Deloitte.

Solar City Master Plan

for Surat

Final Report

Supported by

Ministry of New and Renewable Energy

Government of India, New Delhi

Deloitte Touche Tohmatsu India Private Limited

Acknowledgement

This Master Plan is an outcome of the Ministry of New and Renewable Energy's (MNRE) Solar City Programme, which is a part of the 11th Five Year Plan. Under this programme Deloitte Touche Tohmatsu India Private Limited (DTTIPL) was entrusted to prepare the Master Plan for Surat. DTTIPL expresses its gratitude to Surat Municipal Corporation for the extensive support and assistance they have provided during the entire period of development of this master plan. We would like to thank officials and other staff members from Surat Municipal Corporation for their consistent support in preparing and finalizing the report.

The report benefited enormously from a peer review process by a gamut of experts from DTTIPL, SMC, officials from World Business Council on Sustainable Development (WBCSD), officials of Brookhaven National Laboratory of the U.S. Department of Energy, and different stakeholders of Surat Solar City programme. We acknowledge their contributions and suggestions which streamlined the structure and composition of the master plan.

The report would not have been possible without the generous support MNRE, Government of India. We extend our gratitude to the officials of MNRE for their valuable advice and guidance during the preparation of this report.

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CDM	Clean Development Mechanism
BEE	Bureau of Energy Efficiency
CO2e	Carbon Dioxide Equivalent
CFL	Compact Fluorescent Light
DDTIPL	Deloitte Touche Tohmatsu India Pvt. Ltd.
EE	Energy Efficiency
ESCO	Energy Services Company
ETC	Evacuated Tube Collector
GEDA	Gujrat Energy Development Agency
GHG	Greenhouse Gas
JNNUSM	Jawaharlal Nehru National Solar Mission
LED	Light Emitting Diode
MNRE	Ministry of New & Renewable Energy
MSW	Municipal Solid Waste
NDNC	Non Domestic Non Commercial
RE	Renewable Energy
SNA	State Nodal Agency
RDF	Refuse Derived Fuel
SMC	Surat Municipal Corporation
ULB	Urban Local Bodies

UNITS

MWh	Megawatt hour
kV	Kilovolts
kW	Kilo Watt
kWh	Kilowatt Hour
MW	Mega Watt
MLD	Million liters per day
MU	Million Units
MTOE	Million Tonnes of Oil Equivalent
TOE	Tonnes Of Oil Equivalent
tCO^2	Tonnes of Carbon Dioxide

1 EXECUTIVE SUMMARY

There is a continuous increase in the demand for energy and associated Greenhouse Gas (GHG) emission in various sectors supporting each of the urban epicentres. With the view to reduce dependence on conventional sources of energy to meet the increasing demand, Solar City programme has been initiated by the Ministry of New and Renewable Energy (MNRE), Government of India (GoI). This programme is a part of Government of India's Eleventh Five Year Plan. The main focus of the programme is to reduce the increasing energy demand; and dependence on fossil fuels to meet this demand across different sectors in the fast urbanizing cities in the country. With an increase in population and economic activity, urban areas face a situation where there are both gross and peak energy deficits. In case of Surat City, the population is expected to rise to 5.53 million by the end of 2015-16 and 6.88 million by the end of 2020-21; whereas the gross energy demand excluding transportation sector is expected to increase by 6.17% per year to reach a value of 1.84 Million Tonnes of Oil Equivalent (MTOE) by 2015-16 and 2.37 MTOE by 2020-21.

As has been the case with the wide-scale introduction of renewable energy technologies and energy efficiency measures across the country; Surat Municipal Corporation (SMC) has taken the initiative to develop it as a Solar City. Solar City programme strives to integrate efforts in Energy Efficiency (EE) across different energy consuming sectors in the city and utilization of available Renewable Energy (RE) resources such as solar energy, wind energy, biomass, and municipal wastes to meet reduction targets as per the guidelines provided by MNRE.

The development of master plan has benefitted from the active participation of SMC, Gujarat Energy Development Agency (GEDA), distribution companies, industry associations, builders associations, educational institutions, and energy supply agencies in the city and others. The exercise includes study of five different sectors, namely, municipal, commercial, institutional, residential and industrial. However, as an additional exercise on request by the SMC, baseline energy consumption in the transportation sector has also been included in the report. The key components of the study comprised of: -

(1) Baseline (2010-11) energy assessment and demand forecasting for the year 2015-16 and 2020-21.

(2) Energy planning and sector-wise strategy for meeting 10% reduction target through RE and EE.

(3) Budget estimation for achieving the reduction targets.

(4) Implementation plan, awareness generation and capacity building.

During the baseline year for the city the maximum energy consumption was in the form of electricity followed by coal, PNG, LPG, petrol, diesel, CNG and kerosene in order. The consumption trend for all the fuels and sources of energy has been increasing during the past five years, except for Kerosene and PNG. Kerosene has shown a

continuously decreasing trend whereas; PNG consumption has shown both increasing and decreasing trends during the past five years. The actual and projected energy consumption for Surat City except transportation sector has been depicted in the following table: -

Table 1: Baseline Energy Consumption across Different Sectors and Demand Forecasting

Sector	Baseline Energy Consumption, 2008-09 (GWh)	Baseline Energy Consumption, 2010-11 (GWh)	Projected Energy Consumption , 2015-16 (GWh)	Projected Energy Consumption , 2020-21 (GWh)
Municipal	131.07	144.84	179.70	228.64
Commercial	1,347.28	1,404.25	2,132.07	3,519.87
Residential	3,117.72	3,143.82	3,865.69	5,002.35
Industrial	9,162.38	12,006.26	15,173.18	19,289.85
Total	13,758.44	16,699.17	21,350.63	28,040.71

Municipal sector is expected to see around 4.41% average annual increase in energy consumption after 2010-11, whereas industrial sector, residential and commercial sectors are expected to see an annual increase in energy consumption by around 4.79%, 4.22% and 8.71% respectively.

As mandated in the solar city programme for a target reduction of 10% by 2015-16, the value for Surat City estimated in terms of electricity units is around 2,135 GWH (MU). This reduction target has been distributed across the forthcoming five years in the proportion of 0% for 2011-12, 10% for 2012-13, 25% for 2013-14, 35% for 2014-15, and 30% for 2015-16. Based on the analysis of potential for demand side measures through EE and supply side augmentation through RE, following targets are proposed for different sectors in order to develop it as a “Solar City”.

Table 2: Reduction Target for Sectors

Sectors	Reduction Target (GWH)						Total Reduction of GHG emission in five years ('000 tCO_2e)
	2011-12	2012-13	2013-14	2014-15	2015-16	Total	
	1st Year (0%)	2nd Year (10%)	3rd Year (25%)	4th Year (35%)	5th Year (30%)		
Municipal	--	17.40	43.49	60.89	52.19	173.97	146.13
Commercial	--	13.79	34.48	48.27	41.37	137.91	115.84
Residential	--	44.24	110.60	154.84	132.72	442.41	371.62
Industrial	--	138.21	345.52	483.73	414.62	1,382.08	1160.95
Total	Nil	213.64	534.09	747.73	640.90	2,136.38	1794.56

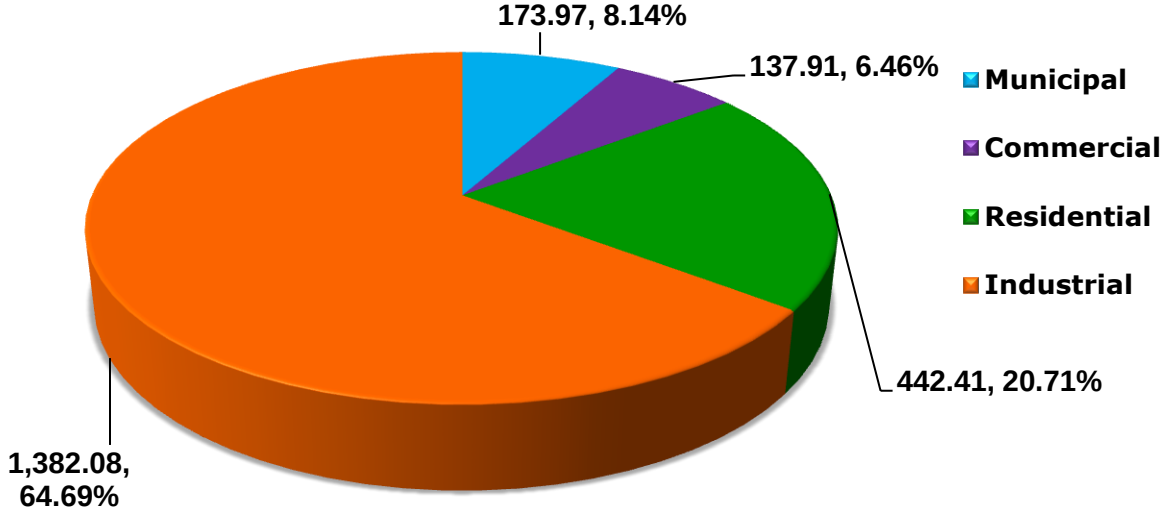

Figure 1: Reduction Targets Allotted to Different Sectors to be achieved by 2015-16

Various option of generating power form renewable energy resources has been assessed and suggested in the Master Plan. Some of the renewable energy options assessed are in biomass power, waste to energy, solar energy technologies and wind power. Some generic EE measures have been suggested common to all the sectors and some specific to certain sectors depending upon its suitability.

Based on the sector wise proposed project activity to improve the present and projected energy consumption scenario of the city, quantum of investment required for various sectors is estimated for Solar City Development

Plan over a specified time frame to achieve the mission goals. Gross investment need is approximately `73202 Crores for next five years. The costing provided for the projects is a rough cost estimation based on similar kind of projects and vendor interaction with suitable escalation factors in each sector during the implementing period.

Table 3: Budgetary Estimation to Meet Reduction Targets

Sector	Government Subsidy (Million INR)	Users Contribution (Million INR)	Total Budget required (Million INR)
Municipal	361	4,277	4,638
Commercial	998	2,865	3,863
Residential	4,406	9,076	13,482
Industrial	13,757	37,462	51,218
Total value	19,523	53,680	73,202
Percentage	26.67%	73.33%	100.00%

The action plan for achieving the set goals includes implementation of recommended renewable energy and energy conservation project across all the sectors. A Solar City Cell has been established within Surat Municipal Corporation which shall facilitate and oversee the adoption and implementation of such projects.

Surat Municipal Corporation and Industries are very keen to use renewable sources of energy generation such as wind, bio-gas, municipal solid waste etc. SMC has already installed 3 MW capacity Wind Power Plant and total 3.5 MWe capacity of Bio gas power plants run on gas produced from liquid sewage waste. More than 50 MW capacity Wind Power Plants are already installed by industries during 2011-12 to 2012-13. SMC is installing 8.4 MW Wind Power Plant in Jamnagar District for its Katargam Water Works and other Water Distribution Satiations expected to be commissioned in Mar-2013. 100 kWp SPV based power plant is already commissioned at Science Centre. Installation of total 2.3 MW_e Bio-gas based power plants is going on. Moreover, work of installation of 16.25 MW_e capacity Solid Waste based power plant is already entrusted. The Solar City Cell shall work for the following.

- To get ECBC notified immediately
- To ensure that the building by- laws are changed in accordance with it.
- To ensure that all upcoming non-residential buildings are brought under the ambit of ECBC and to incorporate the relevant green building elements.

- To ensure that the major new commercial and government buildings are GRIHA certified.

Various capacity building and awareness generation measures have been suggested in the Master Plan which shall facilitate quick adoption of RE and EE options across various sectors. However, to achieve energy reduction targets' of magnitude 2,136 GWh, about 800 MW of Solar and Wind Power projects needs to be installed. Hence, we would like to highlight the following points.

(1) Projected energy consumption during the year 2015-16 for industrial sector would reach 71% of the total city consumption value.
(2) The share of electricity consumption is 42% of total energy consumption of Surat City whereas coal's contribution is 36% and 22% is contributed by other fuels.
(3) As EE & RE targets are 10% of conventional energy demand and which will be mainly met through electricity generation/ electricity conservation; therefore, EE & RE measures of 23.8% of total electricity consumption will be required.
(4) As per prevailing regulation- Procurement of Energy from Renewable Sources Regulations, 2010; total minimum quantum of purchase from various RE sources for distributing agencies is as below: -

Year	Total	Wind	Solar	Biomass, Bagasse and Others
2012-13	7.00%	5.50%	1.00%	0.50%

Abovementioned point no. (2) & (3) indicates that minimum RPPO (Renewable Power Purchase Obligation) is 7% at present is quite less against expected total RE generation requirement of 16%. Moreover, as per RPPO regulation, distribution agencies can purchase power/ REC certificate(s) from industries/ establishments outside of Surat City also; hence, they shall not purchase RE power beyond their RPPO %age and it may further reduce sizeable quantum of electricity to be purchased from RE sources.

