area)
Approximate area required for installaton	150	sqm
Indicative cost of the system	500000	INR
MNRE subsidy @1400.00 per m2	210000	INR
Energy savings per day average	262.5	kWh
Electricity savings per year	95813	kWh
Annual cost savings from saving electricity	479063	INR
Payback period	0.61	years
Emission reduction	78	tonnes

Rooftop PV system for diesel abetment	30	kWp
Approximate area required	30	sqm
Indicative cost of the system with 1 day battery backup	6750000	INR
MNRE Subsidy @Rs.75 per Wp	2250000	INR
Approximate annual energy generation	45000	kWh
Fraction of DG power replaced	39%	
Amount of diesel saved per year	11250	litres
Cost savings from diesel per year	450000	INR
Annual O&M Cost of DG sets	150000	INR
Payback period	8	years
Emission reduction	36	tonnes

(iii) Summary of RE strategy for Hospitals

The analysis of the above two case studies of a 100 bedded hospital and a 50 bedded hospital in Thane has revealed the huge energy consumption patterns in sector. Hospitals are a growing infrastructure need of any developing city. Hence the source to future energy consumptions lies in the proper streamlining of energy consumption patterns in these building sectors. Policy mandates and programmes for facilitating the adoption/installation of renewable energy technology in these building type will be a milestone for future energy savings. Adoption of Renewable energy systems in 25% of the hospitals will save 3.31 MU energy per year reducing GHG emission by 2790 tonnes per year. The payback period for solar water heater system for hospitals is about one year only due maximum use of hot water in health care facility.

Table 52 : Summary of RE systems for Hospitals

		RE System Proposed				
Educational Institutes	**Numbers**	**SWH/SC system**	**PV system**	**Biogas / Biomass system (cum)**	**Energy Savings (MU)**	**Total Emission reduction**
Hospitals				0		
Small hospitals and nursing homes with less than 50 beds	442	884000	442	0	11.11	9379.24
Hospitals with more than 100 beds	13	130000	392	0	2.12	1778.58
Agreegate	455	1014000	834	0	13.23	11157.82
Targeting 25% implementation	114	253500	209	0	3.31	2789.46
Investment (Lakh INR)		253.5	469	0		
MNRE subsidy @Rs.1400.00 per sqm		71	209	0		
Beneficiary/state/TMC contribution		183	261	0		

4.3.4. Renewable Energy Systems for Educational Institutes

Educational institutes are major establishments in the commercial sector of a city. Although they are not major source of energy consumption in the city yet they account for a substantial degree of energy utilization. The official website of Thane gives the following figures of educational institutes in Thane. The city has 308 primary/ nursery schools, apprx. 35 intermediate and high schools, five engineering colleges, nine degree colleges. The government primary schools provide free mid-day meal to its students. Community solar cookers can be used to cook mid-day meal in these schools. The institutes having hostels can use solar water heater to supply hot water to the bath rooms and the kitchen thereby providing bathing comfort to the students and hot water for cooking.

(i) Use of Solar cookers for cooking mid-day meals in primary schools

Solar Cookers can have an apt utilization for cooking mid-day meals in primary schools. Assuming 50% of the schools in Thane have a mid-day meal programme a target of 50% for the framework of 5 years has been considered.

Table 53 : Target for Introducing Solar Cookers in Primary Schools

		Unit
Total no of primary schools	308	Nos.
Schools providing mid day meal for students	50%	
Target for introducing of solar cooker in 5 years	50%	
Number of Solar Cooker to be installed in 5 years plan	77	Nos.
Average savings of LPG domestic cylinder per year (14kg)	10	Nos.
Total LPG saved per year	10780	kg
Total energy saved per year	0.16	MU
Indicative cost of installation	15.40	Lakh
MNRE subsidy for solar cooker @30%	4.62	Lakh
Benefeciary/ State/ TMC share	10.78	Lakh
Cost of energy savings	2.70	Lakh
Payback period	4.00	years
Emission reduction per year	38	Tonnes

(ii) Summary of RE strategy for Educational Institutes

The two renewable energy options can effectuate a considerable energy saving in educational institutes are the solar water heaters and solar PV systems. The potential for energy savings in different educational institutes in Thane is tabulated below. The figures give a gross idea about the financial implications and emission reductions rendered by installation of the aforementioned renewable energy systems.

Table 54 : Summary of RE strategy for educational institutes

		RE System Proposed				
Educational Institutes	**Numbers**	**SWH/SC system**	**PV system**	**Biogas / Biomass system (cum)**	**Energy Savings (MU)**	**Total Emission reduction**
		LPD/ Nos.	**kWp**			**Tonnes/ year**
Primary Schools/ Nursery (TMC)	308	77	77	0	0.16	37.61
Intermediate & High schools	35	0	9	0	0.01	10.68
Medical Colege	1	5000	5	0	0.07	56.10
Engineering College	5	25000	25	0	0.33	280.50
Degree College	9	4500	45	0	0.12	99.90
Polytechniques	3	6000	15	0	0.09	78.30
Other Institutes	4	2000	20	0	0.05	44.40
Aggregate	365	42577	195.75	0	0.84	607.49
Target 25% in 5 years	91	10644	49	0	0.21	151.87
Investment (Lakh INR)		26	110	0		
MNRE subsidy @Rs.1750.00 per sqm		11	49	0		
Beneficiary/state/TMC contribution		15	61	0		

(iv) Summary of RE strategy for Commercial and Institutional Sector

The target of RE strategy for commercial and institutional sector is to achieve about 3% of total energy savings requirement. The strategy, once implemented fully will save 5MU of energy per year and reduce GH of 3187.33 tonnes per year. The primary focus should be given to introduction of solar water heaters for hotels, restaurants, hospitals and other residential institutes, which will save 1.80MU per year. Solar PV power plant should be introduced for diesel abatement in the establishment that are using diesel sets as standby power supply source. The restaurants and hotels that has considerable amount of food and organic waste, should introduce biogas system. Use of solar cooker for preparing mid-day meal in primary schools will be an attractive option to save LPG for cooking and creation of awareness and demonstration about use of renewable energy devices among school children.

Table 55 : RE Strategy for Commercial and Institutional Sector

RE Strategy for Commercial and Institutional sector	Potential Users (Numbers)	Target Users(Numbers)	Units of Target	Target Capacity	Total Investment (Lakh INR)	MNRE subsidy (Lakh INR)	Sate/ TMC/ Beneficiary's contribution	Amount of Energy Saved (MU)	Emissions Reductions per year (Tonnes)
Solar Cooker for mid-day meal in schools	154	77	Nos.	77	15.40	4.62	10.78	0.16	37.61
Solar Water Heaters for Hotels, Restaurants, Hospitals	1773	443	LPD	400644	416.04	120.63	295.42	4.73	4006.44
Solar PV Power Plant for Hotels, Restaurants, Hospitals.	1773	443	kWp	715	1609.75	715.45	894.31	1.07	872.84
Biogas for Hotels and Restaurants	953	238	CuM	674	67.43	33.71	33.71	1.43	60.01
					2108.62	**874.40**	**1234.22**	**7.39**	**4976.91**

4.3.5. RE Strategy for Industrial Sector

The industry sector in Thane consumes 42% of total electricity and considerable amount of coal, diesel and LPG for its different manufacturing and process industries. Thane City has about 7270 odd large, small and medium scale industries. The system capacity assumed is average capacity and will vary based on the size of

the industry and energy requirement. Introducing proposed systems in 25% of the industries will save 1.66 MU of energy per year reducing 1366 tonnes of GHG emission.

Table 56 : RE Strategy for industrial sector in TMC

		RE System Proposed			
Small Scale Industries	**Numbers**	**SWH system**	**PV system**	**Energy Savings (MU)**	**Total Emission reduction**
		LPD/ Nos.	**kWp**		**Tonnes/ year**
Engg. Mechanical	2847	0	2847	4.27	3473
Electrical	84	0	42	0.06	51
Chemical	80	79715	80	1.06	894
Plastic	52	0	13	0.02	16
Paper	49	48734	24	0.61	517
Electromic	40	0	20	0.03	24
Printing	36	0	18	0.03	22
Consulting services	30	0	15	0.02	18
Rubber	21	20886	10	0.26	222
Foundry	16	0	16	0.02	20
Forging	16	0	16	0.02	20
Instrumentation	15	0	15	0.02	18
Farmaceutical	14	13924	14	0.19	156
Garments	12	0	6	0.01	7
Textiles	12	0	3	0.00	4
Cosmetic	9	0	2	0.00	3
Glassware	7	0	2		
Food Processing	4	3829	1		
Soaps & Allied	2	0	1		
Others	137	0	34		
Aggregate	484.2071	163259	3141	6.64	5465
Targeting 25% implementation	121	40815	785	1.66	1366
Investment (Lakh INR)		40.81	1766.86		
MNRE subsidy @Rs.1400.00 per sqm		6.73	785.27		
Beneficiary/state/TMC contribution		34.08	981.59		

4.3.6. RE Strategy for Municipal Sector

The municipal sector of Thane city consumes 3.00% of total electrical energy in the city. The primary consumers in this sector are street lights, outdoor lights in parks and monuments, markets, office buildings of the Municipal Corporation, advertising hoardings, water supply, sewerage treatment plant etc. Renewable energy devices are suggested to all categories of consumers depending upon the energy

demand. The sector has ample opportunity to save energy through introducing renewable energy and energy conservation measures and could show case these initiatives to encourage people to adopt further.

(i) Renewable Energy System for Municipality building and other Office Buildings

One of the main buildings of the municipal corporation consumes about 0.67 MU of electricity per year. The loads consume most of the energy are air conditioners, fans and lighting loads. A 80kWp PV Power plant is recommended for the building to supply power during load shedding hours.

Table 57 : RE Strategy for TMC municipal sector

Name of the Building	**Main Administrative Building, Municipal Corporation, TMC**	
Total premise area	23400	sqm
Built up area	3375	sqm
Average Load Shedding	4	hours/day

	Total No.s	**Load (W)**	**Total Load (kW)**	**Hours of Operation**	**Consumption / Day (kWh)**	**Annual Utilisation (days)**	**Annual Consumption (kWh)**
Ceiling Fans	550	75	41.25	10	413	300	123750
Air Conditioner	87	1500	130.50	8	1044	300	313200
Television	10	100	1.00	2	2	264	528
Refrigerator	8	200	1.60	1	2	264	422
Electric Water Pump	2	3750	7.50	4	30	300	9000
Water Cooler	5	300	1.50	4	6	300	1800
Incandescents	12	60	0.72	4	3	264	760
CFLs	240	18	4.32	5	22	264	5702
Fluorescent Long	1650	55	90.75	8	726	264	191664
Fluorescent Short	20	14	0.28	4	1	264	296
Computers	80	100	8.00	10	80	300	24000
Printers	10	100	1.00	10	10	300	3000
TOTAL			**288.42**		**2248**		**674123**

Recommended Renewable Energy System:

Rooftop PV system for diesel abetment	80	kWp
Approximate area required	80	sqm
Indicative cost of the system with 1 day battery backup	18000000	INR
MNRE subsidy for diesel abetment @75.00/Wp	6000000	INR
Approximate annual energy generation	120000	kWh
Fraction of DG power replaced	35%	
Amount of diesel saved per year	18947	Ltrs.
Cost savings from diesel per year	757895	INR
Annual O&M Cost of Generator sets	100000	INR

Payback period	14	years
Emission reduction	53	tonnes

(ii) Renewable Energy System for Markets

We did a survey of five main markets in the city to know the power consumption in these markets. The average number of shops in each market was 90.Primarily the shop owners use electricity to power the electrical equipments like bulb, tubelight, fans, Acc etc. Taking the note of load shedding in the city and the increasing bill of diesel fuel for generators, we have suggested some RE technologies for the commercial shops which if implemented will result in substantial reduction in conventional energy and the resultant emissions.

Table 58 : RE Systems for Markets

		Unit
Capacity of solar PV system for Shops	500	Wp
Indicative cost of incorporating Solar PV to Shop's inverter	60000	INR
Total no of shops in five big markets	450	Nos.
Shops uses Inverter during load shedding	100%	
Target to introduce solar charger for inverter in 5 years	50%	
Number of solar inverter to be installed in 5 years plan	225	Nos.
Total PV capacity installed	113	kWp
Energy genereted by PV arrays per year	0.17	MU
Cost of energy saved	8	Lakh
Indicative cost of installation	135	Lakh
MNRE subsidy @50%	67.5	Lakh
User's share	67.5	Lakh
Payback period	8	years
Emission reduction per year	137	Tonnes

(iii) RE System for Outdoors lighting (Streets, Traffic, Road safety etc.)

The city has about 30077 outdoor lights, which have been fixed for illumination streets, wards, etc. The objective is to introduce one solar PV outdoor light in every three conventional lights so that minimum illumination level is maintained during load shedding hours. The tables below indicate targets, investment thereon and energy savings potential etc.

Table 59 : RE Systems for Outdoor lights, Road safety

Street Light Details	Existing SL (Nos.)	Solar SL (Nos.)
150 watt sodium points	30077	10026
Total	**30077**	**10026**
Targeting 50% in 5 years		5013

PV module capacity (Wp)		40
Total PV Module capacity (kWp)		201
Total Investment (Lakh INR)		752
MNRE subsidy @50% (Lakh INR)		376
TMC/ State/ Beneficiary share (Lakh INR)		376
Energy Generated (MU per year)		0.30
Emission reduction (Tonnes per year)		244
Payback period (Years)		25

Table 60 : Summary of RE Strategy for outdoor light and road safety

	Total Potential	Target	Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ TMC/ User's Share (Lakh)	Energy Saved (MU per year)	Emissions Reductions per year (Tonnes)
LED based Street Light in every 3 alternative existing street light to maintain minimum level of illumination during load shedding	10026	5013	751.93	376	375.96	**0.30**	**243.62**
Solar PV Traffic Lights (2x74Wp) @	31	16	7.75	3.88	3.88	0.0034	2.79
Solar Blinkers (37Wp) @	100	50	7.50	3.75	3.75	0.0028	2.25
Road Stud @ 1 stud in 2m for 50% of 60km main road	15000	3750	45.00	22.50	22.50	0.02	13.67
			812.18	**406.09**	**406.09**	**0.32**	**262.33**

(iv) Renewable Energy Systems for Parks

Thane City has 99 'Municipal Parks' where electrical energy is consumed for outdoor lighting and water pumping for sprinkling irrigation. Solar PV outdoor lights and solar pumps are recommended for these parks.

Table 61 : Renewable Energy Systems for Parks

	No. of units	Unit load (W)	Total Load (kW)	Hours of operation	Energy Demand per day (kWh)
Flood light	9	250	2.25	10	22.5
CFL outdoor light	50	20	1.00	10	10
Water Pump	1	1000	1.00	10	10
Total		1270	4.25	30	42.5
RE Options:					
Options	**Nos.**	**Capacity**	**Unit**	**Investment (Lakh)**	
Converting 50% of conventional outdoor	30	74	Wp	6.64	

light into solar light to provide basic minimum illumination during load shedding					
Providing solar pump for sprinklers	1	1	kWp	1.75	

Table 62 : Summary of RE Strategy for Thane Municipal Corporation Parks

Total Number of Parks in Thane	99	Nos.
Targeting 50% in 5 years	50	Nos.
Total PV system capacity per park	3.18	kWp
Total investment	329	Lakh
MNRE Subsidy @50%	164	Lakh
TMC/ state/ Park Operator	164	Lakh
Energy saved per year	0.24	MU
Emission reduction per year	191	Tonnes
Cost of electricity saved per year	12	Lakh
Payback period	14	Years

(v) Summary of RE Strategy for Municipal Sector

The Municipal sector can contribute 0.98MU energy savings per year through introducing RE devices in the different municipal utilities and services reducing GHG emission by 795.44 tonnes per year.

Table 63 : Summary of RE Strategy for Municipal Sector in Thane

RE Strategy for Municipal Sector	Units of Target	Target Capacity	Total Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ TMC/ User's Share (Lakh)	Amount of Energy Saved (MU)	Emissions Reductions per year (Tonnes)
70kWp PV Power Plant for Municipal and other Office Buildings	Nos.	10	1800.00	900	900.00	0.75	610
LED based Solar Street Light	Nos.	5013	751.93	375.96	375.96	0.30	244
Solar PV Traffic Lights	Nos.	16	7.75	3.88	3.88	0.00	3
Solar Blinkers (37Wp)	Nos.	50	7.50	3.75	3.75	0.00	2
Road Stud @ 1 stud in 2m for 50% of 91km main road	Nos.	3750	45.00	22.50	22.50	0.02	14
Outdoor lights for Parks	Nos.	1460.25	328.56	164.28	164.28	0.16	132
Solar Pumps for Parks	Nos.	49.5	86.63	43.31	43.31	0.07	60
Replacing other hoardings with Solar Hoarding	Nos.	250	375.00	187.50	187.50	0.19	153
PV system for Inverters in the market shops	Nos.	225	135	67.5	67.5	0.38	305
			3537.36	**1769**	**1768.68**	**1.87**	**1522**

4.3.7. Waste to Energy Potential in Thane

Discussion with MSW department in the TMC, reveals the waste characterization for Municipal Solid waste in Thane to be as indicated in Table 64 :. Based on 2006 figures, the total waste quantity at dumpsites and at

the dustbins aggregated to 600 MT/day. The total waste generated can be classified as biodegradable and non - biodegradable.

Table 64 : Municipal Solid Waste Characterization (2006)

Waste Composition	Percentage Waste	Quantity (MT/Day)
Bio-degradable	76.9%	461.4
Non-biodegradable (Inert)	23.1%	138.6
Total Waste	100%	600

A rough assessment of the potential of recovery of energy from MSW through different treatment methods can be made from knowledge of its calorific value and organic fraction, as under. Since relevant details are not available for Thane, widely used estimates for municipal solid waste in India have been used.

(i) Waste to Energy Potential through thermo-chemical conversion

In thermo-chemical conversion all of the organic matter, biodegradable as well as non-biodegradable, contributes to the energy output. Total electrical energy generation potential is estimated to be 2.33 MWe and savings per year with 70% PLF is estimated as 14.46 MU.

Table 65 : Waste to Energy through thermo-chemical conversion

		Unit
Total waste generated	80	Tonnes
Net Calorific Value (conservative estimate)	2400	kcal/kg
Energy recovery potential (NCV x W x 1000/860)	223256	kWh
Power generation potential	9302	kW
Conversion efficiency	25%	
Net Power generation potential	2.33	MWe
Plant Load Factor	70%	
Net electrical energy savings potential @70% PLF	14.26	MU
Emission reduction per year	11551	Tonnes
Total Investment	1628	Lakh
MNRE subsidy @ 50% subject to maximum of Rs.300.00 per MW	698	Lakh
State/City/Private Power Producer	930	Lakh
Cost savings	642	Lakh
Payback period	1.45	Years

(ii) Waste to Energy Potential through bio-methanation

In bio-chemical conversion, only the biodegradable fraction of the organic matter can contribute to the energy output. It is estimated that a 0.84MWe electrical energy generation is possible from this process which could save about 5.13 MU of energy every year assuming a 70% of PLF.

Table 66 : Waste to Energy through bio-methanation

		Unit
Total waste generated	80	Tonnes
Total biodegradable volatile solid (VS)	30%	
Typical digestor efficiency	60%	
Typical bio-gas yield (m3 / kg. of VS destroyed)	0.80	CuM/kg
Biogas yield	11520	CuM
alorific Value of bio-gas	5000.00	kcal/CuM
Energy recovery potential	66976.74	kWh
Power generation potential	2791	kW
Conversion efficiency	30%	
Net Power generation potential	0.84	MWe
Plant Load Factor	70%	
Net electrical energy savings potential	5.13	MU
Emission reduction per year	4158	Tonnes
Total Investment	502	Lakh
MNRE subsidy @ R.200.00 lakh per MW	167	Lakh
State/City/Private Power Producer	335	Lakh
Cost savings	231	Lakh
Payback period	1.45	Years

(iii) Liquid Waste to Energy Potential from Sewage Treatment Plant (STP)

Thane City has sewage treatment plants through which approximately 54 MLD of wastewater being treated every day. Energy consumption in these sewage treatment plants is about 0.96 MU per year (2007-08). The produce of waste water treatment can be used as a raw material for anaerobic distention and subsequent power generation. A very preliminary assessment shows that there is potential of generating 1.88 MWe power which could deliver 11.55 MU of electrical energy per year with 70% PLF. Surat Municipal Corporation has established three such power plants with aggregate capacity of 3.50MWe with financial support from MNRE which have been running successfully since several years. A detailed study has to be made for Thane to generate power from STPs.

Table 67 : Waste to Energy from Sewage Treatment Plant

		Unit
Total waste water generated	54	MLD
Total biodegradable organic/ Volatile Solid available for Biomethanation	54	Tonnes/day
Typical Digestion Efficiency	60%	
Typical Biogas yield	0.8	cum / kg
Biogas yield	25920	cum
Electricity (kWh)	150697.67	kWh
Capacity of the plant	6279.07	KW
Conversion Efficiency	30%	
Total Electricity Generated	1.88	MWe

Plant Load Factor	70%	
Net electrical energy savings potential	11.55	MU
Emission reduction per year	9356	Tonnes
Total Investment	1130.23	Lakh
MNRE subsidy @40% subject to maximum of Rs.200.00 lakh per MW	376.74	Lakh
State/City/Private Power Producer	753.49	Lakh
Cost savings	519.79	Lakh
Payback period	1.45	Years

(iv) Summary of Waste to Energy Potential in Thane City

A very preliminary assessment for energy recovery from MSW and STPs has been done based on the widely used assumptions and presented in the table below.

Table 68 : Summary of waste to energy potential in Thane City

RE Strategy for Municipal Sector	Units of Target	Target Capacity	**Total Investment (Lakh)**	**MNRE subsidy (Lakh)**	**Sate / TMC / User's Share (Lakh)**	**Amount of Energy Saved (MU)**	**Emissions Reductions per year (Tonnes)**
Waste to Energy Potential for thermo-chemical conversion	MWe	2.33	1628	698	930	14.26	11551
Waste to Energy Potential for bio-methanation	MWe	0.84	502	167	335	5.13	4158
Liquid Waste to Energy Potential from Sewage Treatment Plant (STP)	MWe	1.88	1130	377	753	11.55	9356
			3260	**1242**	**2019**	**30.95**	**25066**

CHAPTER 5

This chapter delves into Energy Efficiency strategy for residential, commercial, industrial and municipal sector of Thane city. The chapter later develops the strategies for Thane city based on the Energy conservation and Energy Efficiency measures in the city and the baseline energy consumption and future energy demands of the city.

5. ENERGY EFFICIENCY STRATEGIES FOR THANE

While renewable energy technologies would provide clean energy, EE and DSM measures would help in reducing the energy demand. Energy Efficiency (EE) initiatives are the most financially feasible energy saving options in India today. In this report the EE measures have been thoroughly analyzed for all the four sectors, i.e. residential, commercial, industrial as well as municipal. The financial and technical analysis is provided for each strategy suggested in all the sectors. The list of EE and DSM measures suggested for different sectors is given below:

Residential Sector:

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast
- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Replacement of conventional refrigerators with EE star rated refrigerators
- Replacement of conventional water pumps with EE water pumps
- Reduce energy consumption in existing private buildings
- Reduce energy consumption in all new construction

Commercial and institutional building Sector:

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast
- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Replacement of conventional refrigerators with EE star rated refrigerators
- Replacement of conventional water pumps with EE water pumps

Industrial Sector:

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast

- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Energy efficiency in motors, furnaces, boilers, etc.

Municipal Sector:

- Replacement of 150 watt HPSV with LEDs
- Replacement of 40 watt T8/T12 tube lights with T5 tube lights
- Sensors for automatic on/off of street lights
- Proper pump-system design (efficient Pump, pumps heads with system heads
- Installation of variable speed drivers
- Power saver installation in pump house
- Plugging of leakages in the water supply system and use of efficient pumps and motors
- Energy Efficiency Measures in WTP

A sector-wise techno-economic analysis of potential energy efficiency and DSM measures has been carried out.

5.1. EE Strategy for Residential sector

Residential sector consumes largest amount of energy. Important proven and cost effective measures for the sector are described in this section. Based on the survey, it was found that incandescent lights are still used a lot in the residential sector. Utilizing the survey data the savings due to replacement of incandescent lamps with CFL are calculated and are presented in the table below.

(i) Replace Incandescent Lamps with Fluorescent

Incandescent bulbs are the major and the most common source of high energy consumption in the residential area. Replacement of incandescent lamps has acquired a substantial precedence in all the energy efficiency strategies as the most feasible option. The techno commercial for replacement of incandescent bulbs with CFL is given below. An assumption of 80% households utilizing CFLs has been considered as target group for replacements and an 80% replacement is assumed for the calculations below.

Table 69 : Replacement of incandescent lamps with fluorescent

Cost of electricity savings		**Unit**
Total Residential household	343904	Nos.
Household using incandescent bulb	62%	
Target to replace incandescent bulb with CFL	80%	
Number of incandescent bulb to be replaced per household	1	Nos.
Total number of incandescent bulb to be replaced	170576	Nos.
Indicative cost of installation	256	Lakh
Energy saved by replacing 60W bulb with 15W CFL	16810303	kWh
Cost of electricity savings	588	Lakh
Payback period	0.43	years

Emission reduction per year	13616	Tonnes

(ii) T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast

A conventional tube light (with magnetic ballast consuming 15W) consumes around 55 watts. It can be replaced with T5 tube (28W) with electronic ballast (4W) which will require around 32W. The calculations have been done for a period of 5 years assuming 80 % replacement of T 12 /T8 tube lights can be possible in 83% of the households using T12/T8 tube lights.

Table 70 : T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast

		Unit
Total Residential household	343904	Nos.
Household using T8/T12 tubelights	93%	
Target to replace T8/T12 by T5 tubelights	80%	
Number of incandescent bulb to be replaced per household	2	Nos.
Total number of T8/T12 tubelights to be replaced	511729	Nos.
Indicative cost of installation	2559	Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electronic ballast)	17183865	kWh
Cost of electricity savings	601	Lakh
Payback period	4.25	years
Emission reduction per year	13919	Tonnes

(iii) Efficient ceiling fans to replace conventional ceiling fans

Replacing conventional fans with star rated fans can save substantial amount of electrical energy and money. The financial and technical analysis for replacement of conventional ceiling fans in residential sector of Thane city assumes that 25% replacement should be possible in almost 100% of the households.

Table 71 : Efficient Ceiling Fans to Replace Conventional Ceiling Fans

		Unit
Total Residential household	343904	Nos.
Household using Conventional Fans	99%	
Target to replace CF by EE Fans	25%	
Number of Conventional fan to be replaced per household	3	Nos.
Total number of Conventional Fans to be replaced	255349	Nos.
Indicative cost of installation	3830	Lakh
Energy saved by replacing Conventional Fans by EE Fans	12582308	kWh
Cost of electricity savings	440	Lakh
Payback period	9	years
Emission reduction per year	10192	Tonnes

(iv) Replacement of conventional air-conditioners with EE star rated ACs

Survey results in Thane reveal that approximately 18% of residential households had a 1.5 ton air conditioners on average. The energy consumption by a 1.5 ton unit is approximately 7.2 kWh per day. For calculating the energy savings by switching to more energy efficient air conditioners it is assumed that 66% households in Thane owns an air –conditioner and 25% air conditioners can be assumed as potential target for replacement with energy efficient ACs.

Table 72 : Replacement of conventional air-conditioners with EE star rated ACs

		Unit
Total Residential household	343904	Nos.
Household using Conventional AC	44%	
Target to replace Conventional Acs by EE star rated AC	25%	
Number of Conventional ACs to be replaced per household	1	Nos.
Total number of Conventional ACs to be replaced	37829	Nos.
Indicative cost of installation	5674	Lakh
Energy saved by replacing Conventional ACs by EE Star Rated ACs	25875337	kWh
Cost of electricity savings	906	Lakh
Payback period	6	years
Emission reduction per year	20959	Tonnes

(v) Replacement of conventional refrigerators with EE star rated refrigerators

One of the most common appliance used in homes are the refrigerators. With increasing affordability refrigerators have become an indispensable item in most Indian households. They come in the capacity range of 200-400 litres. These days many BEE star rated energy efficient refrigerators are available in the Indian market. A conventional refrigerator of 200 watts has been taken to provide the calculations below. An assumption of 25 % households with conventional refrigerators is taken to show the energy savings.

Table 73 : Replacement of Conventional Refrigerators with EE Star Rated Refrigerators

		Unit
Total Residential household	343904	Nos.
Household using Conventional Refrigerators	92%	
Target to replace Conventional Refrigerators by EE Star Rated Refrigerators	25%	
Number of Conventional Refrigerators to be replaced per household	1	Nos.
Total number of Conventional Refrigerators to be replaced	79098	Nos.
Indicative cost of installation	4746	Lakh
Energy saved by replacing Conventional Refrigerators by EE Star Rated Refrigerators	37492414	kWh
Cost of electricity savings	1312	Lakh
Payback period	3.6	years

Emission reduction per year	30369	Tonnes

(vi) Replacement of conventional water pumps with EE star rated water pumps

Survey in Thane has shown that residential households use water pumps of 1.5 HP capacity which has an approximate electrical consumption of 2.2 kWh. Assuming 5% households in Thane use water pumps, 10% replacement of conventional pumps by energy efficient pumps have been targeted for energy savings.

Table 74 : Replacement of conventional water pumps with EE star rated water pumps

		Unit
Total Residential household	343904	Nos.
Household using Water Pumps	2%	
Target to replace Conventional Water Pump by EE Pump	10%	
Number of Conventional Pumps to be replaced per household	1	Nos.
Total number of Conventional Pumps to be replaced	963	Nos.
Indicative cost of installation	9.63	Lakh
Energy saved by replacing Conventional Water Pumps by EE Water Pumps	105441	kWh
Cost of electricity savings	3.69	Lakh
Payback period	2.61	years
Emission reduction per year	85	Tonnes

(vii) Summary of EE Strategy in Residential Sector

The estimated potential of energy savings in the residential sector through energy efficiency measures is 66 MU per year which is alone can meet 47.83% of the target of 230.1 MU energy savings per year in Thane City. The reduction of emission through EE measures in residential sector is 89140 tonnes per year. Replacement of incandescent bulbs with CFL, conventional fans, refrigerators and air conditioners with star rated one is the most potential scope for energy savings.