It means very high %age of RE generation shall not be purchased by distribution agencies and hence, benefits of various existing policies and relaxation given under Solar & Wind energy generation tariff wouldn't be available to consumers in the Surat city and achieving targets under Solar City wouldn't become feasible. Hence, special consideration to Surat city for the followings for effective implementation of Solar City programme: -

(1) Surat is implementing targets for industrial sector; hence, additional subsidies and encouragement should be given.

(2) To achieve installation of 791 MW of Solar & Wind Power, additional subsidy for the power plants installed under RPPO obligations and appropriate subsidy so that installation of WPP & SPP are encouraged.

(3) Necessary change should be made to encourage for achieving EE & RE targets under Solar City programme.

Thus, encouragement must be provided in terms of Capital Subsidy and/ or tariff benefits so that conducive environment is created for Surat city to complete the targets proposed.

Further, for effective implementation of the targets: -

(1) To create a Solar City Fund, like Textile Up-gradation Fund created for protecting and proliferating Textile Industries in country, which will provide:

i. Capital and/or interest based subsidy
ii. Long term low interest term loan with less than 20% margin

(2) To extend existing accelerated depreciation benefits for capital investment for Solar Power Plant also for Solar Cities.

(3) To extend Special Area Demonstration Project Program of MNRE to Surat under PPP mode.

(4) To create a portal for Energy Efficiency & Renewable Energy Products and Services including Regional Funds and Other Resource availability.

2 INTRODUCTION

2.1 Background

India is one of the fastest growing economies in the world. With increasing economic growth there has been an un-precedented upsurge in India's urban sector. Rapid urbanization is laying pressure on existing infrastructure and natural resources. There is a continuous increase in the demand for energy in various sectors supporting each of the urban epicenters. Urban areas currently use 67 percent of world's energy and account for over 71 percent of global Green House gas (GHG) emissions which are expected to rise to 73 and 76 percent respectively by 2030[1].

With such a rapid expansion, there is a need to shift in energy resources and to develop a framework that will encourage and assist cities in assessing their present energy consumption status, setting clear targets and preparing action plans for generating energy through renewable energy sources and in conserving energy through energy efficiency measures in delivering urban services. In order to overcome this situation and make the Indian cities energy-sustainable & self-reliant, Ministry of New and Renewable Energy (MNRE), Government of India, launched a program namely "Development of Solar Cities"

"Development of Solar city" is one of the most ambitious programs launched by Ministry of New and Renewable Energy (MNRE). The program assists Urban Local Governments in:

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

The main focus of the programme is to reduce the increasing energy as well as power demand across different sectors in the fast urbanizing cities in the country.
The program aims at *minimum 10% reduction* in projected demand against the business as usual scenario 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. This 10% will be from Renewable Energy sources and Energy Efficiency measures.

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[1] (International Energy Agency-IEA 2008)

2.2 Goal & Objective of the Solar City Program set by MNRE

The Goal of the program is to promote the use of Renewable Energy in Urban Areas by providing support to the Municipal Corporations/ Urban Local bodies (ULBs) for preparation and implementation of a Road Map to develop their cities as Solar Cities. The main objectives of the programme are:

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

Based on the assessment of potential for demand side measures along with that of supply side intervention through renewable energy technologies, the following targets are proposed in order to develop it as a Solar City.

2.3 Methodology

The entire work of developing this master plan to make Surat a solar city has been a collaborative effort of Deloitte Touche Tohmatsu India Private Limited (DTTIPL), Gurgaon and SMC along with different stakeholders in the city. The transformation of Surat into a solar city will require a holistic approach in bringing new and improved technologies for energy conservation and mainstreaming renewable energy power generation into the established power sector presently dominated by fossil fuel power plants. As per the MNRE guidelines for the preparation of solar cities, transportation sector has been excluded from the master plan. However, seeing a rapidly growing transportation sector and its associated energy demand, an energy assessment study was also carried out to understand the growth in vehicular population and the associated fuel consumption. It is already the second year of the implementation phase for solar cities as envisaged by MNRE, hence the baseline has been shifted from the 2008-09 to 2010-2011 to provide sufficient time to Gujarat Energy Development Agency (GEDA) and SMC for the implementation of the master plan.

The key points of the study comprised of the following

- Baseline determination
- Strategy for bringing RE and EE interventions in different sectors
- Developing a Master Plan

For baseline determination various energy supply agencies were contacted, representatives from different sectors were also contacted to understand the energy consumption patterns. Field contact was also done to assess the energy consumption pattern in the household sector taking sample form all the seven zones of Surat, under each income class of households. Industry survey was done to assess the energy requirement in all types of industries operating within the municipal limits. Field contact was also done to assess the enrgy consumption pattern in Commercial and Institutional sectors. Detailed energy inventory was collected and analyzed for

understanding the energy need of the Municipal sector. The methodology also included review of RE and EE programs and policies. Various options were explored and analyzed with the aim of meeting the reduction targets. This was followed by a techno-economic evaluation of various RE and EE measures. The Master Plan has been developed taking feasible RE and EE measures. The analysis of existing resources; energy consumption across various sectors; inventories; and projections of various energy-infrastructure requirements are based on-the data provided by Surat Municipal Corporation (SMC); Torrent Power Limited (TPL); Dakshin Gujrat Vij company Limited (DGVCL); Oil companies; field contact done in Industrial and Residential sectors and various government agencies. The data was collected from aforementioned sources over a period of 5-6 months. Secondary data collection was supplemented with primary field contact to understand the consumption pattern in different sectors laying special focus on residential and industrial sectors.

Green House Gas (GHG) emission is directly correlated with fossil fuel consumption. Estimation for GHG emission in various sectors is based on the International Panel for Climate Change (IPCC) default emission factors for various fuels. For conversion of Electrical energy into CO_2 equivalent, the average value of grid emission factors (from 2006 to 2010) applicable in the state of Gujarat was estimated. The average value so calculated is 0.84 tCO_2/MWh of electricity produced.

3 ABOUT THE CITY

Surat city, also known as the economic capital of Gujarat, has been proactive in strategizing its future. Surat Municipal Corporation (SMC) is the urban local body that leads the urban development initiatives in the city. Faced with the challenge of rapid increase in urban population, the city has formulated urban growth management strategies focusing on enhancement of infrastructure and creation of a safe and sustainable environment which can promote and sustain growth[1]. To cater to rapid urbanization in peripheral areas, the expansion of city area from 112 sq km to 326 sq km was undertaken. Today, it stands in the list of 60 Indian cities selected for converting them into a "Solar City".

Figure 2: Location Map of Surat

3.1 Climate

Surat is situated in the west coast (21.17°N Latitude and 72.83°E Longitude) of India in the state of Gujarat. It falls in the Sub-humid zone and experiences hot humid climate owing to its proximity with the Arabian Sea. The average annual rainfall in the region is 931 mm. The highest rainfall is recorded in the month of August (average 292mm). It has a perennial river Tapi flowing through the city. However, river Tapi experiences frequent floods because of its huge upstream catchment area of 62225 Km^2. The soil is majorly layered, black cotton soil. The terrain is almost flat. It has an average elevation of 13 meters above Mean Sea Level. In summer, the maximum temperature ranges between 42°C and 24°C. During the winter, the temperature varies between 31°C and 9°C.

[1] City Development Plan

Surat is blessed with good sunshine throughout the year. The average annual insolation in the city is 5.22 kW/ m^2/ day.

3.2 Economy

Surat is one the fastest growing Indian cities in terms of economic prosperity. The city has registered an annualized GDP growth rate of 11.5 per cent over the past seven fiscal years with an absolute GDP $22 billion at current price, according to the data compiled by economic research firm Indicus Analytics. Surat is known for its thriving diamond and textile industry. Though often affected by floods and earthquakes, the city has always come out on top. Improved infrastructure has been key to Surat's rapid rise. A number of elevated roads and flyovers have facilitated the thriving diamond and textile business of the city. Surat has low unemployment rates, high job rates and one of the highest per capita incomes among Indian cities.

Surat's Contribution to State and Nation's Economy is as follows[2]

- 44 % of the world's total rough diamond cutting and polishing
- 75 % of the nation's total rough diamond cutting and polishing
- 43 % of the nation's total diamond exports
- 40 % of the nation's total manmade fabric production
- 33 % of the nation's total manmade fiber production
- 10 % of the nation's total manmade fiber export(2003-04)
- 19 % of the nation's total fabric production (2003-04)

Some of the major industries operating within the city limits are listed below

Table 4: Major Industries in the City

Major Industries	Numbers
Texturizing Units	500
Power Looms	450000
Process Houses	400
Zari Units	6610
Dyeing and Printing Mills	326
Dyes and Chemicals	130
Plastic Units	200
Diamond Units	10000
Food Products	56
Information Technology	300

Source: CDP 2008-2013

[2] City Development Plan

3.2.1 Textile Industry

Surat is a dominant player in the textile sector.. Surat is one of the largest centers in the world for production of synthetic fabrics, mainly nylon and polyester. At present, there are about 0.6 million power-looms (about 60,000 units) in the city region and the sector provides for over 1.2 million jobs in Surat. The textile processing units are the major backbone of the Surat city's economy. They depend mainly on ground water for its processing and withdraw about 700 to 1000 cubic meter of water every day. There are about 60 thousand shops and establishments engaged in trading activity in general with textile as a predominant sector. Surat is the home of zari industry in India which dates back to 16th Century. Today there are above 6610 zari units that employ approximately 47500 workers.

3.2.2 Diamond Industry

Gujarat accounts for almost 80 % of the diamonds processed in India. Of this, 90 % are processed by the units located in and around Surat alone. The emergence of the industry in the region which did not have raw material, markets or worker base is a significant feat. Coupled with ease of establishing small-scale industries, various governmental policies aimed at increasing the export of polished diamonds aided the growth of such units in the city. Like textiles, diamond cutting and polishing is also a labour intensive industry employing about 500000 workers in about 25000 units of all sizes operating within the urban region. India's first private Special Economic Zone has been functioning near Sachin in Surat since November 2000. The industry requires a low capital base, is non-polluting, high on employment generation and is a leading contributor to foreign exchange reserve.

3.2.3 Industrial Estates

The Gujarat Industrial Development Corporation (GIDC) established in and around the city of Surat are: Pandesara, Khatodara, Udhana, Katargam, Sachin and Bhestan. Textiles, chemicals and diamond are major units located in these estates.The city is compact and has been outwardly expanding along the transport corridors. The growing trends indicate sprawl tendency towards south and north east. Some signs of growth extending towards northern side across the river are visible.

3.2.4 Zari Industry

The silver and gold brocade (Zari) industry, embroidery, and weaving of textiles in Surat have a 300-year old history. Since the 1980s, the industry got some boost due to growing exports. There are about 6,610 Zari units that employ approximately 47,500 workers. Difficulties in availability of skilled labour, high cost of raw material, outdated technology and changing preferences of the consumers have led to a severe contraction of the industry.

3.3 Master Plan Area

An important step in the development of the "Solar City Master Plan" is defining its geographical boundary or limits. The spatial limits considered for developing the Master Plan are areas which fall within the Municipal Boundary. Area within Municipal limits is distributed in seven Zones. The area under each of the seven zones is shown below in Table **5**. Total area which comes under the SMC is 326.52 km^2. The seven zones are also categorized based on their relative position in the city, they are; north, south, east, west, central, south-east and south-west.

Athawa is the zone with the highest area and the central zone has the least area with an area of 8.18 km^2. Industrial area is the highest in Udhana whereas residential area is maximum in Athawa with an area of 35.55 square kilometers. The highest share of land use is attributed to the Residential Sector comprising 41% of the total land area of the city.