Table 75 : Summary of EE Strategy in Residential Sector

EE Measures in residential sector	**Unit**	**Target Capacity**	**Investment (Lacs INR)**	**Amount of Energy Saved (MU)**	**Emissions Reductions (Tonnes)**
Indicative cost of replacing 60 watt incandescent with 15 watt CFL	Nos.	170576	256	17	13616
Indicative cost of replacing T12/T8 with T5 FTL	Nos.	511729	2559	17	13919
Indicative cost of replacing conventional Fans with EE star rated fans	Nos.	255349	3830	13	10192
Indicative cost of replacing conventioanl AC with EE star rated AC	Nos.	37829	5674	26	20959
Indicative cost of replacing conventional refrigerator with EE star rated refrigerator	Nos.	79098	4746	37	30369
Indicative cost of installing a EE water pump	Nos.	963	10	0	85
			17075	**110**	**89140**

5.2. EE Strategy for Commercial Sector

The commercial sector comprises primarily of offices, shopping malls, markets, hotels and restaurants and comprises of a mix of air conditioned and non air-conditioned buildings. The prime load centers in the sector are air-conditioning, lighting and pumps/equipment. The major share of electricity consumption is attributed to by air-conditioning in a full conditioned building followed by lighting, whereas the prime energy consumption in a non-air conditioned building is lighting followed by space conditioning (coolers, fans, etc.). The energy conservation and efficiency measures targeted for commercial sector thus should be aimed at enhancing efficiency levels and deploying conservation options for lighting and air conditioning. Thus efficiency and conservation have to be addressed in existing and new buildings to affect overall demand and consumption reduction.

While retrofit options in existing buildings are restricted to system upgrades (e.g. upgrade to efficient chillers, air handling units, pumps in HVAC system or upgrade to efficient lighting systems), new buildings offer ample opportunities for walls & roof, efficient glazing, energy efficient lighting & HVAC system and renewable energy integration for water heating or power generation)

Energy efficiency in the commercial sector is also hugely dependent on replacement of conventional equipment with more energy efficient appliances. All kinds of building sectors are available in Thane ranging from hotels, hospitals, shops, malls, hostels, educational institutes and restaurants. The strategies here target all these building types in Thane.

(i) Replace Incandescent Lamps with Fluorescent

CFL usage has been widespread in the last few years and it is high time that all commercial establishments should voluntarily replace the high energy consuming incandescent lamps with CFLs. From survey results we have assumed that 15% of the commercial sector establishments use incandescent bulbs and 64% of establishment use T8/T12 tube lights. A target to replace 80% of the incandescent bulbs in this household is assumed to give the calculations below.

Table 76 : Replacement of incandescent lamps with fluorescent

		Unit
Total Commercial Consumers	42156	Nos.
Consumers using incandescent bulb	15%	
Target to replace incandescent bulb with CFL	80%	
Number of incandescent bulb to be replaced per comsumer	10	Nos.
Total number of incandescent bulb to be replaced	50587	Nos.
Indicative cost of installation	76	Lakh
Energy saved by replacing 60W bulb with 15W CFL	4097563	kWh
Cost of electricity savings	205	Lakh
Payback period	0.37	years
Emission reduction per year	3319	Tonnes

Table 77 : Replace T12/T8 tube light by T5 tube light

		Unit
Total Commercial Consumers	42156	Nos.
Consumers using T8/T12 tubelights	64%	
Target to replace T8/T12 by T5 tubelights	80%	
Number of incandescent bulb to be replaced per consumer	2	Nos.
Total number of T8/T12 tubelights to be replaced	43168	Nos.
Indicative cost of installation	216	Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electronic ballast)	1191430	kWh
Cost of electricity savings	60	Lakh
Payback period	3.62	years
Emission reduction per year	965	Tonnes

(ii) Replacement of inefficient fans

Analysis of the sample survey of Thane city reveals that maximum commercial establishments in Thane city have fans. Conventional fans have an average energy consumption of 1.03kWh per day. Assuming 25% of the conventional fans in the commercial sector of Thane can be replaced with more energy efficient fans the following techno-commercials have been calculated.

Table 78 : Replacement of Conventional Fans

		Unit
Total Commercial Consumers	42156	Nos.
Consumers using Conventional Fans	86%	
Target to replace CF by EE Fans	25%	
Number of Conventional fan to be replaced per consumer	3	Nos.
Total number of Conventional Fans to be replaced	24472	Nos.
Indicative cost of installation	367	Lakh
Energy saved by replacing Conventional Fans by EE Fans	513903	kWh
Cost of electricity savings	26	Lakh
Payback period	14.29	years
Emission reduction per year	416	Tonnes

(iii) Replacement of conventional air-conditioners with EE star rated ACs

Commercial establishments are usually equipped with air conditioners. Survey in Thane city reveals that 1.5 tons air conditioners are more popular in the commercial buildings. Assuming that 47% of the commercial establishments own an air conditioner, 25% target replacement of inefficient air-conditioners with more efficient conditioners are taken into consideration for the below mentioned calculations.

Table 79 : Replacement of Conventional Air-Conditioners with EE Star Rated ACs

		Unit
Total Commercial Consumers	42156	Nos.
Consumers using Conventional ACs	47%	
Target to replace Conventional ACs by EE star rated ACs	25%	
Number of Conventional ACs to be replaced per household	5	Nos.
Total number of Conventional ACs to be replaced	24767	Nos.
Indicative cost of installation	3715	Lakh
Energy saved by replacing Conventional ACs by EE Star Rated ACs	16940389	kWh
Cost of electricity savings	847	Lakh
Payback period	4.39	years
Emission reduction per year	13722	Tonnes

(iv) Replacement of conventional refrigerators with EE star rated refrigerators

Refrigerators in commercial sector are restricted to the food outlets, restaurants, hotels, guest houses, and ice-cream parlors. General trend reveals that the refrigerators of the range of 200-400 W are found in the commercial sector of Thane City. Approximately 63% of the consumers own a refrigerator and a target of replacing 25% refrigerators has been taken to show the energy saving potential of replacing conventional refrigerators in commercial sector of Thane city.

Table 80 : Replacement of Conventional Refrigerators with EE Star Rated Refrigerators

		Unit
Total Commercial Consumers	42156	Nos.
Consumers using Conventional Refrigerators	63%	
Target to replace Conventional Refrigerators by EE Star Rated Refrigerators	25%	
Number of Conventional Refrigerators to be replaced per consumer	1	Nos.
Total number of Conventional Refrigerators to be replaced	6640	Nos.
Indicative cost of installation	448	Lakh
Energy saved by replacing Conventional Refrigerators by EE Star Rated Refrigerators	3147156	kWh
Cost of electricity savings	157	Lakh
Payback period	3	years
Emission reduction per year	2549	Tonnes

(i) Summary of EE Strategy in Commercial & Institutional Sector

The estimated energy savings potential from commercial and institutional sector through energy efficiency measures is 26MU per year, which is 11.25% of total target to achieve. Potential for GHG reduction is 20971 tonnes per year.

Table 81 : Summary of EE Strategy in Commercial & Institutional Sector

EE Measures	Units	Targets	Investment (INR)	Electricity Saved (MU)	Emissions Saved (Tonnes)
Indicative cost of replacing 100 watt incandescent with 15 watt CFL	Nos.	50587	76	4	3319
Indicative cost of replacing T8/T12 tube lights with T5 FTL	Nos.	43168	216	1	965
Indicative cost of replacing conventional fans with EE fans	Nos.	24472	367	1	416
Indicative cost of replacing conventional AC with EE star rated AC	Nos.	24767	3715	17	13722
Indicative cost of replacing conventional refrigerators with EE star rated refrigerators	Nos.	6640	448	3	2549
Indicative cost of installing EE water pumps	Nos.	0	0	0	0
			4822	**26**	**20971**

5.3. EE Strategy for Industrial Sector

Thane has around 7270 industrial units a registered customer of MSEDCL. They are also contributing a lot towards the huge energy consumption in Thane city. Energy efficiency measures are the most financially feasible option in this sector too.

(i) Replacement of incandescent with CFLs

Industrial sector survey in Thane city reveals that almost all of them use incandescent bulbs as lighting appliances. A 80 % target of replacing incandescent bulbs with CFLs is taken to provide the energy savings calculations below.

Table 82 : Replacement of incandescent with CFLs in Industrial sector

		Unit
Total Industrial Consumers	7270	Nos.

Consumers using incandescent bulb	29%	
Target to replace incandescent bulb with CFL	80%	
Number of incandescent bulb to be replaced per comsumer	9	Nos.
Total number of incandescent bulb to be replaced	14505	Nos.
Indicative cost of installation	29	Lakh
Energy saved by replacing 100W bulb with 20W CFL	3133102	kWh
Cost of electricity savings	157	lakh
Payback period	0.19	years
Emission reduction per year	2538	Tonnes

(ii) Replacement of T8/T12 by T5 tube lights

The T12 and Tt8 tube lights are also frequently used in the industrial sector in Thane city. Survey results show that almost 94% consumers use these appliances. The energy saving potential by replacement of T12 and T8 with more efficient T5 tube lights is calculated below assuming a replacement of 80% appliances in target households. The financial and technical details of the replacement in Thane city industrial units are given below.

Table 83 : Replacement of T8/T12 tube lights

		Unit
Total Industrial Consumers	7270	Nos.
Consumers using T8/T12 tubelights	94%	
Target to replace T8/T12 by T5 tubelights	80%	
Number of incandescent bulb to be replaced per consumer	7	Nos.
Total number of T8/T12 tubelights to be replaced	39909	Nos.
Indicative cost of installation	200	Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electronic ballast)	1407165	kWh
Cost of electricity savings	70	Lakh
Payback period	2.84	years
Emission reduction per year	1140	Tonnes

(iii) Replacement of Conventional Fans by EE Star Rated Fans

Conventional fans are other energy guzzlers in industrial units of Thane city. They are used for longer hours in this sector hence the replacement of conventional energy efficient fans with more efficient ones would bring about a lot of energy savings. 100% of industrial units have installed a conventional fan which can be targeted for replacement. Assuming a replacement of 25% of the conventional fans with energy efficient fans the economics and technical details of replacement are tabulated below.

Table 84 : Replacement of conventional fans by EE star rated fans

		Unit
Total Commercial Consumers	7270	Nos.
Consumers using Conventional Fans	100%	
Target to replace CF by EE Fans	25%	

Number of Conventional fan to be replaced per consumer	15	Nos.
Total number of Conventional Fans to be replaced	26808	Nos.
Indicative cost of installation	402	Lakh
Energy saved by replacing Conventional Fans by EE Fans	514716	kWh
Cost of electricity savings	26	Lakh
Payback period	16	years
Emission reduction per year	417	Tonnes

(iv) Replacement of Conventional ACs with EE Star Rated ACs

Almost 70 % of the surveyed industrial units in Thane City had the ownership of air conditioning units in their office premises. Assuming the replacement of 25% of the air-conditioning units with star rated air conditioning units the figures related to installments and energy savings are given below.

Table 85 : Replacement of Conventional ACs with EE Star Rated ACs

		Unit
Total Industrial Consumers	7270	Nos.
Consumers using Conventional ACs	70%	
Target to replace Conventional ACs by EE star rated ACs	25%	
Number of Conventional ACs to be replaced per household	2	Nos.
Total number of Conventional ACs to be replaced	2163	Nos.
Indicative cost of installation	334	Lakh
Energy saved by replacing Conventional ACs by EE Star Rated ACs	739686	kWh
Cost of electricity savings	37	Lakh
Payback period	9	years
Emission reduction per year	599	Tonnes

(v) Summary of EE Strategy in Industrial Sector

Energy Efficiency measures with mere replacement of incandescent bulbs, inefficient fans, ac and refrigerators in industrial sector of Thane city can save at least 5.79 MU energy per year reducing GHG emission by 4694 tonnes per year.

Table 86 : Summary of EE Strategy for Industrial Sector

EE Measures	Units	Target	**Investment (INR)**	**Electricity Saved (MU)**	**Emissions Saved (Tonnes)**
Indicative cost of replacing 100 watt incandescent with 15 watt CFL	Nos.	14505	29	3.13	2538
Indicative cost of replacing T12/T8 tubelights with T5 tube lights	Nos.	39909	200	1.41	1140
Indicative cost of replacing conventional fans with EE star rated fans	Nos.	26808	402	0.51	417
Indicative cost of replacing conventional AC with EE star rated	Nos.	2163	334	0.74	599

AC					
	Nos.		**965**	**5.79**	**4694**

5.4. EE Strategy for Municipal Sector

Municipal services annually incur huge expenditures on electricity consumption to cater to the local public services. Hence energy efficiency has become the call of the day for municipal organizations in India, owing to growing city needs. The Bureau of Energy Efficiency in India has already come out with the Manual for development of Municipal Energy Efficiency Projects. Energy conservation drives in the municipal corporations and councils will become an exemplary initiative for similar activities in eth city. As a high visibility and administration center Municipal bodies across India should go ahead in implementing the strategies and replicating the success stories.

5.4.1. EE measures in Street Lighting

Street lighting is one of the major sources of energy consumption in municipal area. 150 HPSV are mostly used as streetlights to lighten the different wards under municipal corporation jurisdiction.

(i) Replacement of 150 watt HPSV with 56 watt LEDs

250 watts high pressure sodium vapor lamps are frequently used in street lighting fixture in municipal area. They can be replaced with more energy efficient LEDS available in the Indian market today. A 100% target to replace 250W HPSV lamps with LEDs is taken for Thane city, to provide the techno-economics of implementing the replacement and bringing about energy savings.

Table 87 : Replacement of 150 watt HPSV with LED

		Unit
Total number of 150 watt HPSV	30077	Nos.
Target to replace HPSV lamp with LEDs	100%	
Total number of 56 watt LEDs needed	30077	Nos.
Indicative cost of installation	11128	Lakh
Energy saved by replacing 150 watt HPSV with 56 watt LED	12383302	kWh
Cost of electricity savings	619	Lakh
Payback period	17.97	years
Emission reduction per year	10030	Tonnes

(ii) Sensors for automatic on/off of street lights

Automatic street lights ensure that energy is not wasted by lights turned on during day time. Many streetlights in India face this predicament due to faulty manually controlled street lights. Manual control involves labor costs, energy wastes and poor efficiency , hence Municipal street lights should hasten the

process of installing automatic sensors. Solar sensors are the new and upcoming products in the market today and should be applied by municipalities for higher efficiency in the operation and maintenance of municipal street lights. Thane city showed predominantly manual control of municipal street lights and hence it is highly recommended for switch over to automatic sensors preferably solar automatic sensors.