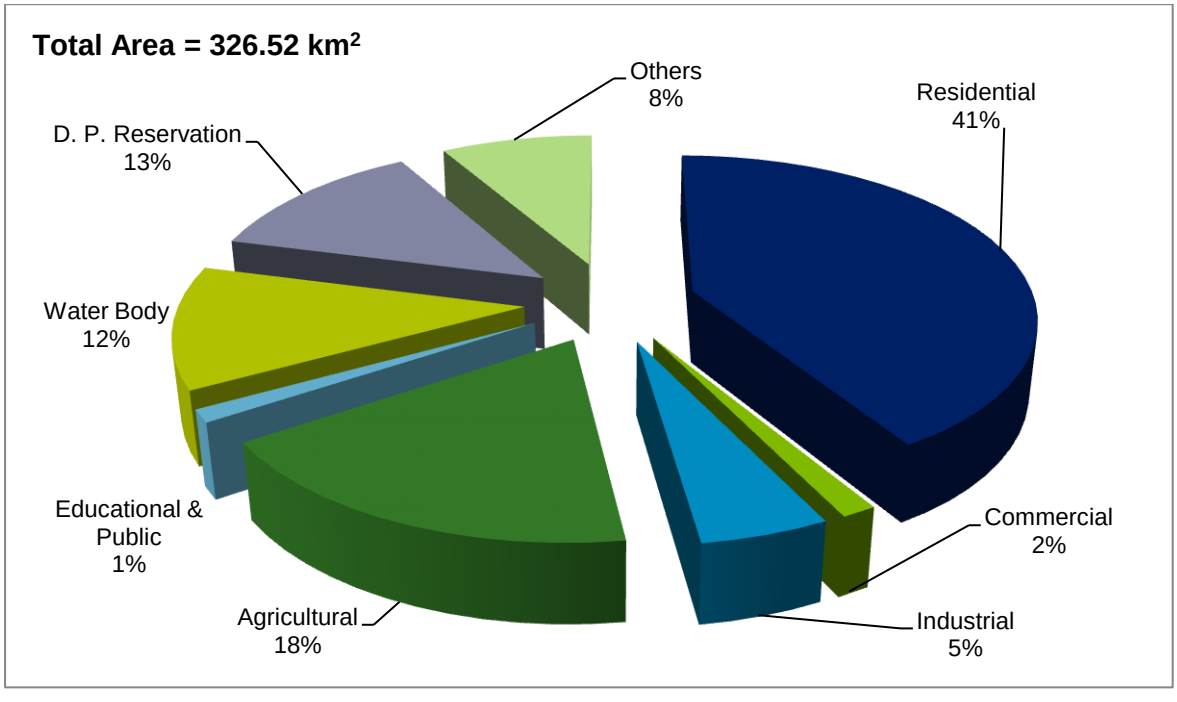


Figure 3: Land-use pattern in Surat City

Table 5: Zone Wise Land Use Pattern in Surat City

Purpose of Land Use	Central	Udhana (South)	Athawa (South-West)	Rander (West)	Katargam (North)	Varachha (East)	Limbayat (South-East)	Total	Percentage Land Usage(%)
	Area in km^2								
Residential	6.63	18.56	35.55	24.8	15.97	19.45	13.99	134.95	41.33
Commercial	0.22	0.38	0.75	0.6	0.44	0.92	1.22	4.54	1.39
Industrial	--	9.33	1.63	0.25	2.79	2.34	0.12	16.47	5.04
Agricultural	--	16.9	19.31	12.83	3.08	6.43	0.15	58.7	17.98
Educational & Public	0.1	0.03	3.1	0.27	0.15	0.42	--	4.08	1.25
Water Body	0.98	3.85	12.73	9.21	6.79	5.36	0.46	39.38	12.06
D. P. Reservation	0.23	5.36	28.63	3	1.7	0.85	1.35	41.11	12.59
Others	0.03	7.35	10.21	0.32	5.44	1.76	2.2	27.3	8.36
Total	8.18	61.76	111.91	51.28	36.36	37.53	19.49	326.52	100
Percentage Zonal	2.51	18.91	34.27	15.71	11.14	11.49	5.97	100	

Source: CDP 2008-2013

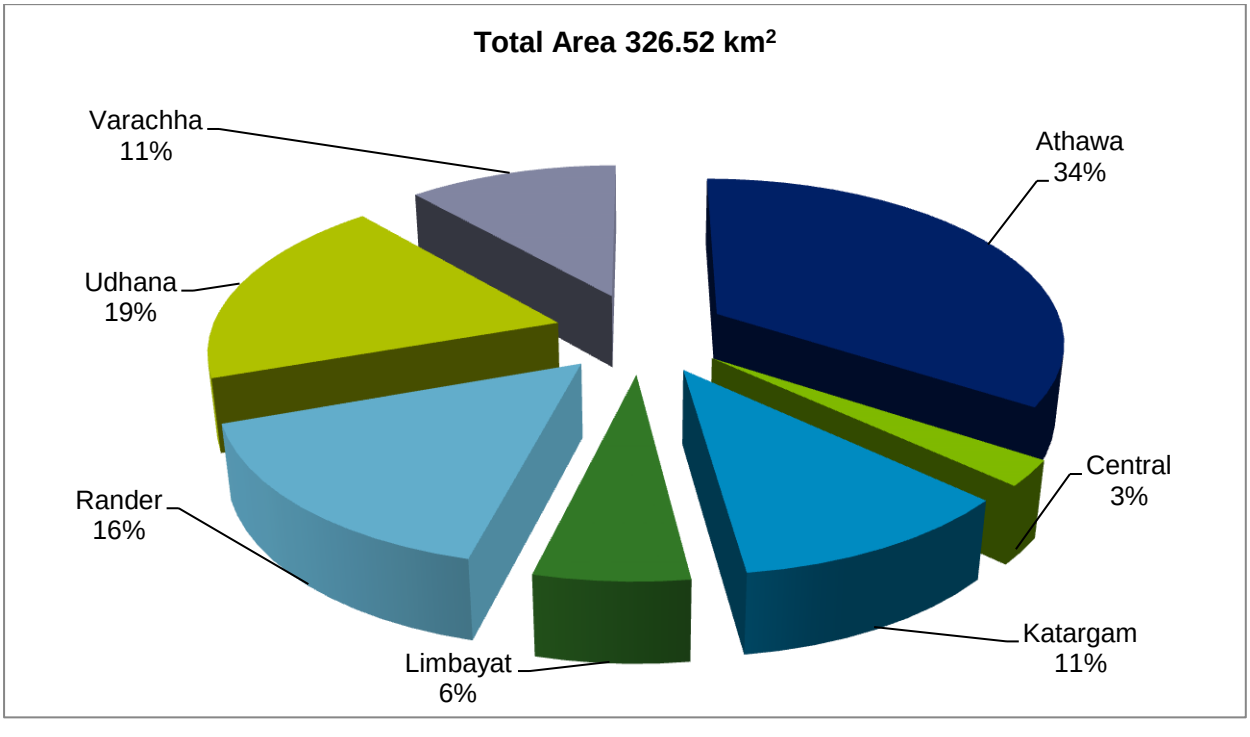


Figure 4: Zone-wise land distribution in Surat City

Athawa or south-west zone of the city is 34 % of the city area followed by Udhana and Rander.

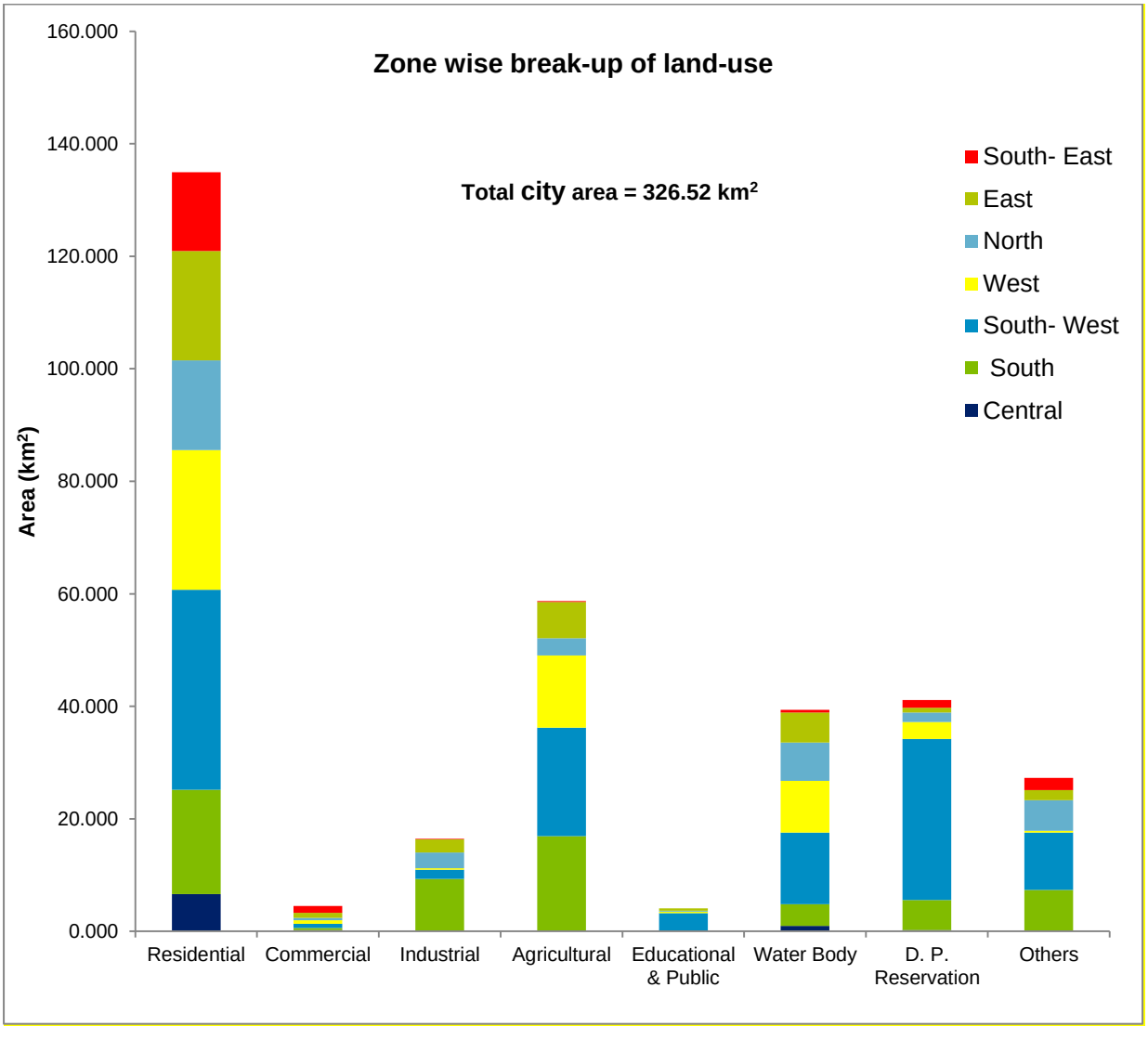


Figure 5: Zone-wise break-up of Land use in Surat City

3.4 Demography

3.4.1 Population

Development of any city is directly linked with is population & its long term growth rate. Requirement of energy, infrastructure and other basic amenities is directly related to the population of the city. Surat has recorded a decadal growth rate of 82.84 % from its 2001 figure (According to Census 2011) and by 2021 it is expected to reach 6.88 Million with a decadal growth rate of 54.66%. This rapid surge in population growth has happened due to the robust industrial growth rate.

Table 6: Population trend in Surat Municipal Area

Year	1951	1961	1971	1981	1991	2001	2011	Projected 2021
SMC area (km^2)	8.18	8.18	33.85	55.56	111.2	111.3	326.5	326.52
Population (Lakh Persons)	2.23	2.88	4.72	7.77	14.99	24.34	44.5	68.825
Decadal Growth Rate (%)	–	29.05	63.75	64.65	93	62.38	82.84	54.66 (Avg. Decadal Growth Rate
Population Density (persons/ km^2)	27284	35211	13934	13977	13483	21873	13629	21079

Source: City Development Plan (2008-13) and SMC

This is mainly due to the migration of large number of worker population from eastern India for work in the industries. It is one of the fastest growing cities in India. Being an industrial and commercial hub, it attracts large number of people for employment. The rise in urban population is especially within the municipal limits is attributed to the rise in industrial and commercial activities

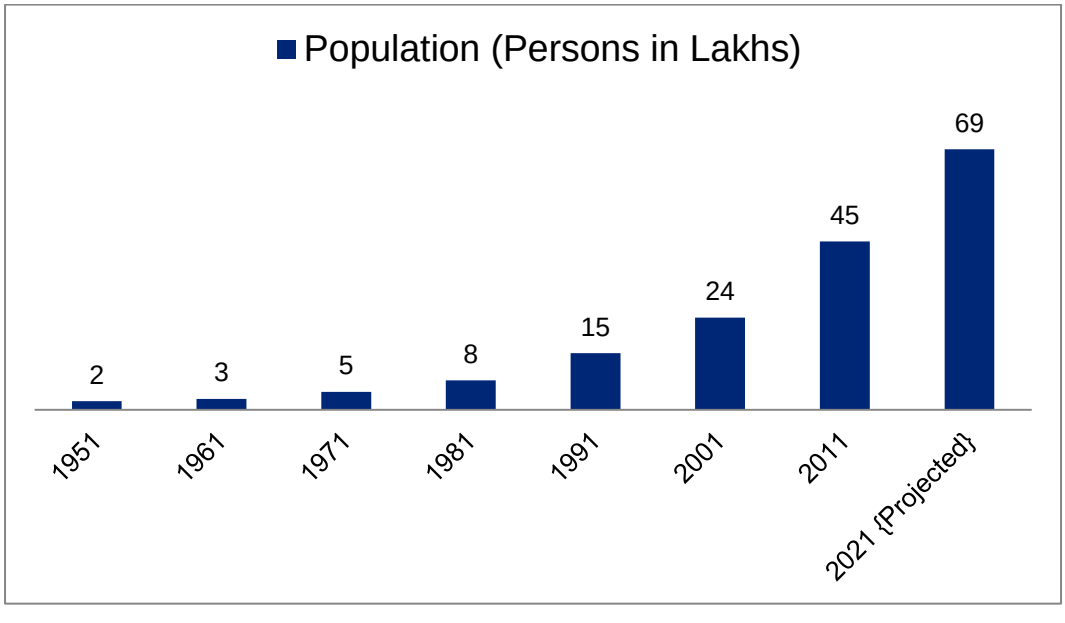


Figure 6: Population Growth in Surat Municipal Area

3.4.2 Income level among households

Total number of households in Surat City is 1096115. Average household size is 5.85 in general populace whereas average household size has been found to be 5.65 in slum population. It is seen that 44% of Households of the city are in the income range of INR 5000-10,000/- per month. It is also seen that in ward no 25, 8% households have a sizable monthly income exceeding Rs.1 lakh. Majority of people in this ward have monthly income between Rs. 25,000 to Rs. 50,000. This is the richest ward of the city, but it also has 12% households with

monthly family income less than INR 2000/-. In ward no 21 & 37 high percentages (19% & 18% respectively) of households, have family income less than INR 2000 as against the city average of 4.93%. This income variation has important implication over energy consumption. The following data can facilitate in strategizing for implementation of the Solar City Master Plan.