(iii) Energy Efficiency Measures in Water Pumping

Water pumping is one of the major utility practices which consume high energy. The energy efficiency initiatives for water pumping in India have been going on for quite some time. BEE state in its Manual for Development of Municipal Energy Efficiency Projects states that 25% energy savings can be obtained from initiatives in water systems alone. In Karnataka Municipal energy efficiency Improvement initiatives, water pumping has been addressed. This has been further taken up as a Municipal Energy efficiency CDM project. The effort can be replicated throughput other municipalities sin India. This would bring about a lot of energy savings in water pumping utilities.

(iv) Proper pump-system design (efficient Pump, pumps heads with system heads

Proper water pumping design can bring about lots of energy savings in the running and maintenance cost of water pump systems. Careful designing is required to assess the volume of water to be pumped and the height it needs to be raised to. Fluid piping soft wares can be utilized for designing water pumps in Municipal bodies. A 20% saving is assumed for design based energy efficiency of water pumping systems. The techno-economics given below for this initiative is based on this assumption.

Table 88 : Proper pump-system design (efficient Pump, pumps heads with system heads)

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	20.01
Annual Energy Cost in Rs. (lacs)	700.35
Saving %	20%
Total annual Saving in MU	4.002
Annual Saving in Rs. (lacs)	140.07
eCO_2 (Tonne) Reduction	3241.62

(v) Installation of variable speed drivers

Dimension and adjustment losses are two of the major energy loss sources in pumping processes. Adjusting pump speed or using Variable Speed Driver to adjust speed is one way to decreasing both the aforementioned losses in pumping processes. An assumption of 5% savings is taken to provide the financial and technical details of installing variable speed drivers in municipal water pumping systems in Thane City.

Table 89 : Variable Speed Drivers

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	20.01

Annual Energy Cost in Rs. (lacs)	700.35
Saving %	5%
Total annual Saving in MU	1.0005
Annual Saving in Rs. (lacs)	35.0175
eCO2 (Tonne) Reduction	810.405

(vi) Power saver installation in pump house

An assumption of 15% savings is taken as the energy saving potential for installing power saver in municipal pump houses. The following techno-economics is based on this assumption.

Table 90 : Power saver installation in pump house

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	20.01
Annual Energy Cost in Rs. (lacs)	700.35
Saving %	15%
Total annual Saving in MU	3.0015
Annual Saving in Rs. (lacs)	105.0525
eCO2 (Tonne) Reduction	2431.215

(vii) Energy Efficiency Measures in STP

Pumping systems are utilized in water treatment plants of the municipal corporations whose energy efficiency can also be determined through efficient system design. A considerable amount of energy can be saved taking suitable measures in STP. TMC should initiate energy audit in all its utility services and installations to take a stalk of the energy consumption and potential savings.

(viii) Proper pump-system design (efficient pump, pumps heads with system heads)

The same principle of speed adjustment to reduce adjustment and dimension energy losses in water pumping process applies in water treatment plants. An assumption of 5% saving is taken into consideration for giving the techno-economics of installing variable

Table 91 : Proper pump-system design (efficient pump, pumps heads with system heads)

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	0.96
Annual Energy Cost in Rs. (lacs)	33.6
Saving %	20%
Total annual Saving in MU	0.192
Annual Saving in Rs. (lacs)	350
eCO_2 (Tonne) Reduction	156

(ix) Installation of variable speed drivers

Installation of variable speed drivers for municipal pumps could save at least 5% energy resulting total savings of 0.05MU per year reducing 39 tonnes of GHG emission.

Table 92 : Variable Speed Drivers

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	0.96
Annual Energy Cost in Rs. (lacs)	33.6
Saving %	5%
Total annual Saving in MU	0.05
Annual Saving in Rs. (lacs)	1.68
eCO2 (Tonne) Reduction	39

(x) Power saver installation in pump house

An assumption of 15% savings has been taken to calculate the energy saving potential and financial implications of installing power saver in pump houses.

Table 93 : Power saver installation in pump house

Standard/Recommended Condition	Value
Annual Energy Consumption in MU	0.96
Annual Energy Cost in Rs. (lacs)	33.6
Saving %	5%
Total annual Saving in MU	0.05
Annual Saving in Rs. (lacs)	1.68
eCO2 (Tonne) Reduction	39

(xi) Summary of EE Strategy for Municipal Sector

The energy savings potential through energy efficiency measures in municipal sector is 26.21 MU per year which is about 11.39% of total target to achieve.

Table 94 : Summary of EE Strategy for municipal sector

	EE Measures	Targ	Investm	Electric	Emissi

		et	ent (Lakh)	ity Saved (MU)	ons Saved (Tonnes)
	Indicative cost of replacing 150 watt HPSV with 56 watt LED	30077	11128	12.38	10030
	100% timer based operation and installation of power saver	226	192	5.43	4402
Water Supply	Proper pump-system design (efficient Pump, pumps heads with system heads			4.00	3241.62
	Installation of variable speed drivers			1.00	810.405
	Standard/Recommended Condition			3.00	2431.215
STP	Proper pump-system design (efficient Pump, pumps heads with system heads			0.19	155.52
	Installation of variable speed drivers			0.05	38.88
	Standard/Recommended Condition			0.14	116.64
			11320	**26.21**	**21226**

CHAPTER 6

6. ACTION PLAN AND BUDGET

6.1. Year-wise Goals of Energy Savings

The table below presents a summary of year wise goals for energy savings through introduction of renewable energy and taking energy efficiency measures. The goal is to minimum 10% reduction in projected total demand of 1680MU of conventional energy at the end of five years to be achieved through energy saving from energy efficiency measures and generation from renewable energy installations.
The master plan sets a goal of total savings of 222.28MU with 113.18MU from renewable energy installation and 109.10MU from energy efficiency measures.

Table 95 : Energy savings goal over 5 years solar city implementation period

	Energy Savings target over 5 years period of implementation							
RE and EE Strategy for Thane City	**1st Year**	**2nd year Cumulative**	**3rd year Cumulative**	**4th year Cumulative**	**5th year Cumulative**	**Total Energy Savings (MU)**	**% of savings target to achieve**	**Emission reduction/ year**
RE for Residential Sector	10.33	25.83	46.49	72.31	103.30	103.30	44.90%	96654
RE for Commercial & Inst. Sector	0.74	1.85	3.33	5.18	7.39	7.39	3.21%	4977
RE for Industrial Sector	0.17	0.42	0.75	1.16	1.66	1.66	0.72%	1366
RE for Municipal Sector	0.17	14.68	20.15	32.12	32.63	32.63	14.18%	26435
Total for RE strategy	14.50	36.25	65.24	101.49	144.99	144.99	63.01%	129432
EE for Residential Sector	11.00	27.51	49.52	77.03	110.05	110.05	47.83%	89140
EE for Commercial Sector	2.59	6.47	11.65	18.12	25.89	25.89	11.25%	20971
EE for Industrial Sector	0.58	1.45	2.61	4.06	5.79	5.79	2.52%	4694
EE for Municipal Sector	2.62	6.55	11.79	18.34	26.21	26.21	11.39%	21226
Total for EE Strategy	16.79	41.99	75.57	117.56	167.94	167.94	72.99%	136032
RE and EE Combined Strategy	31.29	78.23	140.82	219.05	312.93	312.93		265464
	14%	34%	61%	95%	136%	136%		

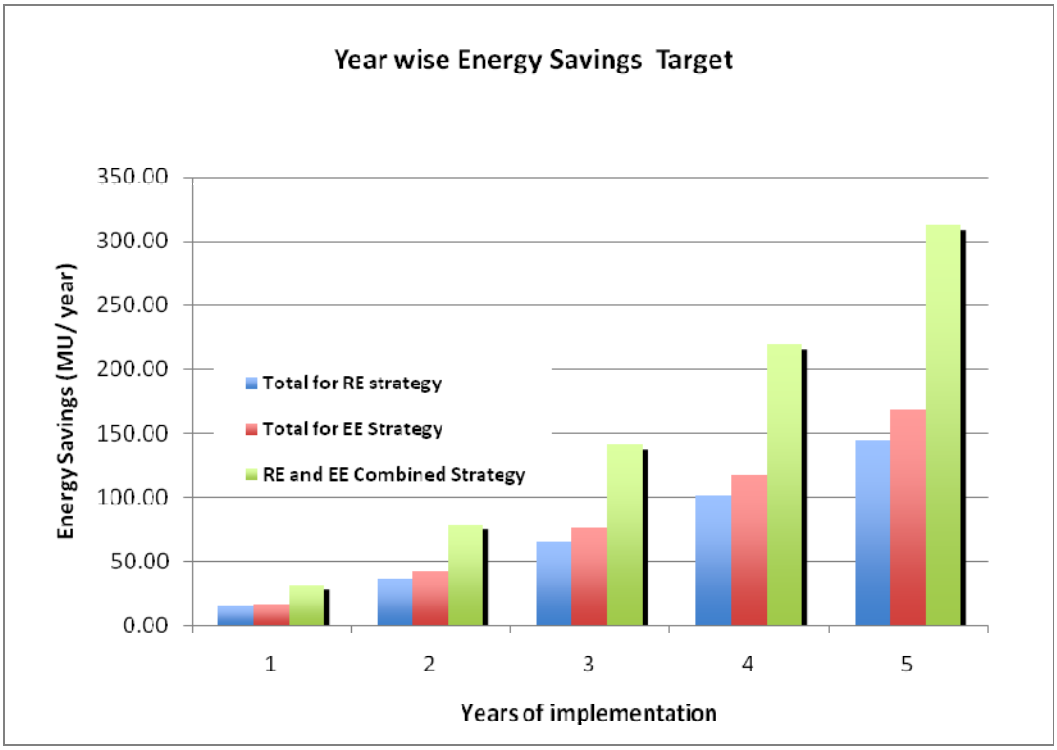


Figure 19 : Year wise energy savings targets for Thane Solar City

Table 96 : Year wise Goal of Energy Savings (Please zoom in for better view)

Year-wise goals of savings

Activities	Unit for Capacity Targeted	Year 1 Capacity Targeted	10% Savings (MU)	target CO2 reduction (tonnes)	Year 2 Capacity Targeted	15% Savings (MU)	target CO2 reductio n	Year 3 Capacity Targeted	20% Savings (MU)	target CO2 reductio n	Year 4 Capacity Targeted	25% Savings (MU)	target CO2 reductio n	Year 5 Capacity Targeted	30% Savings (MU)	target CO2 reductio n	Aggregate in 5 years Capacity Targeted	Savings (MU)	CO2 reduction (tonnes)	230.1 % of target in MU
Renewable Energy Strategy																				
RE Strategy for Residential Sector																				
Installation of Solar Water Heating System (100/125LPD system)	Nos.	2545	4.01	3247	3817	6.01	4870	5090	8.02	6493	6362	10.02	8117	7635	12.02	9740	25449	40.08	32466	17.42%
Use of Solar cookers (Box and dish type)	Nos.	688	0.70	168	1032	1.05	252	1376	1.40	336	1720	1.75	420	2063	2.10	504	6878	7.00	1680	3.04%
Solar lanterns to replace kerosene lamps	Nos.	69	0.02	6	103	0.04	9	138	0.05	13	172	0.06	16	206	0.07	19	688	0.25	63	0.11%
Use Solar Home Systems (SHS)	Nos.	69	0.11	27	103	0.16	41	138	0.22	55	172	0.27	69	206	0.33	82	688	1.09	275	0.47%
Using Solar PV for Home Inverters	Nos.	2682	1.01	815	4024	1.51	1222	5365	2.01	1630	6706	2.51	2037	8047	3.02	2444	26825	10.06	8148	4.37%
Using Solar PV for replacement of DG/ Kerosene Generator sets	Nos.	929	1.39	2830	1393	2.09	4245	1857	2.79	5660	2321	3.48	7075	2786	4.18	8491	9285	13.93	28302	6.05%
Solar Water Heater Systems for Residential Apartment Complex	LPD	160000	1.89	1600	240000	2.84	2400	320000	3.78	3200	400000	4.73	4000	480000	5.67	4800	1600000	18.90	16000	8.21%
Solar PV Power Pack for Residential Apartment Complex	kWp	800	1.20	972	1200	1.80	1458	1600	2.40	1944	2000	3.00	2430	2400	3.60	2916	8000	12.00	9720	5.22%
Total for Residential Sector			10.33	9665		15.50	14498		20.66	19331		25.83	24163		30.99	28996		103.30	96654	44.90%
RE Strategy for Commercial Sector																				
Solar Cooker for mid-day meal in schools	Nos.	8	0.02	4	12	0.02	6	15	0.03	8	19	0.04	9	23	0.05	11	77	0.16	38	0.07%
Solar Water Heaters for Hotels, Restaurants, Hospitals and Institutes	LPD	40064	0.47	401	60097	0.71	601	80129	0.95	801	100161	1.18	1002	120193	1.42	1202	400644	4.73	4006	2.06%
Solar PV Power Plant for Hotels, Restaurants, Hospitals and Institutes	kWp	72	0.11	87	107	0.16	131	143	0.21	175	179	0.27	218	215	0.32	262	715	1.07	873	0.47%
Biogas for Hotels and Restaurants	CuM	67	0.14	6	101	0.21	9	135	0.29	12	169	0.36	15	202	0.43	18	674	1.43	60	0.62%
Total for Commercial & Institutional Sector			0.74	498		1.11	747		1.48	995		1.85	1244		2.22	1493		7.39	4977	3.21%
RE Strategy for Industrial sector																				
Solar Water Heaters for Industries	LPD	4081	0.05	41	6122	0.07	61	8163	0.10	82	10204	0.12	102	12244	0.14	122	40815	0.48	408	0.21%
Solar PV Power Plant, Inverter etc	kWp	79	0.12	96	118	0.18	144	157	0.24	192	196	0.29	240	236	0.35	287	785	1.18	958	0.51%
Biogas system from organic/food waste	CuM	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0.00%
Total for Industrial Sector			0.17	137		0.25	205		0.33	273		0.42	342		0.50	410		1.66	1366	0.72%
RE Strategy for Municipal Sector																				
50kWp PV Power Plant for Municipal and other Office Buildings	Nos.	1	0.08	61	2	0.11	92	2	0.15	122	3	0.19	153	3	0.23	183	10	0.75	610	0.33%
LED based Solar Street Light	Nos.	501	0.03	24	752	0.05	37	1003	0.06	49	1253	0.08	61	1504	0.09	73	5013	0.30	244	0.13%
Solar PV Traffic Lights	Nos.	2	0.00	0	2	0.00	0	3	0.00	1	4	0.00	1	5	0.00	1	16	0.00	3	0.00%
Solar Blinkers (37Wp)	Nos.	5	0.00	0	8	0.00	0	10	0.00	0	13	0.00	1	15	0.00	1	50	0.00	2	0.00%
Road Stud @ 1 stud in 2m for 50% of 91km main road	Nos.	375	0.00	1	563	0.00	2	750	0.00	3	938	0.00	3	1125	0.01	4	3750	0.02	14	0.01%
Outdoor lights for Parks	Nos.	146	0.02	13	219	0.02	20	292	0.03	26	365	0.04	33	438	0.05	40	1460	0.16	132	0.07%
Solar Pumps for Parks	Nos.	5	0.01	6	7	0.01	9	10	0.01	12	12	0.02	15	15	0.02	18	50	0.07	60	0.03%
PV system for Inverters in the market shops	Nos.	23	0.04	31	34	0.06	46	45	0.08	61	56	0.09	76	68	0.11	92	225	0.38	305	0.16%
Waste to Energy Potential for thermo-chemical conversion	MWe	0.00	0.00	0	2.33	14.26	11551	0	0.00	0	0	0.00	0	0	0.00	3465	2.33	14.26	11551	6.20%
Waste to Energy Potential for bio-methanation	MWe	0.00	0.00	0	0	0.00	0	0.84	5.13	4158	0	0.00	0	0.00	0.00	1248	0.84	5.13	4158	2.23%
Liquid Waste to Energy Potential from Sewage Treatment Plant (STP)	MWe	0.00	0.00	0	0	0.00	0	0	0.00	0	1.88	11.55	9356	0.00	0.00	2807	1.88	11.55	9356	5.02%
Total for Municipal Sector			0.17	137		14.51	11756		5.47	4432		11.97	9699		0.51	7931		32.63	26435	14.18%
Total for RE strategy			11	10437		31	27206		28	25032		40	35448		34	38830		144.99	129432	63.01%
Energy Efficiency Strategy																				
EE Strategy for Residential sector																				
Replace Incandescent Lamps with Fluorescent	Nos.	17058	1.68	1362	25586	2.52	2042	34115	3.36	2723	42644	4.20	3404	51173	5.04	4085	170576	16.81	13616	7.31%
T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast	Nos.	51173	1.72	1392	76759	2.58	2088	102346	3.44	2784	127932	4.30	3480	153519	5.16	4176	511729	17.18	13919	7.47%
Efficient ceiling fans to replace conventional ceiling fans	Nos.	25535	1.26	1019	38302	1.89	1529	51070	2.52	2038	63837	3.15	2548	76605	3.77	3058	255349	12.58	10192	5.47%
Replacement of conventional air-conditioners with EE star rated ACs.	Nos.	3783	2.59	2096	5674	3.88	3144	7566	5.18	4192	9457	6.47	5240	11349	7.76	6288	37829	25.88	20959	11.25%
Replacement of conventional refrigerators with EE star rated refrigerators	Nos.	7910	3.75	3037	11865	5.62	4555	15820	7.50	6074	19774	9.37	7592	23729	11.25	9111	79098	37.49	30369	16.29%
Replacement of conventional water pumps with EE water pumps	Nos.	96	0.01	9	144	0.02	13	193	0.02	17	241	0.03	21	289	0.03	26	963	0.11	85	0.05%
Total for Residential Sector			11.00	8914		16.51	13371		22.01	17828		27.51	22285		33.01	26742		110.05	89140	47.83%
EE Strategy for Commercial Sector																				
Replace Incandescent Lamps with Fluorescent	Nos.	5059	0.41	332	7588	0.61	498	10117	0.82	664	12647	1.02	830	15176	1.23	996	50587	4.10	3319	1.78%
T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast	Nos.	4317	0.12	97	6475	0.18	145	8634	0.24	193	10792	0.30	241	12950	0.36	290	43168	1.19	965	0.52%
Efficient ceiling fans to replace conventional ceiling fans	Nos.	2447	0.05	42	3671	0.08	62	4894	0.10	83	6118	0.13	104	7341	0.15	125	24472	0.51	416	0.22%
Replacement of conventional air-conditioners with EE star rated ACs.	Nos.	2477	1.69	1372	3715	2.54	2058	4953	3.39	2744	6192	4.24	3430	7430	5.08	4117	24767	16.94	13722	7.36%
Replacement of conventional refrigerators with EE star rated refrigerators	Nos.	664	0.31	255	996	0.47	382	1328	0.63	510	1660	0.79	637	1992	0.94	765	6640	3.15	2549	1.37%
Replacement of conventional water pumps with EE water pumps	Nos.	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0	0.00	0	0.00%
Total for Commercial Sector			2.59	2097		3.88	3146		5.18	4194		6.47	5243		7.77	6291		25.89	20971	11.25%
EE Strategy for Industrial Sector																				
Replacement of 100 watt incandescent with 15 watt CFL	Nos.	1451	0.31	254	2176	0.47	381	2901	0.63	508	3626	0.78	634	4352	0.94	761	14505	3.13	2538	1.36%
Replacement of T12/T8 tubelights with T5 tube lights	Nos.	3991	0.14	114	5986	0.21	171	7982	0.28	228	9977	0.35	285	11973	0.42	342	39909	1.41	1140	0.61%
Replacement of conventional fans with EE star rated fans	Nos.	2681	0.05	42	4021	0.08	63	5362	0.10	83	6702	0.13	104	8042	0.15	125	26808	0.51	417	0.22%
Replacement of conventional AC with EE star rated AC	Nos.	216	0.07	60	324	0.11	90	433	0.15	120	541	0.18	150	649	0.22	180	2163	0.74	599	0.32%
Total for Industrial Sector			0.58	469		0.87	704		1.16	939		1.45	1173		1.74	1408		5.79	4694	2.52%
EE Strategy for Municipal Sector																				
Replacement of 150 watt HPSV with 56 watt LED	Nos.	3008	1.24	1003.05	4512	1.86	1504.57	6015	2.48	2006.09	7519	3.10	2507.62	9023	3.71	3009.14	30077	12.38	10030	5.38%
100% timer based operation and installation of power saver	Nos.	23	0.54	440	34	0.82	660	45	1.09	880	56	1.36	1100	68	1.63	1321	226	5.43	4402	2.36%
Proper pump-system design (efficient Pump, pumps heads with system h	Nos.	0	0.40	324	0	0.60	486	0	0.80	648	0	1.00	810	0	1.20	972	0	4.00	3242	1.74%
Installation of variable speed drivers	Nos.	0	0.10	81	0	0.15	122	0	0.20	162	0	0.25	203	0	0.30	243	0	1.00	810	0.43%
Standard/Recommended Condition	Nos.	0	0.30	243	0	0.45	365	0	0.60	486	0	0.75	608	0	0.90	729	0	3.00	2431	1.30%
Proper pump-system design (efficient Pump, pumps heads with system h	Nos.	0	0.02	16	0	0.03	23	0	0.04	31	0	0.05	39	0	0.06	47	0	0.19	156	0.08%
Installation of variable speed drivers	Nos.	0	0.00	4	0	0.01	6	0	0.01	8	0	0.01	10	0	0.01	12	0	0.05	39	0.02%
Standard/Recommended Condition	Nos.	0	0.01	12	0	0.02	17	0	0.03	23	0	0.04	29	0	0.04	35	0	0.14	117	0.06%
Total for Municipal Sector			2.62	2123		3.93	3184		5.24	4245		6.55	5307		7.86	6368		26.21	21226	11.39%
Total for EE Strategy			17	13603		25	20405		34	27206		42	34008		50	40809		168	136032	73%
RE and EE Combined Strategy			28	24040		57	47611		62	52238		82	69456		85	79639		313	265464	136%

6.2. Physical Target and Action Plan

The Master Plan for developing Thane as Solar City sets a target of installing 3.38 MLD capacity Solar water heater with a collector capacity of 67600 sqm, 25.80MWp cumulative solar PV systems, 525CuM Biogas systems, 2.03MWe waste to energy projects and 6201 nos. solar cookers. A list of renewable energy equipments and energy efficient devices has been presented in the table below.

Table 97 : Physical target of RE systems and EE devices

Renewable Energy Devices proposed		
Domestic Solar Water Heating System (100/125LPD system)	25449	Nos.
x 1000 LPD solar water heating system	2041	Nos.

Solar cookers (Box and dish type)	6878	Nos.
Community Solar Cooker	77	Nos.
Solar lanterns	688	Nos.
Use Solar Home Systems (SHS)	688	Nos.
0.25 - 1.0kWp Solar PV system for inverters	37120	Nos.
x 10kWp PV Power Plant for diesel abatement	951	Nos.
x 10CuM Biogas system from organic/food waste	67	Nos.
Solar Street Light	6473	Nos.
Solar PV Traffic Lights	16	Nos.
Solar Blinkers (37Wp)	50	Nos.
Road Stud	3750	Nos.
Solar PV Pumps	50	Nos.
Waste to Energy Power Plant	3	Nos.
Energy Efficient Devices proposed		
CFLs	235669	Nos.
T5 tube light + Electronic Ballast to replace	594806	Nos.
Efficient ceiling fans	306628	Nos.
Star rated ACs	64759	Nos.
Star rated refrigerators	85737	Nos.
Star rated water pumps	963	Nos.
56 watt LED	30077	Nos.
Power saver	226	Nos.

Table 98 : Physical Target and x` Action Plan (Please zoom in for betterview)

Physical Target and Action Plan

Physical Target and Action Plan for achieving the set goals & expected GHG abatements	Unit capacity	Unit	Cumulative Nos.	Agrregate Capacity	Unit	Target for the year 1	Target for the year 2	Target for the year 3	Target for the year 4	Target for the year 5	Total Energy Savings	% of savings target to achieve	Emission reduction / year
Establishment of a "Solar City Cell" within Agra City	1	No.	1	1	No.	1	0	0	0	0	0	0	0
Awaremness and Publicity													
Publicity through electronic media	1	No.	15	15	No.	4	4	3	2	2	0	0	0
Print Media/Publication	1	No.	30	30	No.	9	9	6	3	3	0	0	0
Exhibitions, Outdoor Publicity, Campaign	1	No.	50	50	No.	15	15	10	5	5	0	0	0
Workshops and Seminars	1	No.	10	10	No.	3	3	2	1	1	0	0	0
Renewable Energy Strategy													
RE Strategy for Residential Sector													
Installation of Solar Water Heating System (100/125LPD system)	100	LPD	25449	2544890	LPD	254489	381733	508978	636222	763467	40.08	17.42%	32466
Use of Solar cookers (Box and dish type)	1	No.	6878	6878	Nos.	688	1032	1376	1720	2063	7.00	3.04%	1680
Solar lanterns to replace kerosene lamps	10	Wp	688	7	kWp	1	1	1	2	2	0.25	0.11%	63
Use Solar Home Systems (SHS)	74	Wp	688	51	kWp	5	8	10	13	15	1.09	0.47%	275
Using Solar PV for Home Inverters	0.25	kWp	26825	6706	kWp	671	1006	1341	1677	2012	10.06	4.37%	8148
Using Solar PV for replacement of DG/ Kerosene Generator sets	1	kWp	9285	9285	kWp	929	1393	1857	2321	2786	13.93	6.05%	28302
Solar Water Heater Systems for Residential Apartment Complex	1	LPD	1600000	1600000	LPD	160000	240000	320000	400000	480000	18.90	8.21%	16000
Solar PV Power Pack for Residential Apartment Complex	1	kWp	8000	8000	kWp	800	1200	1600	2000	2400	12.00	5.22%	9720
Total for Residential Sector											103.30	44.90%	96654
RE Strategy for Commercial Sector													
Solar Cooker for mid-day meal in schools	1	No.	77	77	Nos.	8	12	15	19	23	0.16	0.07%	38
Solar Water Heaters for Hotels, Restaurants, Hospitals and Institutes	1	LPD	400644	400644	LPD	40064	60097	80129	100161	120193	4.73	2.06%	4006
Solar PV Power Plant for Hotels, Restaurants, Hospitals and Institutes	1	kWp	715	715	kWp	72	107	143	179	215	1.07	0.47%	873
Biogas for Hotels and Restaurants	1	CuM	674	674	CuM	67	101	135	169	202	1.43	0.62%	60
Total for Commercial & Institutional Sector											7.39	3.21%	4977
RE Strategy for Industrial sector													
Solar Water Heaters for Industries	1	LPD	40815	40815	LPD	4081	6122	8163	10204	12244	0.48	0.21%	408
Solar PV Power Plant, Inverter etc	1	kWp	785	785	kWp	79	118	157	196	236	1.18	0.51%	958
Biogas system from organic/food waste	1	CuM	0	0	CuM	0	0	0	0	0	0.00	0.00%	0
Total for Industrial Sector											1.66	0.72%	1366
RE Strategy for Municpal Sector													
50kWp PV Power Plant for Municipal and other Office Buildings	50	kWp	10	500	kWp	50	75	100	125	150	0.75	0.33%	610
LED based Solar Street Light	40	Wp	5013	201	kWp	20	30	40	50	60	0.30	0.13%	244
Solar PV Traffic Lights	148	Wp	16	2	kWp	0	0	0	1	1	0.00	0.00%	3
Solar Blinkers (37Wp)	37	Wp	50	2	kWp	0	0	0	0	1	0.00	0.00%	2
Road Stud @ 1 stud in 2m for 50% of 91km main road	1	No.	3750	11	kWp	1	2	2	3	3	0.02	0.01%	14
Outdoor lights for Parks	74	Wp	1460	108	kWp	11	16	22	27	32	0.16	0.07%	132
Solar Pumps for Parks	1	kWp	50	50	kWp	5	7	10	12	15	0.07	0.03%	60
PV system for Inverters in the market shops	0.25	kWp	225	56	kWp	6	8	11	14	17	0.38	0.16%	305
Waste to Energy Potential for thermo-chemical conversion	2.33	MWe	1	2.33	MWe	0	2.33	0.00	0.00	0	14.26	6.20%	11551
Waste to Energy Potential for bio-methanation	0.84	MWe	1	0.84	MWe	0	0.00	0.84	0.00	0	5.13	2.23%	4158
Liquid Waste to Energy Potential from Sewage Treatment Plant (STP)	1.88	MWe	1	1.88	MWe	0	0.00	0.00	1.88	0	11.55	5.02%	9356
Total for Municipal Sector											32.63	14.18%	26435
Total for RE strategy											144.99	63.01%	129432
Energy Efficiency Strategy													
EE Strategy for Residential sector													
Replace Incandescent Lamps with Fluorescent	1	No.	170576	170576	Nos.	17058	25586	34115	42644	51173	16.81	7.31%	13616
T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast	1	No.	511729	511729	Nos.	51173	76759	102346	127932	153519	17.18	7.47%	13919
Efficient ceiling fans to replace conventional ceiling fans	1	No.	255349	255349	Nos.	25535	38302	51070	63837	76605	12.58	5.47%	10192
Replacement of conventional air-conditioners with EE star rated ACs:	1	No.	37829	37829	Nos.	3783	5674	7566	9457	11349	25.88	11.25%	20959
Replacement of conventional refrigerators with EE star rated refrigerators	1	No.	79098	79098	Nos.	7910	11865	15820	19774	23729	37.49	16.29%	30369
Replacement of conventional water pumps with EE water pumps	1	No.	963	963	Nos.	96	144	193	241	289	0.11	0.05%	85
Total for Residential Sector											110.05	47.83%	89140
EE Strategy for Commercial Sector													
Replace Incandescent Lamps with Fluorescent	1	No.	50587	50587	Nos.	5059	7588	10117	12647	15176	4.10	1.78%	3319
T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast	1	No.	43168	43168	Nos.	4317	6475	8634	10792	12950	1.19	0.52%	965
Efficient ceiling fans to replace conventional ceiling fans	1	No.	24472	24472	Nos.	2447	3671	4894	6118	7341	0.51	0.22%	416
Replacement of conventional air-conditioners with EE star rated ACs:	1	No.	24767	24767	Nos.	2477	3715	4953	6192	7430	16.94	7.36%	13722
Replacement of conventional refrigerators with EE star rated refrigerators	1	No.	6640	6640	Nos.	664	996	1328	1660	1992	3.15	1.37%	2549
Replacement of conventional water pumps with EE water pumps	1	No.	0	0	Nos.	0	0	0	0	0	0.00	0.00%	0
Total for Commercial Sector											25.89	11.25%	20971
EE Strategy for Industrial Sector													
Replacement of 100 watt incandescent with 15 watt CFL	1	No.	14505	14505	Nos.	1451	2176	2901	3626	4352	3.13	1.36%	2538
Replacement of T12/T8 tubelights with T5 tube lights	1	No.	39909	39909	Nos.	3991	5986	7982	9977	11973	1.41	0.61%	1140
Replacement of conventional fans with EE star rated fans	1	No.	26808	26808	Nos.	2681	4021	5362	6702	8042	0.51	0.22%	417
Replacement of conventional AC with EE star rated AC	1	No.	2163	2163	Nos.	216	324	433	541	649	0.74	0.32%	599
Total for Industrial Sector											5.79	2.52%	4694
EE Strategy for Municipal Sector													
Replacement of 150 watt HPSV with 56 watt LED	1	No.	30077	30077	Nos.	3008	4512	6015	7519	9023	12.38	5.38%	10030
100% timer based operation and installation of power saver	1	No.	226	226	Nos.	23	34	45	56	68	5.43	2.36%	4402
Proper pump-system design (efficient Pump, pumps heads with system he	1	No.	0	0	Nos.	0	0	0	0	0	4.00	1.74%	3242
Installation of variable speed drivers	1	No.	0	0	Nos.	0	0	0	0	0	1.00	0.43%	810
Standard/Recommended Condition	1	No.	0	0	Nos.	0	0	0	0	0	3.00	1.30%	2431
Proper pump-system design (efficient Pump, pumps heads with system he	1	No.	0	0	Nos.	0	0	0	0	0	0.19	0.08%	156
Installation of variable speed drivers	1	No.	0	0	Nos.	0	0	0	0	0	0.05	0.02%	39
Standard/Recommended Condition	1	No.	0	0	Nos.	0	0	0	0	0	0.14	0.06%	117
Total for Municipal Sector											26.21	11.39%	21226
Total for EE Strategy											167.94	72.99%	136032
RE and EE Combined Strategy											312.93	136.00%	265464