Table 7: Income Group Categorization across different Wards

Ward	<2K	2-5K	5-10K	10-25K	25-50K	50-75K	75-100K	>100K
ward 1	0	24	40	36	0	0	0	0
ward 2	4	25	36	32	4	0	0	0
ward 3	0	27	27	43	3	0	0	0
ward 4	0	0	7	70	17	7	0	0
ward 5	4	21	54	18	4	0	0	0
ward 6	12	15	58	15	0	0	0	0
ward 7	7	52	37	4	0	0	0	0
ward 8	0	23	60	17	0	0	0	0
ward 9	8	31	31	27	4	0	0	0
ward 10	0	19	41	41	0	0	0	0
ward 11	3	7	73	17	0	0	0	0
ward 12	3	13	53	27	0	0	3	0
ward 13	0	21	29	33	13	4	0	0
ward 14	0	8	42	50	0	0	0	0
ward 15	4	13	30	35	9	4	4	0
ward 16	0	20	53	27	0	0	0	0
ward 17	7	24	38	24	0	7	0	0
ward 18	0	19	22	48	4	7	0	0
ward 19	0	7	36	57	0	0	0	0
ward 20	3	42	33	18	3	0	0	0
ward 21	19	56	22	4	0	0	0	0
ward 22	10	10	73	7	0	0	0	0
ward 23	0	38	50	13	0	0	0	0
ward 24	0	32	56	8	4	0	0	0
ward 25	12	0	8	31	38	4	0	8
ward 26	0	8	42	50	0	0	0	0
ward 27	5	19	29	14	33	0	0	0
ward 28	4	32	44	20	0	0	0	0
ward 29	3	30	50	17	0	0	0	0
ward 30	3	17	77	3	0	0	0	0
ward 31	4	19	59	19	0	0	0	0
ward 32	14	36	50	0	0	0	0	0
ward 33	7	30	33	7	19	4	0	0
ward 34	7	37	52	4	0	0	0	0
ward 35	2	15	54	24	2	0	0	2
ward 36	6	44	39	11	0	0	0	0
ward 37	18	16	51	11	2	0	2	0
ward 38	9	15	48	28	0	0	0	0
Overall	**4.93**	**22.54**	**43.7**	**23.63**	**3.74**	**0.91**	**0.27**	**0.27**

Source: CDP 2008-2013

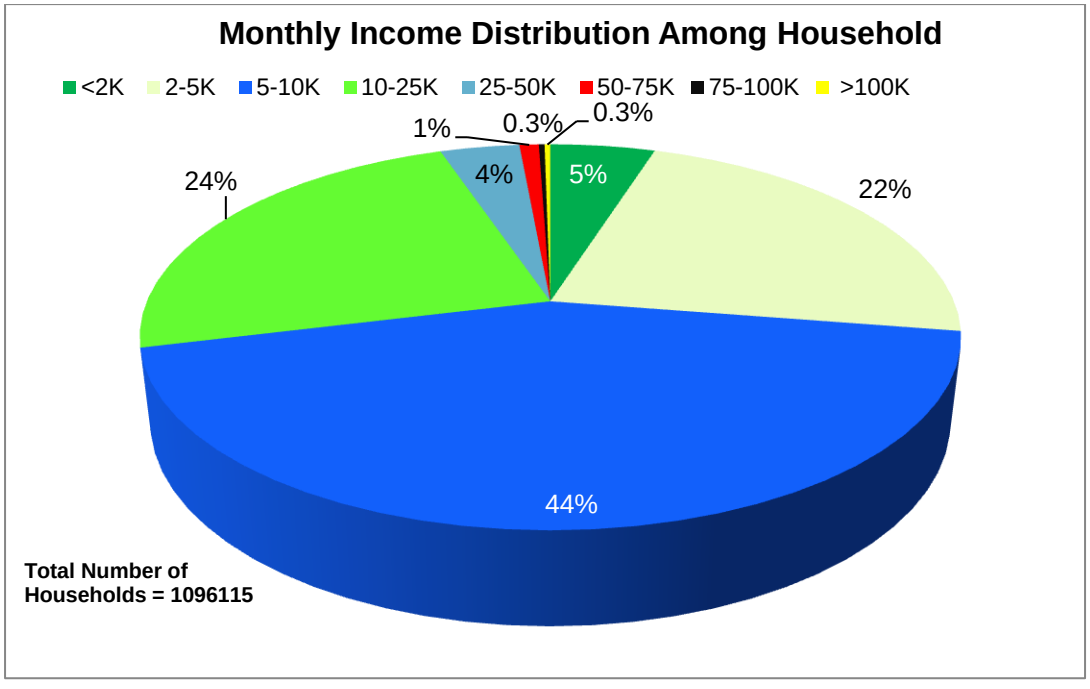


Figure 7: Monthly Income distribution among households

The type of buildings that are present in Surat City have been given in the Table below. Share of residential buildings is around 71% of the total number of 15.34 Lakh buildings in the city.

Table 8: Type of buildings in Surat City

Type of Building	Numbers	Percentage (%)
Residential	1096115	71.37
Industrial	98041	6.38
Commercial	220312	14.34
Institutional	4050	0.26
Government	110	0.01
Others	117279	7.64
Total	**1535907**	**100.00**

Source: ARO, SMC (January 2012)

Type of buildings in non-residential category is shown in the Table below.

Table 9: Type of Non-residential buildings in Surat

Some Specific Type of Buildings	Numbers
Bank	874
Fuel Station	110
Hospital	1119
Hotel	409
Hotel 2	1249
Mall	449
Shop	156159
Total	**160369**

Source: ARO, SMC

4 ENERGY BASELINE ASSESSEMNT AND DEMAND PROJECTION

This chapter focuses essentially on the present scenario of energy consumption in Residential; Commercial, Industrial, Municipal sectors. Based on the consumption trends over the past five growth trends in energy consumption in respective sectors have been predicted.

In order to identify the energy conservation/ Energy Efficiency enhancement options, it is important to understand the pattern of energy consumption in Business As Usual (BAU) scenario. This section deals with the present energy consumption across various sectors. There are two electricity distribution companies (Discoms), namely, Dakshin Gujrat Vij Company Limited (DGVCL), and Torrent Power Limited (TPL), that supply electricity to different consumers in each of the sectors lying within SMC limits. Based on the tariff and connected load the two Discoms have divided the consumers in the following categories.

- Domestic
- Commercial
- Industrial
- Municipal
- Others (agricultural, temporary)

The above sectors not only derive their energy from electricity but also from Piped Natural Gas (PNG), Petrol, Diesel, Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), Kerosene, and coal. Petroleum products are mainly supplied by Indian Oil Corporation Limited (IOCL), Hindustan Petroleum Corporation Limited (HPCL), Bharat Petroleum Corporation Limited (BPCL), which supply Motor Spirit (MS), High Speed Diesel (HSD), Liquefied Petroleum Gas (LPG), kerosene, industrial fuel like Furnace Oil (FO), Light Diesel Oil (LDO) etc. Gujarat Gas Corporation Limited (GGCL) supplies CNG to the transportation sector whereas PNG to the consumers of residential, commercial and industrial sectors. Coal is mainly used for industrial purposes and is brought in the city from the Mandla Port. Wood and Kerosene is mainly utilized in the domestic sector especially in the lower income households. Master Sheet attached with this report contains energy consumption (in MTOE) across different sectors per year during the period from 2006-07 to 2010-11. Table below gives a demand project of energy across different sectors.

Table 10: Baseline Energy and demand forecasting

Sector	2006-07	2010-11	2015-16	2020-21
	Baseline		Projected	
	GWh	GWh	GWh	GWh
Municipal	118.16	144.84	179.7	228.64
Commercial	1079.96	1422.7	2125.03	3499
Transportation	1645.53	2779.69	4245.65	7192.92
Residential	2773.41	3144.17	3866.16	5002.99
Industrial	8542.82	12007.98	15558.5	20236.2
Total	**14159.87**	**19499.32**	**25967.35**	**36141.5**

For each of these sectors future growth rate and demand projection has been done based on the historical data on energy consumption.

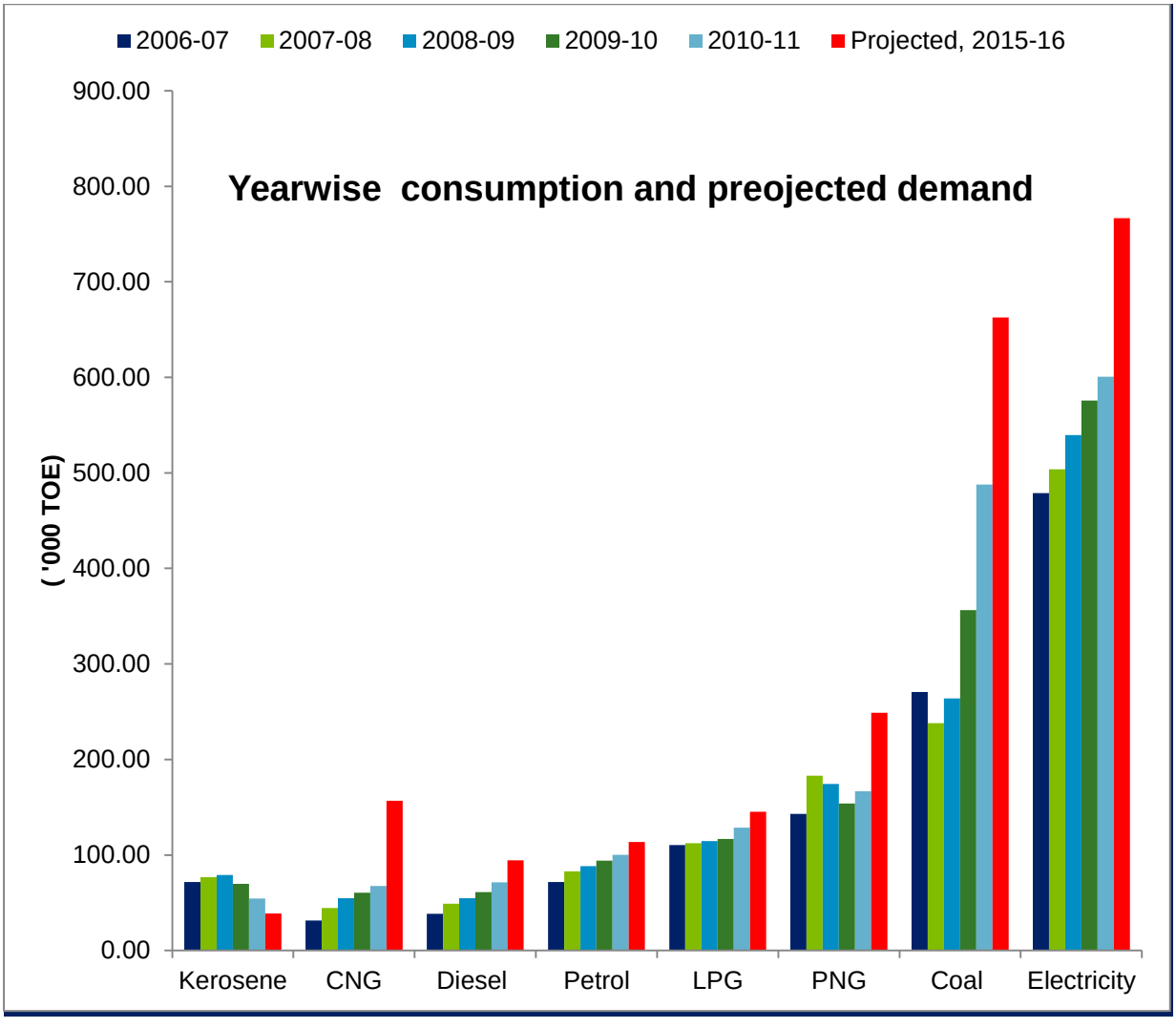


Figure 8: Year wise energy consumption and projected demand

Consumption trend for all the fuels and sources of energy has been increasing during the past five years, except for Kerosene and PNG. Kerosene has shown a continuously decreasing trend whereas; PNG consumption has shown both increasing and decreasing trends during the past five years, reaching a peak during the year 2007-08. During the baseline year 2010-11 the energy consumed was maximum in the form of electricity followed by coal, PNG, LPG etc.