6.3. Implementation Strategy

6.3.1. Establishment of the Solar City Cell

The Solar City Cell is a very integral component of the MNRE's Development of Solar Cities" Scheme. The basic purpose of establishing a Solar City cell is to ensure the parallel set up of a local site for exchange and collection of relevant data for sustenance, promotion and awareness generation of renewable energy and energy efficiency at the local level. The solar city cell will be the focal point and critical player for implementation of the solar city development programme. Solar City Cell will be established within the Thane Municipal Corporation and will function under the full administration of the Thane Municipal Corporation and the Council Chairman will be the highest level authorizing personnel. A senior technical officer at the level of executive engineer or above will be the overall in charge of the solar city cell. The officer in-charge will prepare all strategy and functioning modalities of the solar city cell. A full time technical expert will be associated to the Solar City Cell for day-to-day activities, documentation, communication and every other activity under Solar City Cell. The Solar City Cell will provide technical guidance, expertise and financial analyses of projects for potential investors- individual or companies. It will also help for customer outreach. It will act as a platform where all relevant stakeholders (citizens/manufacturers /banks/institutions etc.) can meet and exchange information on RE and EE.

The Ministry of New and Renewable Energy, Government of India will provide Rs.10.00 Lakh (Rupees ten lakh only) for the establishment and operation the solar city cell for five years. The Thane Municipal Corporation will provide space for the cell and depute one senior engineer/ technical person of the level of executive engineer or above as an overall in-charge of the solar city cell. The detailed functions and modus operandi of the solar city cell is elaborated in the guidebook for development of solar city, which is an integral part of this master plan.

6.3.2. Awareness and Publicity

Awareness and Publicity Programme will be taken up to creating awareness among mass and target sectors in the city about benefits and financial incentive for targeted Renewable Energy systems & devices. Under these programmes, information on technological developments, financial benefits and cost savings from RE system and EE measures, government initiatives and incentives for such devices/ measures, availability, price etc will be disseminated through various media. The Solar City Cell will primarily take up these programmes. MNRE has earmarked Rs.20.00 lakh (Rupees twenty lakh) for each city for awareness and publicity activities under the solar city development programme. The following activities are proposed for creation of awareness and publicity.

(i) Publicity through electronic media

- Production and telecast of documentary films, short duration films, TV spots/advertisements etc through local TV network
- Production and broadcast of Radio sponsored programmes, Radio Spots/jingles and Radio Talks etc. through local FM channels

- Creating an interactive E-Commerce website exclusively for "Thane Solar City" for awareness campaigns, information sharing and support to the users for submission of online application for incentives etc.

(ii) Print Media/Publication

- Advertisements in colour and black & white in Newspapers/magazines/journals etc.
- Printing of booklets/folders/brochures/posters/calendars/Trade Guide/ Compendium/ Newsletters etc. on different promotional schemes under Thane Solar City project.
- Develop educational programs on energy efficiency, distributed generation, and renewable energy systems in buildings for homeowners, businesses, government staff, and those in the building industries.

(iii) Exhibitions, Outdoor Publicity, Campaign

- Use of Exhibitions and Outdoor Publicity activities like hoardings, kiosks, bus panels, bus-stop shelters, wall paintings, computerized animation display systems, etc. in the city.
- Display and demonstration of RE and EE equipments in the Solar City Cell.
- Organizing runs, debates, seminars, quiz, drawing, model making, poster, essay and slogan writing competitions among others for school children and others;
- Promotion and publicity of RE and EE by displaying models and posters etc in different public places, institutions/organizations, hospitals, bus stand etc.
- Encourage maximum participation by residents and business owners in the City's energy efficiency programs through marketing and education.
- Educate government purchasing agents in each City department regarding the benefits of Energy Star rated equipment, including the cost savings to the city.
- Encourage community input on strategies for improving energy efficiency in building.

(iv) Workshops and Seminars

It is proposed to organize workshops and seminars on specific technologies for targeted audiences from residential, commercial, Institutional, Industrial and Municipal Sectors.

6.3.3. Implementation of RE Strategy

The solar city development programme will be implemented through joint participation of the residential citizens of the Thane city, industries, commercial and institutional establishment, city municipal corporation, state government and Ministry of New and Renewable Energy. Financial assistance for installation of various renewable energy devices and systems will be availed as per the provisions of various schemes of the Ministry. Support for various other activities will also be availed as per the scheme provisions of MNRE. The ministry will give priority for support to the cities identified as potential Solar Cities. The Ministry, IREDA and other implementing institutions for promoting the use of renewable energy devices/systems, will consider these cities as priority cities. State Nodal Agency may also request the Ministry to allocate higher targets for installation of various renewable energy devices/systems in these cities under its different schemes through subsidies. Ministry of Urban Development would also be approached for assistance under their schemes

e.g., JNNURM, etc., as well as the Bureau of Energy Efficiency. The following activities are proposed to promote use of renewable energy and energy efficiency measures among different section of people, commercial establishment, institutions, municipality and industries.

(I) Show casing and promotion of different MNRE programmes through different audiovisual publicity, workshop, exhibition, campaign etc.

(II) Establishment of single window clearance mechanism to avail all government incentives. The Solar city cell can be used as a single point contact and clearance centre for all kinds of promotional activities and subsidies for RE and EE devices.

(III) Creation of interactive web based tool for accepting application for availing incentives from MNRE/ State/ City

(IV) Providing technical assistance to project developers in site assessment, feasibility and detailed project report preparation.

(V) Providing assistance in conducting energy audit

(VI) Involvement of financial institution/ IREDA for providing soft loan for large scale promotion of RE projects.

(VII) Setting up of a high level committee including city administration, state nodal agency, developers, MNRE, RE/ EE experts, Finance institution stakeholders from different sectors to oversee and review implementation of the Master Plan

(VIII) Provide additional subsidy/ incentives for those systems which have payback period more that 3 years

(IX) Amend building bye-laws for making the use of solar water heating systems mandatory

(X) Provide rebate in property tax through Municipal Corporations/ Municipalities & in electricity tariff though Utilities/ Electricity Boards to the users of solar water heaters especially in domestic sector.

(XI) Comply MSW Rules 2000 notified by the MoEF and set up projects of suitable capacity for generating energy from the waste collected from the city/town.

(XII) Conduct energy auditing of Govt./Public sector buildings, water pumping and street lightings in the city at regular interval and take necessary steps towards conservation of energy for the same.

(XIII) Issue G.O as regards to construction of energy efficient solar buildings at least in Govt. /Public sectors in accordance with ECBC : 2006 and follow up its implementation rigorously.

(XIV) Organize rigorous publicity, and also the training programmes/ business meets for various stake holders e.g. architects, engineers, builders & developers, financial institutions, NGOs, technical institutions, manufactures/suppliers, RWAs etc. so as to involve them actively in meeting the objective of solar city.

(XV) Generate necessary funds from State Govt. and other funding organizations for achieving the objective of making the city as "Solar City". Benefits of the schemes of Govt. of India will also be taken in meeting the objectives.

(XVI) Promote National Rating System for construction of energy efficient Green Buildings in particular to commercial and institutional buildings

(XVII) Avail financial benefit from Carbon Market

6.3.4. Renewable Energy Pilot Projects

MNRE will provide financial assistance for implementation of pilot projects in all the sectors. Five categories of projects in different RE technologies are proposed in each sector. It is proposed that MNRE will provide financial assistance to meet 75% of the project cost, TMC/ State will support 15% and users will contribute 10% project cost. The total investment for implementation of all proposed pilot projects is estimated as Rs.311.59Lakh out of which MNRE will contribute Rs.233.69Lakh, City/ Sate will contribute Rs.46.74Lakh and the users will contribute Rs.31.16Lakh. All the pilot projects shall be executed in the first year of implementation. All the pilot projects shall be executed in the first year of implementation. The following tables show pilot projects proposed and financial implication thereon in different sectors in the city.

Table 99 : Pilot Projects in Residential Sector

Sl. No.	Proposed Pilot Projects	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Solar lanterns for roadside markets/ hawkers to replace kerosene lamps	10	Wp	100	0.03	3.00	2.25	0.45	0.30
2	PV system for Home inverter	250	Wp	10	0.30	3.00	2.25	0.45	0.30
3	PV system to replace Home Generator	1	kWp	5	2.00	10.00	7.50	1.50	1.00
4	Solar Water Heating System for residential Apartment Complex	5000	LPD	2	5.00	10.00	7.50	1.50	1.00
5	PV Power Plant for residential apartment Complex	25	kWp	2	30.00	60.00	45.00	9.00	6.00
	Total					86.00	64.50	12.90	8.60

Table 100 : Pilot Projects in Commercial and Institutional Sector

Sl. No.	Project	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Community Solar Cooker for mid day meal in schools	1	No.	10	0.20	2.00	1.50	0.30	0.20
2	Solar Water hearts for Hospitals	5000	LPD	2	5.00	10.00	7.50	1.50	1.00
3	Biogas system for Restaurants	10	CuM	2	0.50	1.00	0.75	0.15	0.10
4	Solar Water Heater for Restaurants	5000	LPD	2	5.00	10.00	7.50	1.50	1.00
5	PV system for educational institutes	6	kWp	2	12.91	25.82	19.36	3.87	2.58

	Total					48.82	36.61	7.32	4.88

Table 101 : Pilot Projects in Industrial Sector

Sl. No.	Project	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Biogas system for restaurants	10	CuM	5	2.00	10.00	7.50	1.50	1.00
2	PV System for Leather Industries	1	kWp	2	2.00	4.00	3.00	0.60	0.40
3	Solar Water Heaters for Food processing	2000	LPD	2	2.00	4.00	3.00	0.60	0.40
4	Solar PV system for Garment Industry	0.5	kWp	2	1.00	2.00	1.50	0.30	0.20
5	Solar steam generator process heating	1	Nos.	2	1.00	2.00	1.50	0.30	0.20
	Total					22.00	16.50	3.30	2.20

Table 102 : Pilot Projects in Municipal Sector

Sl. No.	Project	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Solar PV power plant for Municipal building/ bus stand	25	kWp	2	50.00	100.00	75.00	15.00	10.00
2	Solar Streetlights/ traffic lights/ blinkers	74	Wp	100	0.20	20.00	15.00	3.00	2.00
3	Solar PV system for markets	500	Wp	5	0.60	3.00	2.25	0.45	0.30
4	Outdoor PV systems for Municipal Parks	1	No.	2	8.39	16.78	12.58	2.52	1.68
5	Solar Hoardings	1	No.	10	1.50	15.00	11.25	2.25	1.50
	Total					154.78	116.08	23.22	15.48

Table 103 : Summary of Pilot Projects and indicative project cost implication

Sl. No.	Project	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Pilot Project in Residential Sector	86.00	64.50	12.90	8.60
2	Pilot Projects in Commercial & Institutional Sector	48.82	36.61	7.32	4.88
3	Pilot Projects in Industrial Sector	22.00	16.50	3.30	2.20
4	Pilot Projects in municipal Sector	154.78	116.08	23.22	15.48
	Total	**311.59**	**233.69**	**46.74**	**31.16**

6.4. Financial outlays and sharing of fund

The total indicative budget for development of Thane as Solar City is estimated at Rs.668.71 crore which will be invested over the 5 years of implementation period of solar city development programme. The total budget will be shared by the state government/ City authority (5%), MNRE (33%) and the private users (62%). The budget for implementation of RE strategy and EE strategy is estimated at Rs.463.87 crore and is Rs.191.43 crore respectively. Budget for establishment of the Solar City Cell and awareness and publicity is estimated at Rs.48.30 Lakhs which could be enhanced depending upon the requirement. While budget for RE strategy will be shared among MNRE, state/city and private users, private investors will primarily drive EE activities. A substantial amount of investment could be recovered or the entire project could be partially financed through carbon finance mechanism. A suitable methodology will be adopted to avail benefit from carbon market selling the CER generated from the project.