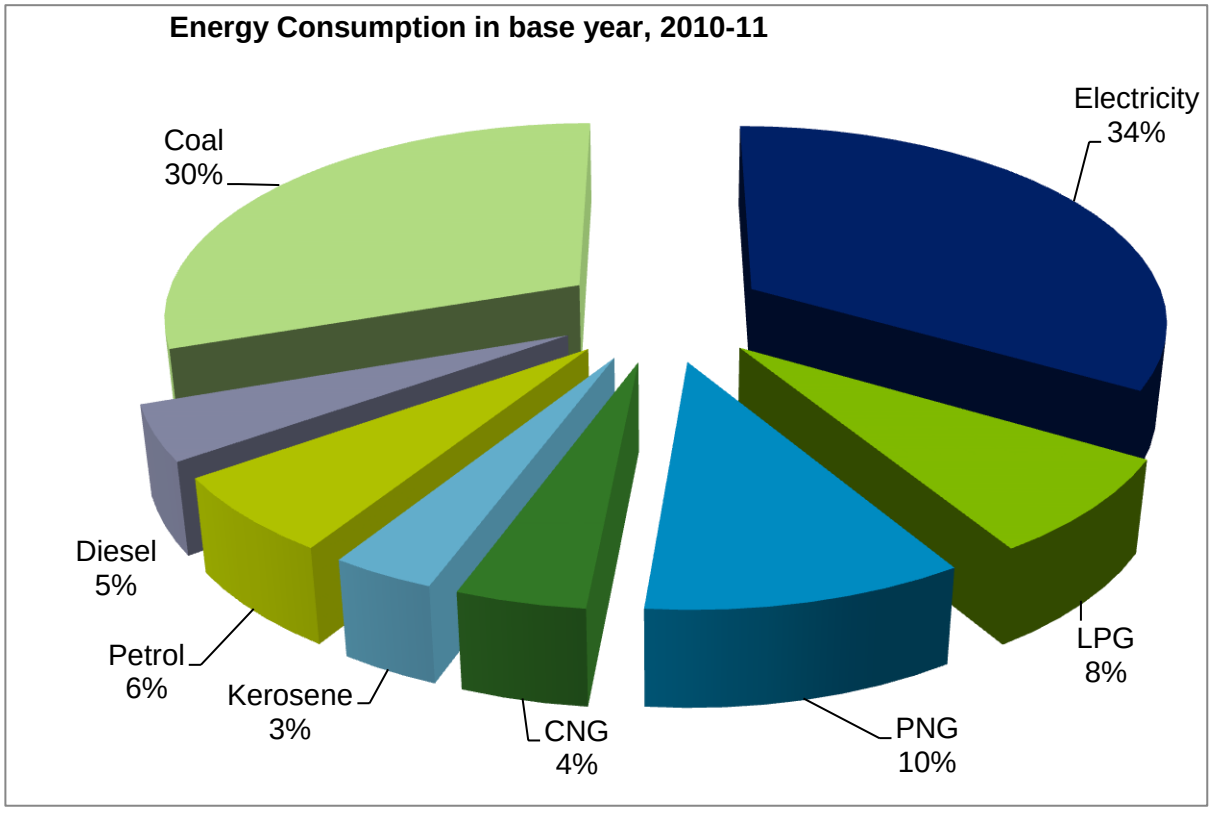


Figure 9: Fuel Wise Energy Consumption in the Baseline Year

PNG and CNG is expected show a better growth rate than LPG, petrol and diesel. For the year 2010-11 the distribution of energy consumption is depicted in the chart above.

Municipal Corporation's consumption is miniscule as compared other sectors. The highest consuming sector during the year 2010-11 was industrial with an aggregate energy consumption of about 1.03 million Tonnes of oil equivalent (MTOE). It is expected to rise to 1.3 MTOE by 2015-16. The sum total of energy consumption from all the sectors during the base year 2010-11 was about 1.67 MTOE and it is expected to rise to 2.26 MTOE by the year 2015-16 and 3.18 MTOE by the year 2020-21.

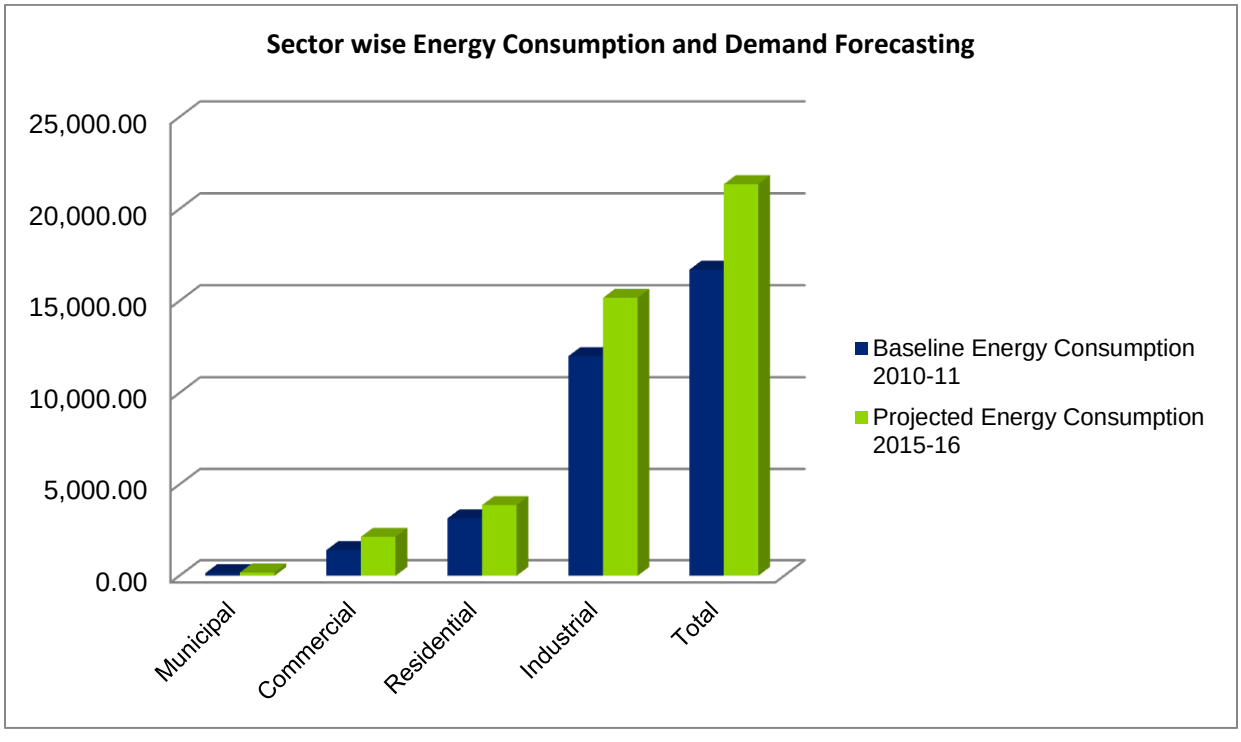


Figure 10: Sector-wise energy consumption and demand forecasting

Green House Gas (GHG) emission is directly associated with energy consumption from conventional sources of energy. The largest contributor towards GHG emission in the city is the industrial sector followed by residential, commercial, transportation and municipal sectors. The grid emission factor for electricity supplied during the period from 2006-07 to 2010-2011 has been estimated to be 0.84 tCO_2/ MWh. Sector wise Figure 11.

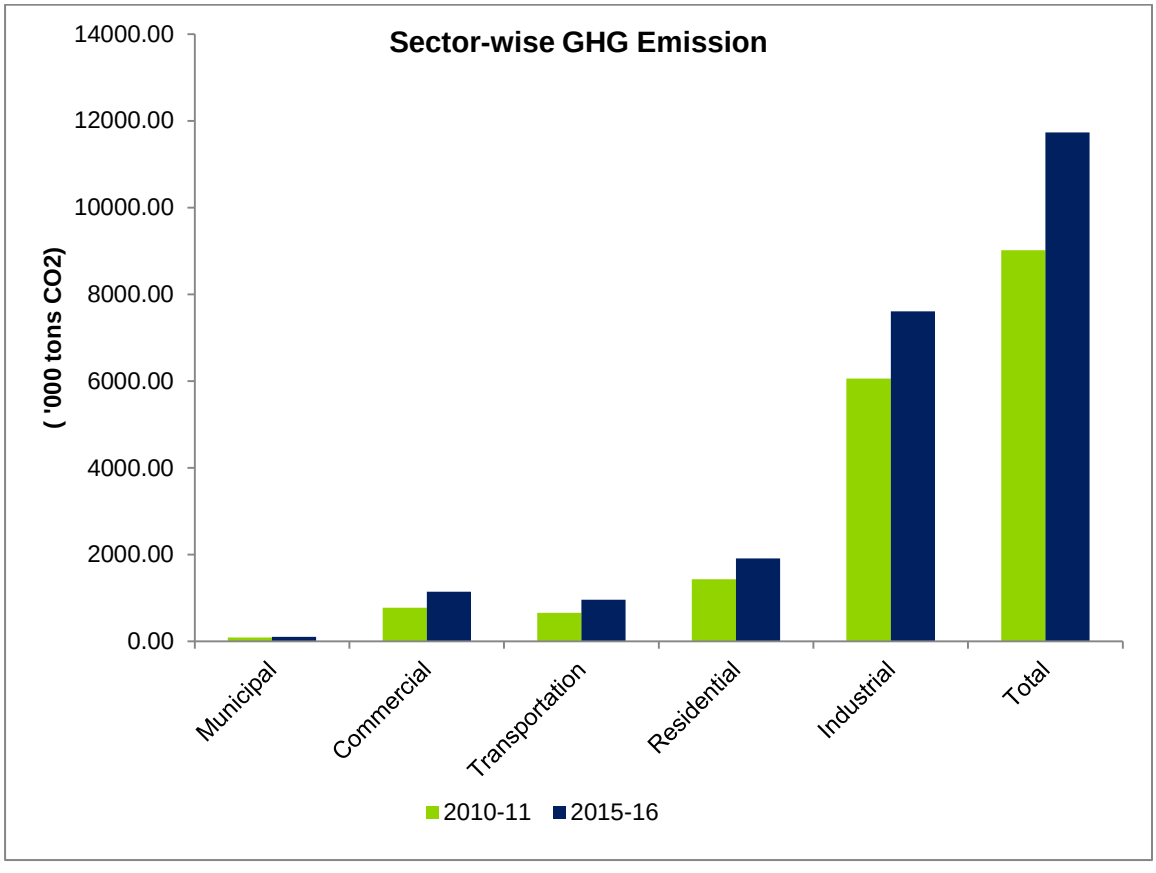


Figure 11: Sector wise GHG Emission across different sectors

Source: Central Electricity Authority (CEA) & Energy supply agencies in Surat City

Total GHG emission for the city during the baseline year 2010-11 was about 16.36 megaTonnes CO_2. Industrial sector was the highest contributor with GHG emission value of 10.04 megaTonnes of CO_2. Residential sector contributed about 2.6 megaTonnes of CO_2 whereas municipal, commercial and transportation sectors contributed 0.12, 1.2 and 2.33 megaTonnes of CO_2 respectively. With rise in energy consumption the total GHG emission is expected to reach about 22.1 megaTonnes of CO_2 by the year 2015-16.

4.1 Municipal Services

In case of street lights, 81 percent of the roads were having street lights in non-slum areas whereas only 48 percent of the slum roads were having street lights leaving 52 percent roads without street light. Footpaths were available on 66 percent of the non-slum roads where as they were only laid on 5 percent of the slum roads.

Table 11: Municipal Services Details

Sr. No.	Service	Volume/ Qty.
1	Water Supply {2010-11}	745 MLD
2	Drainage System {2010-11}	536 MLD
3	Streetlights on 31-Mar-2011	89,280 Nos.
4	MSW Collection {2010-11}	1,183 TPD

Table 12: Electricity consumption and Renewable Energy Generation in Municipal Sector

	Electricity Consumption in MU					Electricity Generation in MU		
Year	Water Supply System	Sewage Disposal System	Street Lighting	Others	Total	Bio Gas WPP	Wind Power	Total
2005-06	65.41	27.02	16.93	5.89	115.25	2.41	-	2.41
2006-07	69.06	25.5	17.36	6.32	118.24	1.38	-	1.38
2007-08	73.16	27.61	19.01	9.56	129.34	1.19	-	1.19
2008-09	73.46	25.73	21.91	9.96	131.07	7.43	-	7.43
2009-10	72.79	26.65	23.01	12.64	135.08	8.86	-	8.86
2010-11	76.06	31.09	24.87	12.81	144.84	6.87	1.31	8.18
Growth Rate	3.40%	3.40%	3.69%	3.73%	-	-	-	-
Projected Demand 2015-16	89.9	36.75	29.82	15.39	171.85	-	-	-
Projected Demand 2020-21	106.25	43.44	35.74	18.48	203.91	-	-	-

Source: SMC Electricity Bill and Utility Company Tariff Order

Table 13: Bio-gas based power Plants of Municipal Corporation

Name of STP (Division)	**Anjana**	**Singanpore**	**Karanj**	**Bhatar**	**Total**
Service No.	27804	460740	415446	415937	-
Supply Agency	TPL	TPL	TPL	TPL	-
Supply Voltage (kV)	11	11	11	11	-
Contract Demand (KVA)	750	675	1000	850	-
Commissioned in	October-03	March-08	March-08	August-08	-
Capacity (MW)	0.5	1	1	1	3.5
Capital Cost (INR Million)	26.2	61.7	62.7	62.1	212.7

Source: SMC Data

Water works in SMC, has well established bio-gas based power generation facility. It produced about 6.87 MU of electricity from the liquid waste collected in its treatment plant during the year 2010-2011. The bio gas based power generation plants are installed in four Sewage treatment facilities located at Anjana, Singanpore, Karanj, and Bhatar with a total installed capacity of 3.5 MW. There is a Municipal Solid Waste (MSW) based 8 MW power generation plant owned and operated by Surat Municipal Corporation. The details of which are provided

in the table below.

Table 14: SMC Owned 8 MW MSW based power plant**.**

Details	Particulars
Total MSW (Municipal Solid Waste) Generated at present	1350 TPD
Qty. Agreed to Process	1000 TPD of Un-segregated MSW
Average Power Generation	13 MW i.e. expected electricity generation in tune of 113.88 MU per annum
Expected to Commissioned in	within 9 months after provision of land
Concession Period	25 Years
Royalty to SMC	INR 30.00 / ton i.e. INR 9.9 Million/ annum, Escalation in royalty @ 5.4% every year up to 25 years.

Source: SMC

Table 15: Summary of Energy Conservation and RE measures Undertaken by SMC

Dept./ Area	Intervention	Energy Saving/ Generation MU	Annual Saving INR million	Net Investment INR Million
Water Supply System	Re-engineering of Water Transmission Routes	13.44	59.68	44.06
	Replacement of inefficient pump sets			
	Contract Demand Rationalization & Improvement of power factor			
	Coating of impeller, replacement of impeller & bowl assembly			
	Replacement of Zero Velocity Valve			
Street Lighting System	Conversion of conventional fluorescent luminaires in to energy efficient luminaires having electronic ballasts & hi-lumen T-8 fl lamps	4.54	14.96	12.6
	Switching "OFF" Streetlights During Low Traffic Period			
	Installation of Energy Conservation Feeder Pillar based on Central Voltage Reduction Method			
Others	Rationalisation CD & Improvement of PF at HT Services	0.6	4.02	13.08
	Replacement of inefficient pump sets & trimming of impellers			
	Installation of LED Based Traffic Signals			
	Switching "OFF" Filtration Plant during non-usage hours at Rustampura Swimming Pool			
	Total (EE/Energy Conservation)	18.59	78.67	69.74
RE Measure	Total (Energy Generation from Bio Gas)	6.87	31.83	174
	Net Energy Generation From Wind Power- Year 2010-11	1.3	6.4	184.4
	Total RE	8.17	38.23	358.4
	Grand Total (RE + EE)	26.76	116.90	428.1
	Total Consumption (MU)	144.84	-	-
	Consumption / Generation Ratio	5.41		

4.2 Commercial

Table 16: Energy Consumption and demand projection in Comercial Sector

Year	2006-07	2007-08	2008-09	2009-10	2010-11	Growth rate (%)	Demand Projection
Energy Source					**(Baseline)**		**2015-16**
Electricity(MU)	541.82	581.80	632.13	684.43	760.51	8.41	1138.60
PNG (Tonnes)	6401.04	7945.75	9873.93	12690.00	14331.72	20.80	36869.65
LPG (Tonnes)	34953.26	35104.12	36861.52	36314.98	36949.40	2.25	41297.52

Source: Various energy supply agencies

The growth rate of electricity consumption in the commercial sector is arrived at by taking the weighted average growth rate of the electricity supplied by the two Discoms. The PNG consumption is growing at a five year CAGR of 20.8 %. The LPG consumption data however is increasing at a growth rate of 2.25 %, calculated by taking CAGR up to the past seven years. In the commercial sector, major usage of gas is in eating outlets including hotels and restaurants. The other commercial users include hospitals, hotels, canteens, bakeries etc.

4.3 Transportation

With the rise in population, income level and ever increasing industrial and commercial activities the transportation sector is poised for a substantial growth in terms of number of commercial, passenger and heavy motor vehicles added every year. The compounded 5 yearly growth rate of vehicles added in the city is estimated to be 34.14 % for the period from 2011- to 2016. So by the end of the financial year 2015 the new vehicles added would be around 708734 and by the end of financial year 2015-2016 the total registered vehicles in the city will reach 2383506.

Table 17: Types and number of vehicles in Surat City

	Number of Vehicles added						
Passenger vehicle Type	1990-95	95-00	2000-05	10-May	CAGR (%)	Projected addition between 2010-15	Number of Registered vehicles as on April 2011
Two-wheeler	148760	210535	308943	401924	33.65	537171	1381156
Three-Wheeler	6450	14441	19061	24133	42.36	34356	82305
Motor car	13796	24999	38172	68067	52.12	103544	191472
Taxi	694	97	844	743	23.68	919	2961

Bus	218	344	310	628	30.7	821	2116
jeep	1652	2577	2819	4403	30.31	5738	14762
Total passenger vehicle added	171570	252993	370149	499898		682548	
Sum of all category of vehicle added	191204	278941	401581	528354	34.14	708734	

Source: Regional Transport Office (RTO)

The requirement of energy in the transportation sector is derived from Motor Spirit (MS), High Speed Diesel (HSD), Compressed Natural Gas (CNG) and Auto LPG. The supply of transportation fuel is mainly dominated by three big oil companies, namely, IOCL, BPCl and HPCL.

Table 18: Energy consumption in Transportation Sector

Year	MS	HSD	CNG
	('000 KL)	('000 KL)	('000 Tonnes)
2006-07	92.02	44.53	29.66
2007-08	106.23	56.96	42.11
2008-09	113.23	63.82	51.52
2009-10	120.57	71.18	57.15
2010-11	128.28	83.04	63.72
8 year CAGR (%)	2.59	5.77	18.35
Projected Consumption	145.78	109.92	147.95

Source : Oil and gas supply agencies

The usage of gas in transportation sector is slightly different from other sectors. Whereas gas is supplied through pipelines continuously for other applications, for automotive applications gas is filled in cylinder fitted to the automobiles. The main advantage of gas for automotive application is that they are pollution free, and provide a cleaner atmosphere in congested cities. In addition, running on CNG yield higher combustion efficiency with resultant cost advantage.

For commercial vehicles to switch to CNG, the major drive has to come from Government regulations. Regulations may lead to conversion of commercial vehicles such as auto rickshaws, taxis, buses, buses into CNG. So for transformation to happen in the transportation sector, thrust should come from the commercial vehicle segment. Once sufficient demand is created and decent supply infrastructure is established, then private vehicles shall also convert to CNG in large numbers which happened in Delhi. The conversion from petrol and diesel to CNG will also be guided by its economic feasibility and its supply in the market. Hence, a robust growth of CNG consumption is expected during 2011 to 2016.

4.4 Residential

Table 19: Baseline Energy Consumption and Demand Forecasting in Residential Area

Year	2006-07	2007-08	2008-09	2009-10	2010-11	Growth rate (%)	Demand Projection	
Energy Source					**(Baseline)**		**2015-16**	**2020-21**
Electricity (MU)	832.6	856.808	1012.079	1068.68	1170.2497	7.9	1711.53	2503.19
LPG ('000 Tonnes)	62.65	64.26	64.43	67.09	73.97	3.75	88.92	106.89
PNG ('000 Tonnes)	22.93	23.19	27.58	29.22	29.95	7.65	43.29	62.59
Kerosene ('000 KL)	84.45	90.44	92.99	82.27	64	-6.5	45.73	32.68

Source: Various energy supply agencies

The electricity consumption in the household sector is rapidly increasing and is shown in fig 3. The growth rate of electricity consumption in the commercial sector is arrived at by taking the weighted average growth rate of the electricity supplied by the two Discoms. The growth rate for the consumption of LPG, PNG, and Kerosene has been calculated based on CAGR up to past 5 years.

With rise in population and rise in family income energy consumption has shown a continuously increasing trend. Growth rate in the consumption of electricity in this sector has been arrived at by giving due consideration to historical trends, expected developmental plans and per capita consumption trends of new and old consumers. The electricity consumption in the base year was 1170.2 MU and the consumption is expected to rise at a rate of 7.9 %. The projected demand based on the expected growth rate is 1711.53 MU for 2015-16.

Similarly, LPG and PNG consumption has also shown an increasing trend. GGCL has established a far reaching PNG gas distribution system in the residential, commercial and industrial sectors. This is evident from the higher growth rate value of PNG consumption as compared to the growth rate of LPG consumption. Kerosene consumption however, has shown a decreasing trend with a CAGR calculated up to past five years has shown a negative growth rate of 6.5%. With ever improving PNG distribution infrastructure in the city coupled with rising petroleum product prices, an increase in the number of households using PNG as cooking and water heating purposes is expected to rise thereby diminishing the use of LPG and Kerosene usage.

PNG in the domestic sector is used as a cooking fuel, replacing the presently used fuels like LPG and kerosene. PNG is continuously available on tap without any need for ordering refills. PNG can also be used as water and space heating purposes.

4.5 Industrial

DGVCL and TPL have separately predicted the demand growth rate under both LT and HT categories of industrial consumption. So the final growth rate in the LT and HT categories is arrived at by taking the weighted average growth rates given by the two Discoms wherein sum of electricity consumption over a period from 2007 to 2011 were taken as weights.

Table 20: Baseline Energy Consumption and Demand Forecasting in Industrial Sector

Year		**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**Growth rate (%)**	**Demand Projection**	
Energy Source						**(Baseline)**		**2015-16**	**2020-21**
Electricity (MU)	LT	3250.9	3454.3	3363.5	3597.9	3608.5	3.45	4275.45	5065.64
	HT	843.3	863.4	1163.9	1242.5	1336.5	4.54	1668.74	2083.54
	Total	4094.2	4317.7	4527.4	4840.3	4945		5944.19	7149.4
PNG (000' Tonnes)		105.5	141.4	127.2	103.1	112.8	1.82	123.47	211.8
Coal (000' Tonnes)		820.1	721.4	799.5	1080.1	1477.8	6.33	2008.54	2730

Source: Various energy supply agencies

Industries that consume PNG mainly are chemical, and Dying & printing. On the basis of the field contact with different industries, the average growth rate is estimated to be 6.33 %. Coal is primarily being consumed in the industrial sector.

In the industrial sector, Natural gas can replace the liquid and gaseous fuels such as Furnace Oil (FO), Light Diesel Oil (LDO), High Speed Diesel (HSD) etc. and LPG used for the heating purposes. Solid fuel such as coal, coke, wood, husk, and bagasse can also be replaced by Natural Gas on account of cleaner burning and longer equipment life. However, the mechanism of change over from solid fuel to natural gas is complex and needs to be viewed, reckoning economic viability and eco-friendliness. In industries, firing and heating in furnaces, kilns, boilers etc. can be carried out using Natural Gas (NG) instead of alternate liquid fuels like HSD, LDO, FO and solid fules like coal and coke. However conversion requires change of burners and installation of pipelines and in some cases, altogether replacement of the equipment.