Table 104 : Sharing of budget for development of Thane Solar City

	Year 1 (Crore)	Year 2 (Crore)	Year 3 (Crore)	Year 4 (Crore)	Year 5 (Crore)	Total (Crore)
State / City Share	14.36	21.54	28.72	35.89	43.07	143.58
MNRE Share	65.96	105.84	133.43	168.42	197.58	671.24
Private Share	90.69	145.33	184.72	234.25	272.06	927.06
Total Budget	171.01	272.71	346.88	438.57	512.72	1741.88

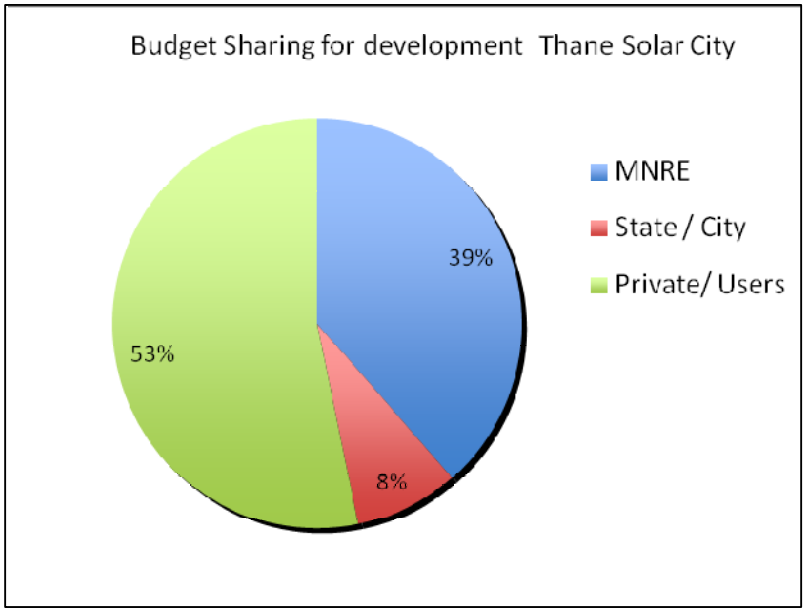


Figure 20 : Sharing of total budget for development of solar city Thane

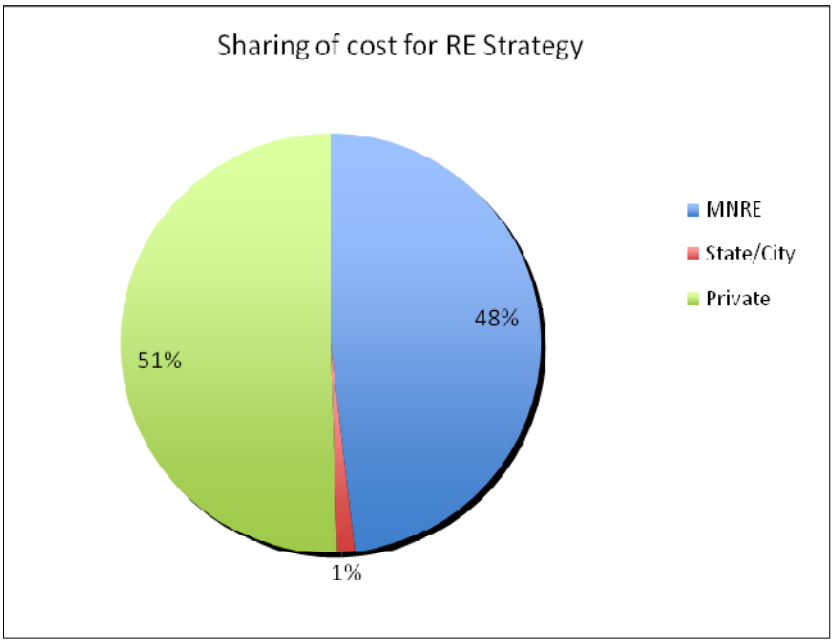


Figure 21 : Sharing of RE Strategy Budget for Thane Solar City

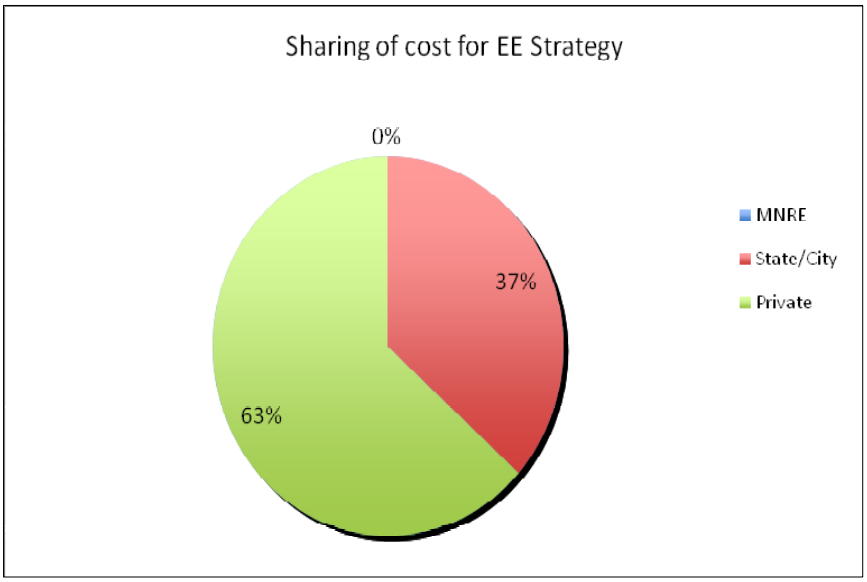


Figure 22 : Sharing of EE Strategy Budget for Thane Solar City

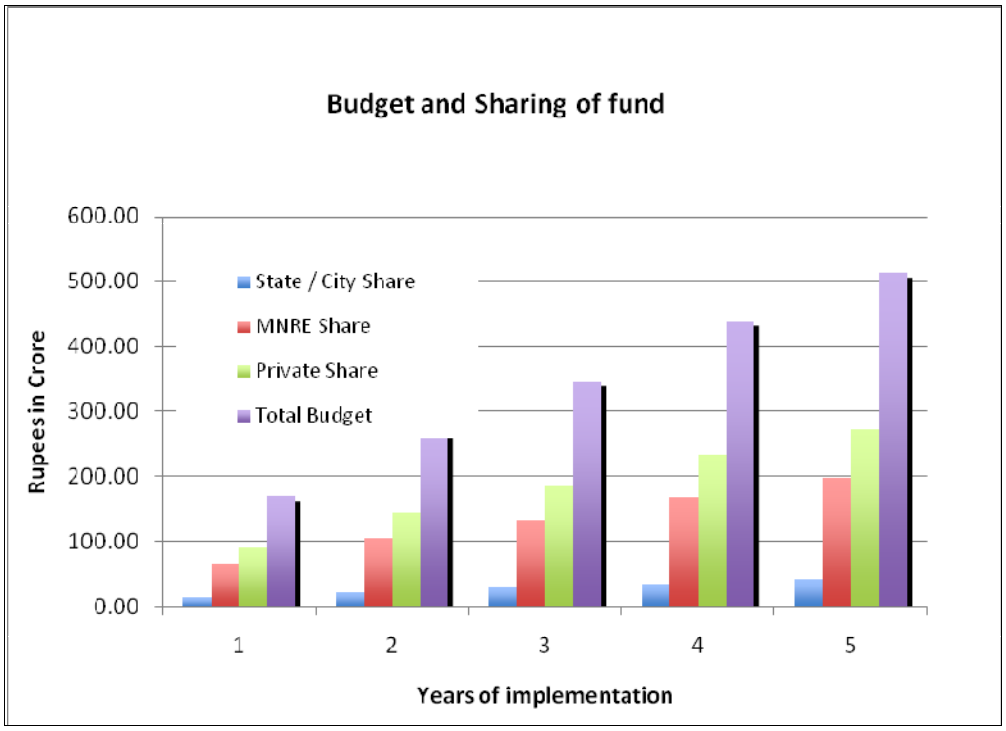


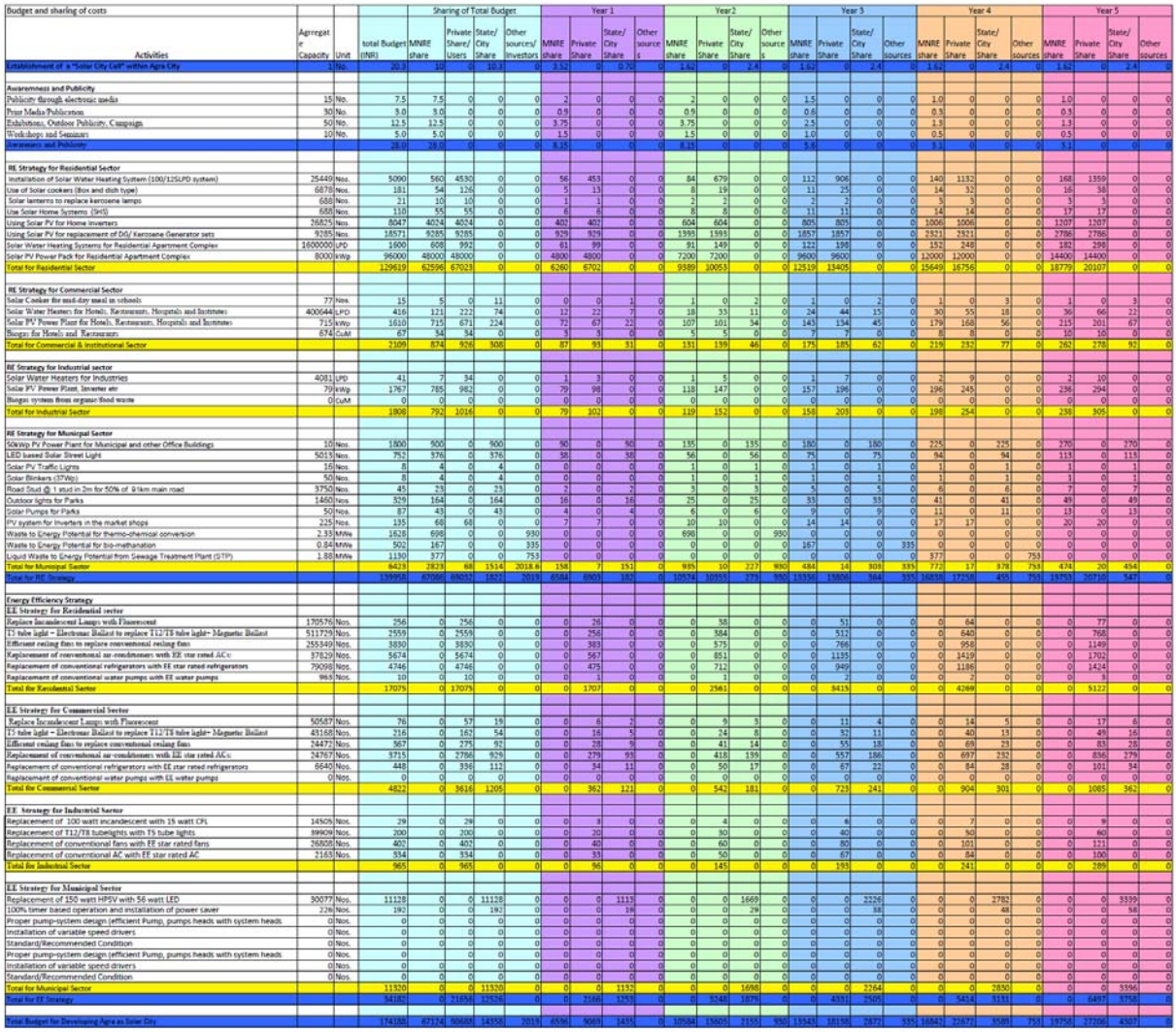
Figure 23 : Year wise sharing of budget for Thane Solar City Programme

Table 105 : Sector wise total budget and annual expenses

	Unit	Total		Year 1	Year 2	Year 3	Year 4	Year 5
MNRE contribution for RE strategy								
Establishment of Solar city cell	Lakh	10.00		3.52	1.62	1.62	1.62	1.62
Publicity and awareness	Lakh	28.00		8.15	8.15	5.60	3.05	3.05
RE for residential sector	Lakh	62596.47		6259.65	9389.47	12519.29	15649.12	18778.94
RE for Commercial & Inst. sector	Lakh	874.40		87.44	131.16	174.88	218.60	262.32
RE for Industrial sector	Lakh	792.00		79.20	118.80	158.40	198.00	237.60
RE for Municipal sector	Lakh	1581.18		158.12	237.18	316.24	395.29	474.35
W2E Project form MSW & STPs	Lakh	1241.86		0.00	697.67	167.44	376.74	0.00
MNRE		67123.91	38.54 %	6596.08	10584.05	13343.47	16842.43	19757.89
State/city contribution								
Establishment of solar city cell		10.30		0.70	2.40	2.40	2.40	2.40
RE for Institutional sector	Lakh	308.21		30.82	46.23	61.64	77.05	92.46
RE for Municipal sector	Lakh	1513.68		151.37	227.05	302.74	378.42	454.10
EE measures for Inst. sector		1205.49		120.55	180.82	241.10	301.37	361.65
EE measures for Municipal sector		11320.23		1132.02	1698.03	2264.05	2830.06	3396.07

State / City		14357.91	8.24%	1435.79	2153.69	2871.58	3589.48	4307.37
Private/ Users contribution								
RE for residential sector	Lakh	67022.71		6702.27	10053.41	13404.54	16755.68	20106.81
RE for Commercial & Inst. sector	Lakh	926.01		92.60	138.90	185.20	231.50	277.80
RE for Industrial sector	Lakh	1015.67		101.57	152.35	203.13	253.92	304.70
RE for Municipal sector	Lakh	67.50		6.75	10.13	13.50	16.88	20.25
EE for Residential sector	Lakh	17074.66		1707.47	2561.20	3414.93	4268.67	5122.40
EE for Commercial & Inst. sector	Lakh	3616.47		361.65	542.47	723.29	904.12	1084.94
EE measures for Industrial sector	Lakh	964.84		96.48	144.73	192.97	241.21	289.45
Private Investor for W2E projects	Lakh	2018.60		0.00	930.23	334.88	753.49	0.00
Private/ Users		92706.46	53.22 %	9068.79	14533.41	18472.46	23425.45	27206.36
Total	Lakh	174188.29		17418.83	26128.24	34837.66	43547.07	52256.49

Table 106 : Budget and Sharing of fund (Please zoom in for better view)