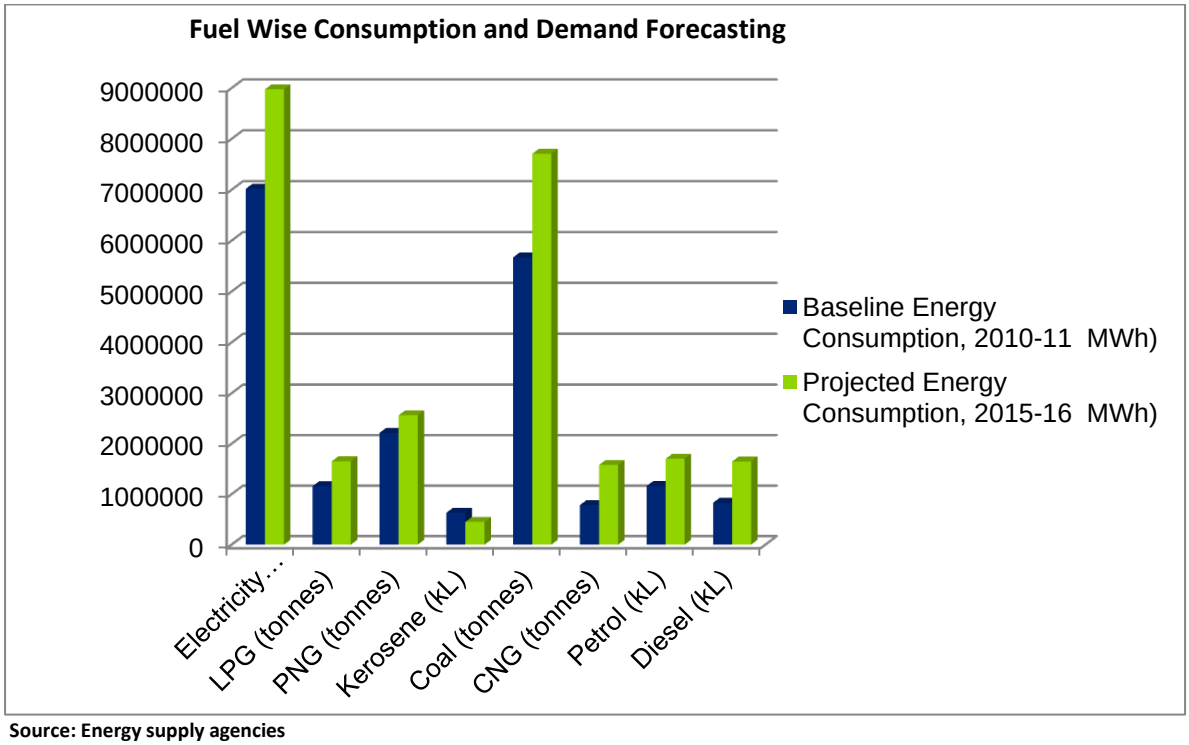
4.6 Gross Energy Consumption and GHG Emission

Table 21: Fuel Wise Gross Energy Consumption of the City and Demand Projection

Energy Source	Baseline Energy Consumption, 2010-11		Projected Energy Consumption, 2015-16		Baseline Emission, 2010-11	Projected Emission, 2015-16
	Std. Unit	(MWh)	Std. Unit	(MWh)	('000 tCO2)	('000 tCO2)
Electricity (GWH)	7020.65	7021910	8974.03	8975644	5897.3	7538.2
LPG (tonnes)	88299.9	1160428	125795	1653189	974.58	1388.4
PNG (tonnes)	179734	2215723	208053	2564841	1860.9	2154.1
Kerosene (kL)	63999	632662.1	45747.8	452240.3	531.34	379.81
Coal (tonnes)	1477753	5671469	2008542	7708584	4763.2	6474
CNG (tonnes)	63719.3	785519	128162	1579959	659.72	1326.9
Petrol (kL)	128283	1163706	187714	1702833	977.34	1430.1
Diesel (kL)	83035	830499.5	164774	1648038	697.49	1384.1
Total		19481916		26285328	16362	22076

Source: Energy supply agencies and IPCC default emission values

Figure 12: Fuel Wise Energy Consumption and Demand Forecasting



Source: Energy supply agencies

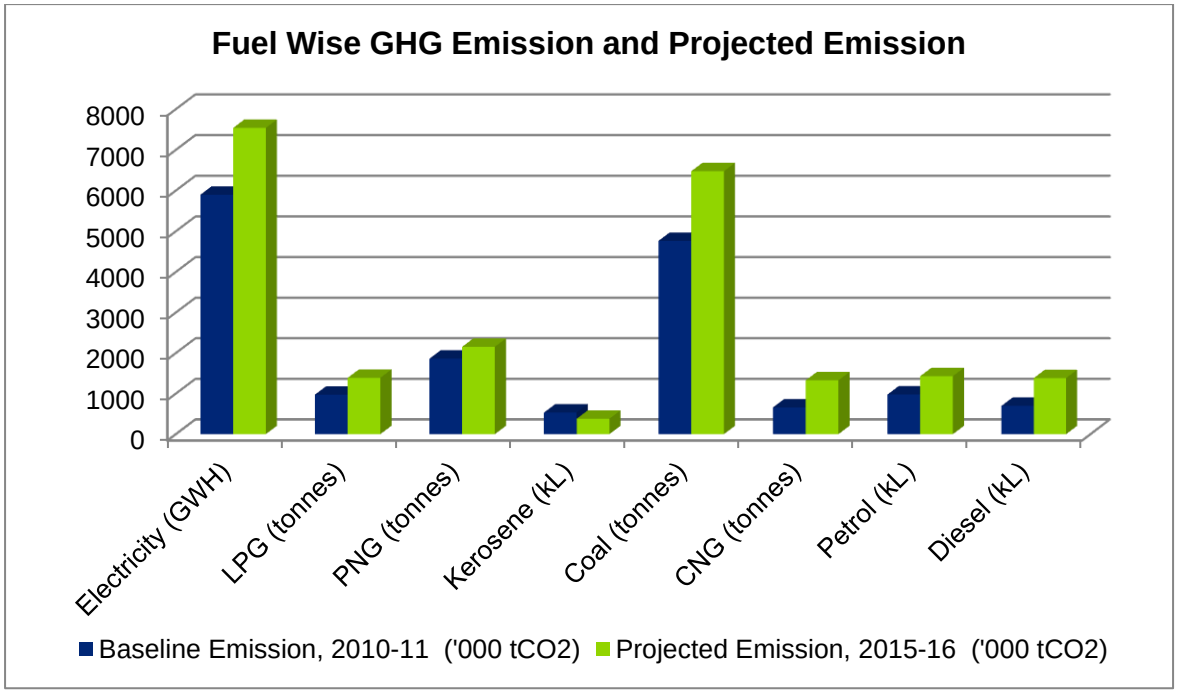


Figure 13: Fuel Wise GHG Emission and Projected Emission

Source: IPCC default emission values and local grid emission factor

Per capita energy demand for Surat city during the year 2010-11 has been as estimated to be 380.34 kg oil equivalent/annum. The projected per capita energy demand by the year 2015-2016 is expected to be 405.83 kg oil equivalent/ annum. This shows a 6.7 % growth in per capita energy demand in five years. The gross energy demand during the year 2010-11 was 1.67 MTOE whereas it is expected to reach 2.2 MTOE in the year 2015-16. This shows an average annual growth rate of 6.64% and a 5 yearly growth rate of 33.21 %. The population growth rate per annum is estimated to be around 5 %. Hence, the energy consumption per capita per annum is growing at a higher rate than the annual population growth rate. This indicates an increasing energy intensive lifestyle and production in the city.

Table 22: Annual Growth Rate in Energy Consumption across Different Sectors

Sector	Yearly Growth Rate in Energy Consumption				
	Energy Consumption (MU)2010-11	**%age**	**Projected Annual Growth Rate**	**Projected Energy Consumption(MU) 2015-16**	**%age**
Residential	3143	16.14	4.60%	3865.69	14.71
Industrial	12006	61.64	5.90%	15173.18	57.74
Commercial	1404	7.21	10.30%	2,132.07	8.11
Municipal	144.84	0.74	3.80%	179.70	0.68
Transportation	2779	14.27	10.50%	4929.9	18.76
Total	**19476.84**	100.00	**6.90%**	**26280.5**	100.00

The gross energy consumption for the city in 2010-11 reached a value of 19477. The gross energy consumption is expected to reach a value of 26280 MU by 2015-16 with an annual average growth rate of 6.9%.

5 ENERGY PLANNING AND SECTOR WISE STRATEGY

From the baseline energy consumption analysis it is observed that the main consumers of energy are Residential, Commercial, and Institutional, Industrial and Municipal sector. It has also been observed from the energy baseline study that energy demand in the city is increasing rapidly due to the following reasons

- Increasing population
- Increasing standard of living
- Increasing commercial and industrial activity

5.1 Assessment of Renewable Energy Resources

Resource assessment is the primary and essential step towards the project identification and evaluation. Various option of generating power form renewable energy resources has been assessed in the subsequent sections.

Biomass like agro-waste in the form of straws and stalks, agro-industrial processing residues such as paddy straw, rice-husks, wheat straw, wheat-husk, mustered – husk etc. and wood from dedicated energy plantations and forest waste can be used as a fuel for power generation. Surat City covers an area of 326.52 km^2 in which 58.70 km^2 area falls under the agricultural area. For economic viability of a biomass based power generation, required volume of agricultural waste will pose a serious challenge within the city limits and its transportation from neighboring villages may not make for a cost effective power generation. The other possible source of biomass within the city boundary is wood. But the forest cover within the city boundary is scanty and dedicated plantation for biomass production is not feasible in the time span of five years. Hence, Biomass generation for Surat city is being ruled out as one of the strategic measures to reduce the fossil fuel consumption.

5.1.1 Waste to Energy

The average generation of municipal Solid Waste (MSW) in Surat city during the year 2010-11 was 1143 MT per day. The characterization of MSW indicates that 60-65% of the waste is kitchen organic waste which contains wet and dry organic matters. Balance constitutes paper, metals, glass, textiles, plastics and polythene and other debris. According to information received from the Surat municipal office, city has door to door waste collection facility, container lifting and secondary lifting with collection efficiency about 80 to 85 %.

Municipal Corporation has power generation ambition from its waste collected. The four end products which are derived from the MSW are as below:

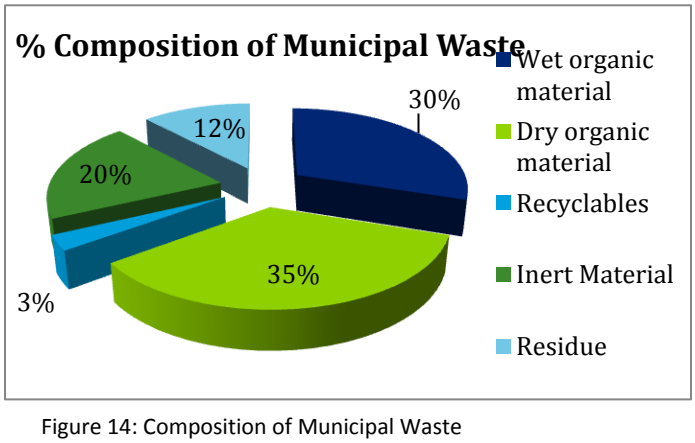


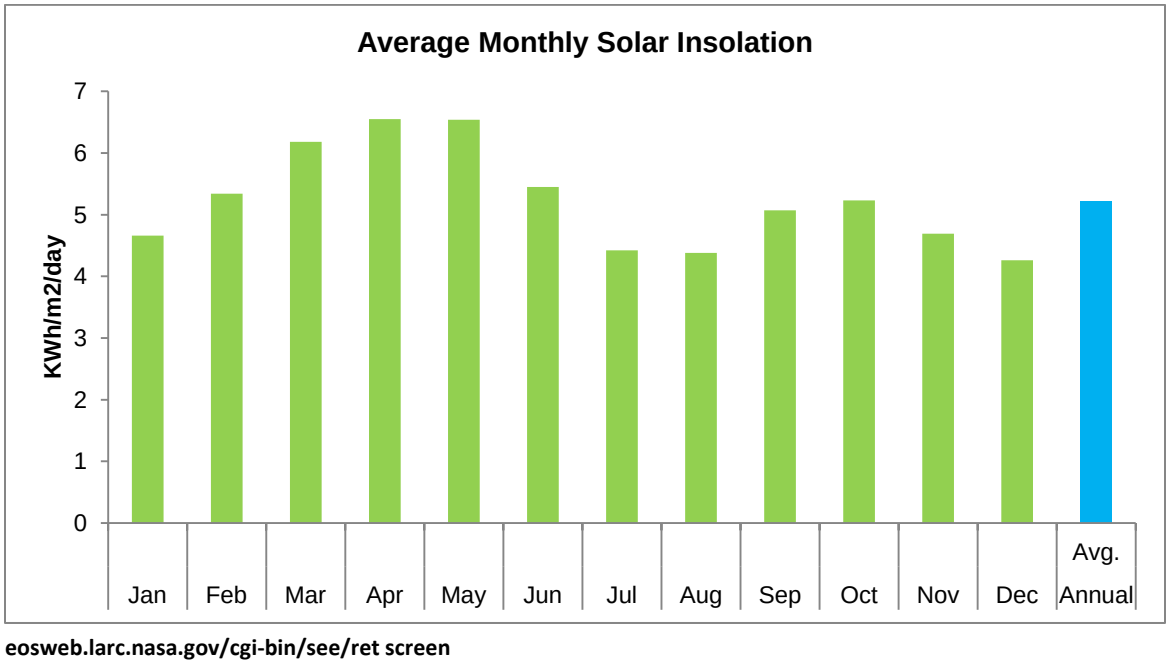
Figure 14: Composition of Municipal Waste
Source: Hanger Biotech Energies Private Ltd

1.Compost – Bio Organic Fertilizer (from wet waste).
2.Green Fuel – Refined RDF (from dry waste)
3.Sand - for construction activity (from inert waste).
4.Metals and Plastics being recycled (from recyclables)

5.1.2 Solar Energy:

The energy content of solar radiation can be used as light, heat and electricity. This diversity makes solar energy an important option to power different energy system all over the world. The interest in solar energy system has been increasing in the recent years throughout the world.