Budget and sharing of costs				Sharing of Total Budget				Year 1				Year2				Year 3				Year 4				Year 5			
Activities	Agregate Capacity	Unit	total Budget (INR)	MNRE share	Private Share/ Users	State/ City Share	Other sources/ investors	MNRE share	Private Share	State/ City Share	Other sources	MNRE share	Private Share	State/ City Share	Other sources	MNRE share	Private Share	State/ City Share	Other sources	MNRE share	Private Share	State/ City Share	Other sources	MNRE share	Private Share	State/ City Share	Other sources
Establishment of a "Solar City Cell" within Agra City	1	No.	20.3	10	0	10.3	0	3.52	0	0.75	0	1.62	0	2.4	0	1.62	0	2.4	0	1.62	0	2.4	0	1.62	0	2.4	0
Awaremness and Publicity																											
Publicity through electronic media	15	No.	7.5	7.5	0	0	0	2	0	0	0	2	0	0	0	1.5	0	0	0	1.0	0	0	0	1.0	0	0	0
Print Media Publication	30	No.	3.0	3.0	0	0	0	0.9	0	0	0	0.9	0	0	0	0.6	0	0	0	0.3	0	0	0	0.3	0	0	0
Exhibitions, Outdoor Publicity, Campaign	50	No.	12.5	12.5	0	0	0	3.75	0	0	0	3.75	0	0	0	2.5	0	0	0	1.3	0	0	0	1.3	0	0	0
Workshops and Seminars	10	No.	5.0	5.0	0	0	0	1.5	0	0	0	1.5	0	0	0	1.0	0	0	0	0.5	0	0	0	0.5	0	0	0
Strategies and Policies			28.0	28.0	0	0	0	8.15	0	0	0	8.15	0	0	0	5.6	0	0	0	3.1	0	0	0	3.1	0	0	0
RE Strategy for Residential Sector																											
Installation of Solar Water Heating System (100/125LPD system)	25449	Nos.	5090	560	4530	0	0	56	453	0	0	84	679	0	0	112	906	0	0	140	1132	0	0	168	1359	0	0
Use of Solar cookers (Box and dish type)	6878	Nos.	181	54	126	0	0	5	13	0	0	8	19	0	0	11	25	0	0	14	32	0	0	16	38	0	0
Solar lanterns to replace kerosene lamps	688	Nos.	21	10	10	0	0	1	1	0	0	2	2	0	0	2	2	0	0	3	3	0	0	3	3	0	0
Use Solar Home Systems (SHS)	688	Nos.	110	55	55	0	0	6	6	0	0	8	8	0	0	11	11	0	0	14	14	0	0	17	17	0	0
Using Solar PV for Home Inverters	26825	Nos.	8047	4024	4024	0	0	402	402	0	0	604	604	0	0	805	805	0	0	1006	1006	0	0	1207	1207	0	0
Using Solar PV for replacement of DG/ Kerosene Generator sets	9285	Nos.	18571	9285	9285	0	0	929	929	0	0	1393	1393	0	0	1857	1857	0	0	2321	2321	0	0	2786	2786	0	0
Solar Water Heating Systems for Residential Apartment Complex	1600000	LPD	1600	608	992	0	0	61	99	0	0	91	149	0	0	122	198	0	0	152	248	0	0	182	298	0	0
Solar PV Power Pack for Residential Apartment Complex	8000	kWp	96000	48000	48000	0	0	4800	4800	0	0	7200	7200	0	0	9600	9600	0	0	12000	12000	0	0	14400	14400	0	0
Total for Residential Sector			129619	62596	67023	0	0	6260	6702	0	0	9389	10055	0	0	12519	13405	0	0	15649	16756	0	0	18779	20107	0	0
RE Strategy for Commercial Sector																											
Solar Cooker for mid-day meal in schools	77	Nos.	15	5	0	11	0	0	0	1	0	1	0	2	0	1	0	2	0	1	0	3	0	1	0	3	0
Solar Water Heaters for Hotels, Restaurants, Hospitals and Institutes	400644	LPD	416	121	222	74	0	12	22	7	0	18	33	11	0	24	44	15	0	30	55	18	0	36	66	22	0
Solar PV Power Plant for Hotels, Restaurants, Hospitals and Institutes	715	kWp	1610	715	671	224	0	72	67	22	0	107	101	34	0	143	134	45	0	179	168	56	0	215	201	67	0
Biogas for Hotels and Restaurant	674	CuM	67	34	34	0	0	3	3	0	0	5	5	0	0	7	7	0	0	8	8	0	0	10	10	0	0
Total for Commercial & Institutional Sector			2109	874	926	308	0	87	93	31	0	131	139	46	0	175	185	62	0	219	232	77	0	262	278	92	0
RE Strategy for Industrial sector																											
Solar Water Heaters for Industries	4081	LPD	41	7	34	0	0	1	3	0	0	1	5	0	0	1	7	0	0	2	9	0	0	2	10	0	0
Solar PV Power Plant, Inverter etc	79	kWp	1767	785	982	0	0	79	98	0	0	118	147	0	0	157	196	0	0	196	245	0	0	236	294	0	0
Biogas system from organic food waste	0	CuM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for Industrial Sector			1808	792	1016	0	0	79	102	0	0	119	152	0	0	158	203	0	0	198	254	0	0	238	305	0	0
RE Strategy for Municipal Sector																											
50Wp PV Power Plant for Municipal and other Office Buildings	10	Nos.	1800	900	0	900	0	90	0	90	0	135	0	135	0	180	0	180	0	225	0	225	0	270	0	270	0
LED based Solar Street Light	5015	Nos.	752	376	0	376	0	38	0	38	0	56	0	56	0	75	0	75	0	94	0	94	0	113	0	113	0
Solar PV Traffic Lights	16	Nos.	8	4	0	4	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
Solar Blinkers (35Wp)	50	Nos.	8	4	0	4	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0
Road Stud @ 1 stud in 2m for 50% of 9 km main road	9750	Nos.	45	23	0	23	0	2	0	2	0	3	0	3	0	5	0	5	0	6	0	6	0	7	0	7	0
Outdoor lights for Parks	1460	Nos.	329	164	0	164	0	16	0	16	0	25	0	25	0	33	0	33	0	41	0	41	0	49	0	49	0
Solar Pumps for Parks	50	Nos.	87	43	0	43	0	4	0	4	0	6	0	6	0	9	0	9	0	11	0	11	0	13	0	13	0
PV system for inverters in the market shops	225	Nos.	135	68	68	0	0	7	7	0	0	10	10	0	0	14	14	0	0	17	17	0	0	20	20	0	0
Waste to Energy Potential for thermo-chemical conversion	2.33	MWe	1628	698	0	0	930	0	0	0	0	698	0	0	930	0	0	0	0	0	0	0	0	0	0	0	0
Waste to Energy Potential for bio-methanation	0.84	MWe	502	167	0	0	335	0	0	0	0	0	0	0	0	167	0	0	335	0	0	0	0	0	0	0	0
Liquid Waste to Energy Potential from Sewage Treatment Plant (STP)	1.88	MWe	1130	377	0	0	753	0	0	0	0	0	0	0	0	0	0	0	0	377	0	0	753	0	0	0	0
Total for Municipal Sector			6423	2823	68	1514	2018	158	7	151	0	935	10	227	930	484	14	303	335	772	17	378	753	474	20	454	0
Total for RE Strategy			139959	67090	69053	1822	2018	6584	6905	183	0	10574	10955	273	930	13336	13806	364	335	16838	17258	455	753	19793	20710	547	0
Energy Efficiency Strategy																											
EE Strategy for Residential sector																											
Replace Incandescent Lamps with Fluorescent	170576	Nos.	256	0	256	0	0	0	26	0	0	0	38	0	0	0	51	0	0	0	64	0	0	0	77	0	0
T5 tube light - Electronic Ballast to replace T12/T8 tube light- Magnetic Ballast	511726	Nos.	2559	0	2559	0	0	0	256	0	0	0	384	0	0	0	512	0	0	0	640	0	0	0	768	0	0
Efficient ceiling fans to replace conventional ceiling fans	255349	Nos.	3830	0	3830	0	0	0	383	0	0	0	575	0	0	0	766	0	0	0	958	0	0	0	1149	0	0
Replacement of conventional air-conditioners with EE star rated ACs	37829	Nos.	5674	0	5674	0	0	0	567	0	0	0	851	0	0	0	1135	0	0	0	1419	0	0	0	1702	0	0
Replacement of conventional refrigerators with EE star rated refrigerators	79098	Nos.	4746	0	4746	0	0	0	475	0	0	0	712	0	0	0	949	0	0	0	1186	0	0	0	1424	0	0
Replacement of conventional water pumps with EE water pumps	963	Nos.	10	0	10	0	0	0	1	0	0	0	1	0	0	0	2	0	0	0	2	0	0	0	3	0	0
Total for Residential Sector			17075	0	17075	0	0	0	1707	0	0	0	2561	0	0	0	3415	0	0	0	4269	0	0	0	5122	0	0
EE Strategy for Commercial Sector																											
Replace Incandescent Lamps with Fluorescent	50587	Nos.	76	0	57	19	0	0	6	2	0	0	9	3	0	0	11	4	0	0	14	5	0	0	17	6	0
T5 tube light - Electronic Ballast to replace T12/T8 tube light- Magnetic Ballast	43168	Nos.	216	0	162	54	0	0	16	5	0	0	24	8	0	0	32	11	0	0	40	13	0	0	49	16	0
Efficient ceiling fans to replace conventional ceiling fans	24472	Nos.	367	0	275	92	0	0	28	9	0	0	41	14	0	0	55	18	0	0	69	23	0	0	83	28	0
Replacement of conventional air-conditioners with EE star rated ACs	24767	Nos.	3715	0	2786	929	0	0	279	93	0	0	418	139	0	0	557	186	0	0	697	232	0	0	836	279	0
Replacement of conventional refrigerators with EE star rated refrigerators	6640	Nos.	448	0	336	112	0	0	34	11	0	0	50	17	0	0	67	22	0	0	84	28	0	0	101	34	0
Replacement of conventional water pumps with EE water pumps	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for Commercial Sector			4822	0	3616	1205	0	0	362	121	0	0	542	181	0	0	723	241	0	0	904	301	0	0	1085	362	0
EE Strategy for Industrial Sector																											
Replacement of 100 watt incandescent with 15 watt CFL	14505	Nos.	29	0	29	0	0	0	3	0	0	0	4	0	0	0	6	0	0	0	7	0	0	0	9	0	0
Replacement of T12/T8 tubelights with T5 tube lights	89909	Nos.	200	0	200	0	0	0	20	0	0	0	30	0	0	0	40	0	0	0	50	0	0	0	60	0	0
Replacement of conventional fans with EE star rated fans	26808	Nos.	402	0	402	0	0	0	40	0	0	0	60	0	0	0	80	0	0	0	101	0	0	0	121	0	0
Replacement of conventional AC with EE star rated AC	2165	Nos.	334	0	334	0	0	0	33	0	0	0	50	0	0	0	67	0	0	0	84	0	0	0	100	0	0
Total for Industrial Sector			965	0	965	0	0	0	96	0	0	0	145	0	0	0	193	0	0	0	241	0	0	0	289	0	0
EE Strategy for Municipal Sector																											
Replacement of 150 watt HPSV with 56 watt LED	30077	Nos.	11128	0	0	11128	0	0	0	1113	0	0	0	1669	0	0	0	2226	0	0	0	2782	0	0	0	3399	0
100% timer based operation and installation of power saver	226	Nos.	192	0	0	192	0	0	0	19	0	0	0	29	0	0	0	38	0	0	0	48	0	0	0	58	0
Proper pump-system design (efficient Pump, pumps heads with system heads	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Installation of variable speed drivers	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standard/Recommended Condition	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Proper pump-system design (efficient Pump, pumps heads with system heads	0	Nos.	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Installation of variable speed drivers	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Standard/Recommended Condition	0	Nos.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total for Municipal Sector			11320	0	0	11320	0	0	0	1132	0	0	0	1698	0	0	0	2264	0	0	0	2830	0	0	0	3396	0
Total for EE Strategy			34142	0	21656	12525	0	0	2165	1252	0	0	3248	1879	0	0	4331	2505	0	0	5413	3131	0	0	6497	3758	0
Total Budget for Developing Agra as Solar City			174188	67724	90668	14458	2018	6596	9069	1435	0	10584	15605	2155	930	15543	18158	2872	335	16843	22677	3589	753	19758	27706	4307	0

6.5. Potential Carbon Market Benefit

The RE and EE activities under solar city programme will considerable amount of green house emission per year. The CER generated under this project can be sold to carbon market under suitable mechanism. It is estimated that a total of 181440 CER could be sold from the project which will give a revenue of Rs.13.06 crore per year. If project life is considered 10 years, the income from carbon market will recover about 20% of the project cost.

Table 107 : Potential Carbon Market Benefit

	Energy Saved (MU)	CER (Tonnes)	Value (Lakh/year)	Project life CER	Total project cost (Lakh)	
CER from entire RE strategy	144.99	129432	931.91	6523.37	139958	4.66 %
CER from Entire EE strategy	167.94	136032	979.43	6855.99	34182	20.06%
CER from entire solar city project	312.93	265464	1911.34	13379.36	174188	7.68 %

Annexure 1 : List of Figures

Annexure 2 : List of Tables

Annexure 3 : References & Bibliography

1. "India Power Scenario", Young India Inc
2. http://maps.grida.no/go/graphic/natural-resource-solar-power-potential, 11.08.09, map credit: Hugo Althenius, UNEP/GRID – Arendal
3. http://www.igreenspot.com/solar-powered-city-concept/, 12.08.09
4. "Solar and Sustainable Cities: Renewable Energy Information on Markets, Policy, Investment and Future Pathways", Eric Martinot, http://www.martinot.info/solarcities.htm, 10.08.09
5. "India: Addressing Energy Security and Climate Change", Ministry of Environment and Forests, Ministry of Power, Bureau of Energy Efficiency, Government of India
6. http://www.indiasolar.com/ren-india.htm, 12.08.09
7. "Solar Radiation Handbook 2008", Solar Energy Centre, Ministry of New and Renewable Energy, Indian Meteorological Institute
8. http://www.mnre.gov.in/
9. Source: MSEDCL
10. Source: State oil Coordinator (HPCL, BPCL, IOCL)
11. Source: State oil Coordinator (HPCL, BPCL, IOCL)
12. Source: State oil Coordinator (HPCL, BPCL, IOCL)
13. http://www.energymanagertraining.com/DesignatedConsumers/main.htm, http://www.hindustanpetroleum.com/en/UI/AboutLPG.aspx
14. Source: MSEDCL, state oil Coordinator (HPCL, BPCL, IOCL)
15. Source: MSEDCL and State Oil Coordinator
16. Thane CDP
17. Source: http://eosweb.larc.nasa.gov/ ; http://www.mnre.gov.in/
18. Source: http://eosweb.larc.nasa.gov/
19. Source: Biomass Resource Atlas of India (http://lab.cgpl.iisc.ernet.in/Atlas/Default.aspx)
20. Source: http://mnes.nic.in/shp-state/maharashtra.htm
21. (Source: Thane Report)
22. http://www.mnre.gov.in/
23. Case-study booklet on Renewable Energy. 2009
24. Source:GEDA
25. Anil Dhussa: Presentation " Biogas in India", MeThane to Markets Partnership – Meeting of Agr. Sub-Committee April 22, 2004
26. CII. 2005. Development of small ESCOs to undertake biomass gasification projects for industrial applications. Report prepared for MNES. Confederation of Indian Industries.
27. Basic Information Sourced from: Ministry of Urban Development and Poverty Alleviation 2000.
28. (Biomethanation of Vegetable Market Waste – Untapped Carbon Trading Opportunities K. Sri Bala Kameswari, B. Velmurugan, K. Thirumaran and R.A. Ramanujam. Department of Environmental Technology, Central Leather Research Institute (CLRI), Adyar, Chennai, India Proceedings of the International Conference on Sustainable Solid Waste Management,5 - 7 September 2007, Chennai, India. Pp.415-420)
29. (Energy Revolution, Green Peace International)
30. Renewable Energy: Economic and Environmental Issues, Pimental et al)
31. (A roadmap for renewable energy risks, Lloyd).
32. Source: Green Peace

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