Most part of India is enabling with rich solar energy resource since it is located in the equatorial sun belt of the earth. The daily average solar energy incident over India varies from 4 to 7 kWh/m^2 with about 2,300–3,200 sunshine hours per year, depending upon location. The daily average global radiation is around 5 Kwh/m2 in north - eastern and hilly areas to about 7 Kwh/m2 in Western regions and desert areas. The monthly average global insolation for all the states is more than 5.25kWh/m2/day for three months - March, April and May. Distribution of monthly diffused solar radiation (kWh/m2) in Surat is given in the graph below.



Source: eosweb.larc.nasa.gov/cgi-bin/see/ret screen

Available solar radiation is sufficient to utilize it efficiently for various applications across all the sectors like Residential, Commercial, Institutional, Industrial and Municipal. The two most important applications of solar energy are Solar Thermal Application and Electricity Generation. The assessment of potential application of solar thermal as well as electrical application is discussed below.

Solar Thermal Applications: It can be used for water heating, space heating, process heat generation and solar cooking in the city. Residents, Hotels, Hospitals and Institutes need hot water almost 6-7 months during the year for bathing, cloth-cleaning, drinking and other purpose, but demand increases during the winter season. During the primary field contact done across various sectors it was observed that, till date penetration of the solar water heater in is very low. Most of the hotels, institutes, and households are still using the electrical geysers and LPG stoves to fulfill the need of hot water. There is great potential for the application of solar thermal technologies particularly Solar Water Heaters (SWH) instead of conventional electrical geysers in the residential, commercial, institutional and other sector. There is also scope of Solar Steam Cooking System application instead of LPG stoves for large scale food cooking in the institutional sector.

Solar Electrical Applications: Solar energy can be used for large scale electricity generation for commercial applications as well as small scale power generation for captive use. Electricity generated is either made available to users through a local grid in a 'stand-alone' mode or connected to the conventional power grid in a 'grid-interactive' mode. Stand-alone power plants provide grid-quality power locally to people to meet their requirements for lighting and other needs. There are also various off-grid applications of solar energy.

Grid Connected Solar Power Technology: The two well establish technology for electricity generation using solar radiation are Concentrating Solar Thermal (CST) and Solar Photovoltaic (SPV).It can be further sub divided based on the basis of type of concentrating device used, type of SPV Panels and type of materials used for SPV Cells. Different type of solar power plant is given below in the chart.

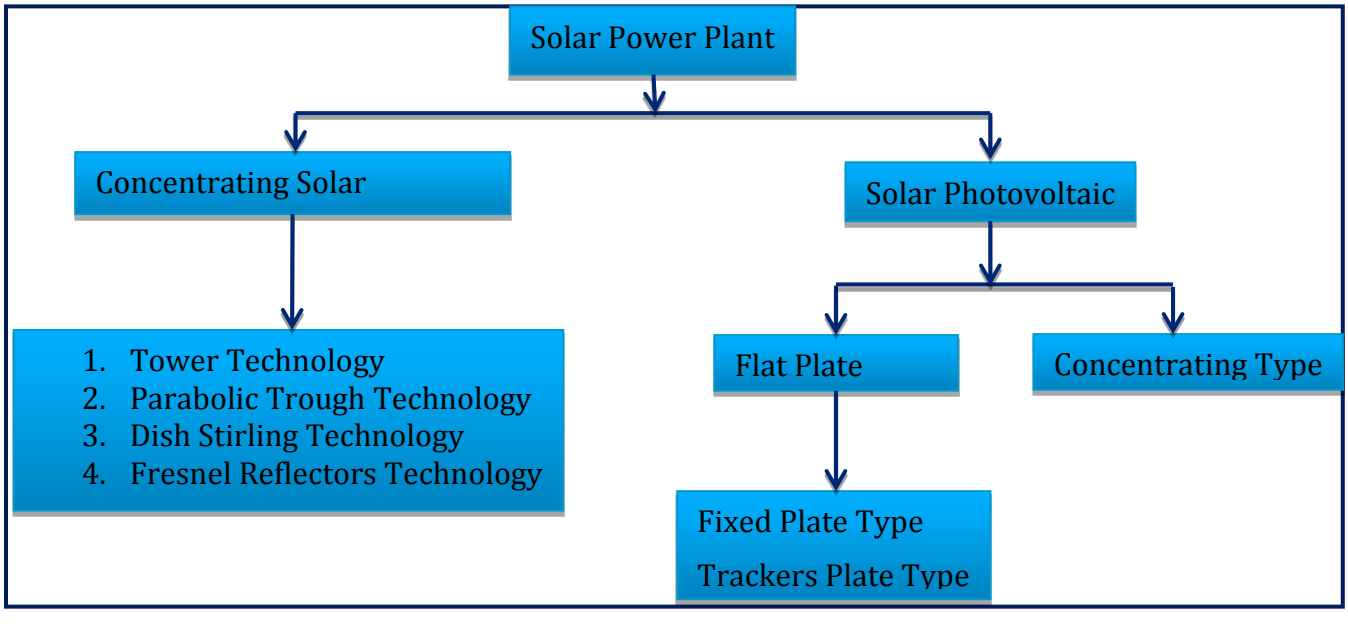


Figure 15: Categories of Solar Power Plant

Large Solar Power Plant in: Both type (CST & SPV) large scale grid connected solar power plants not only need large space, but space that gets a consistent amount of direct sunlight for the efficient production of electricity.
Land Requirement: The land area required for the solar plant is dependent on the amount of solar energy falling

on the Earth, the efficiency of conversion of solar energy to electricity and the amount of open space between the collectors.The following table shows the total area needed to construct a typical fixed and tracking flat type SPV installation of 1 MW capacity.

Table 23: Land Area Requirement for different SPVs

Capacity	Type of Technology	Area Required (Acres)
1MW	Fixed Mont –SPV(Thin-film)	7.5 acres
1MW	Fixed Mount-SPV(Crystalline Silicon)	3.5 acres
1MW	Tracking SPV- 1 axis (Crystalline Silicon)	12 acres(x=215,y=215m)
1MW	Tracking SPV- 2 axes (Crystalline Silicon)	12,5 acres(x=225, y=225)

Source: www.abengoasolar.com

Technology: Fixed flat PV technology is commercially proven and best suitable technology. Costs associated with the technology are high, but the technology is well known and reliable. More recent developments use PV collectors that track the Sun to allow collection of a greater amount of energy and concentrating photovoltaic (CPV) systems that focus the collected solar energy into a smaller area. SPV can be easily connected to the distribution network at the domestic level of 240V or at higher voltage, depending on the size and location of the generating plant.

Off-Grid Application of Solar power: There are huge potential of off-Grid application of solar PV through roof top based solar PV. SPV of different capacities ranging from 5kW to 50Kw can be installed on the roof top of official buildings, Hotels, Hospitals, Institutional buildings in stand-alone mode for the captive use. Solar Street Lighting is the potential application in Municipal Sector. Some other applications are Home Lighting, Solar Lanterns etc. Detail of off-grid application has been discussed further in sector wise energy planning.

5.1.3 Wind Power:

Generation of electricity from wind mainly depends upon the wind density and speed of the wind

5.1.4 Wind Power

A minimum wind speed (Cut-in Speed) is required at which the wind turbine can generate usable power. This wind speed is typically between 7 and 10 mph for most turbines. Centre of Wind Energy Technology(C-WET) which is an autonomous institution by the Ministry of New and Renewable Energy, Government of India, identifies resource rich regions in the country by conducting wind resource micro survey. Gujrat is blessed with good wind velocity. The total wind power potential in Gujrat is around 10609 MW. Wind based power can be set up by the industry owners within Surat city and power purchase agreement can appropriately be worked out with the distribution companies.

5.2 Assessment of Energy Conservations Options

After the analysis of data received from the primary and secondary survey conducted across various sectors it has been observed that there are massive potentials of energy savings by using different measures such as improving the energy efficiency, improving the power factor, retrofitting or replacing the existing energy consuming appliance and systems. The measures which can be widely used in each consumer category and likely to have a significant potential for energy efficiency improvement include lighting, refrigeration, air conditioning, water heating, motors, and water pump sets. Sector wise measures have been discussed in the subsequent sections of the report. Marginal investments are required for improving energy efficiency/retrofitting which can be justified by the short payback periods. By implementing energy conservation measures across different sectors the projected demand can be reduced significantly. Tangible result can be achieved by adopting various models for implementing the energy efficiency projects. One of the very popular models for implementing the energy efficiency projects across various sectors is Energy Services Company Model (ESCO).The concept of ESCO.

5.2.1 ESCOs Model for Energy Saving Projects:

An Energy Services Companies (ESCOs) offers broad range of comprehensive energy solutions including designs and implementation of energy savings projects including a guarantee of the savings. The remuneration of ESCO is linked to the projects performance, which means the ESCO's payment is directly linked to the amount of energy saved.

The ESCO performs an in-depth analysis of the system-designs and energy efficient solution, installs/replaces/retrofits the required elements, and maintains the system to ensure energy savings during the payback period .The savings in energy costs is often used to pay back the capital investment of the project over five to twenty year period. List of qualified ESCOs are available on the BEE website.

5.2.2 “Smart grid” application:

It generally refers to a class of technology people are using to bring utility electricity delivery systems into the 21st century, using computer-based remote control and automation. They are beginning to be used on electricity networks, from the power plants and wind farms all the way to the consumers of electricity in homes and businesses. They offer many benefits to utilities and consumers -- mostly seen in big improvements in energy efficiency on the electricity grid and in the energy users’ homes and offices. Test a smart grid application in a zone/designated district in Surat.

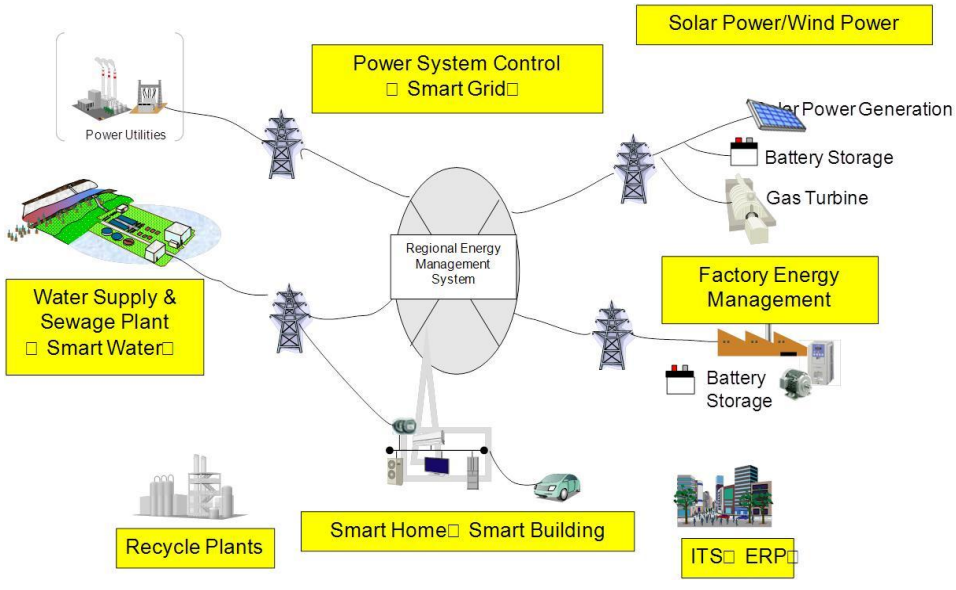


Figure 16: Schematic representation of smart grid

5.2.3 Demand Response:

Demand response provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives. Demand response programs are being used by electric system planners and operators as resource options for balancing supply and demand. Such programs can lower the cost of electricity in wholesale markets, and in turn, lead to lower retail rates. Methods of engaging customers in demand response efforts include offering time-based rates such as time-of-use pricing, critical peak pricing, variable peak pricing, real time pricing, and critical peak rebates. It also includes direct load control programs which provide the ability for power companies to cycle air conditioners and water heaters on and off during periods of peak demand in exchange for a financial incentive and lower electric bills.

5.3 Sector wise Strategies

5.3.1 Municipal Sector

As is common with most municipalities, the major energy loads in Surat Municipal Corporation are typically the water supply and drainage systems and street lighting. SMC spends a large percentage of its annual budget on electricity bill for water-supply, drainage systems & Street Lighting. The total energy consumed by street lighting systems in the base year 2010-11 was 24 MU. Percentage brake-up of energy conservation by each service is given below in the chart. Water works and street lighting systems are the most energy intensive services in municipal sector. Street lighting systems and water works together accounts for 87% of the total energy consumption. Although SMC has taken a lot of initiative for energy conservation and renewable energy interventions but still there is potential for energy conservation and renewable energy.

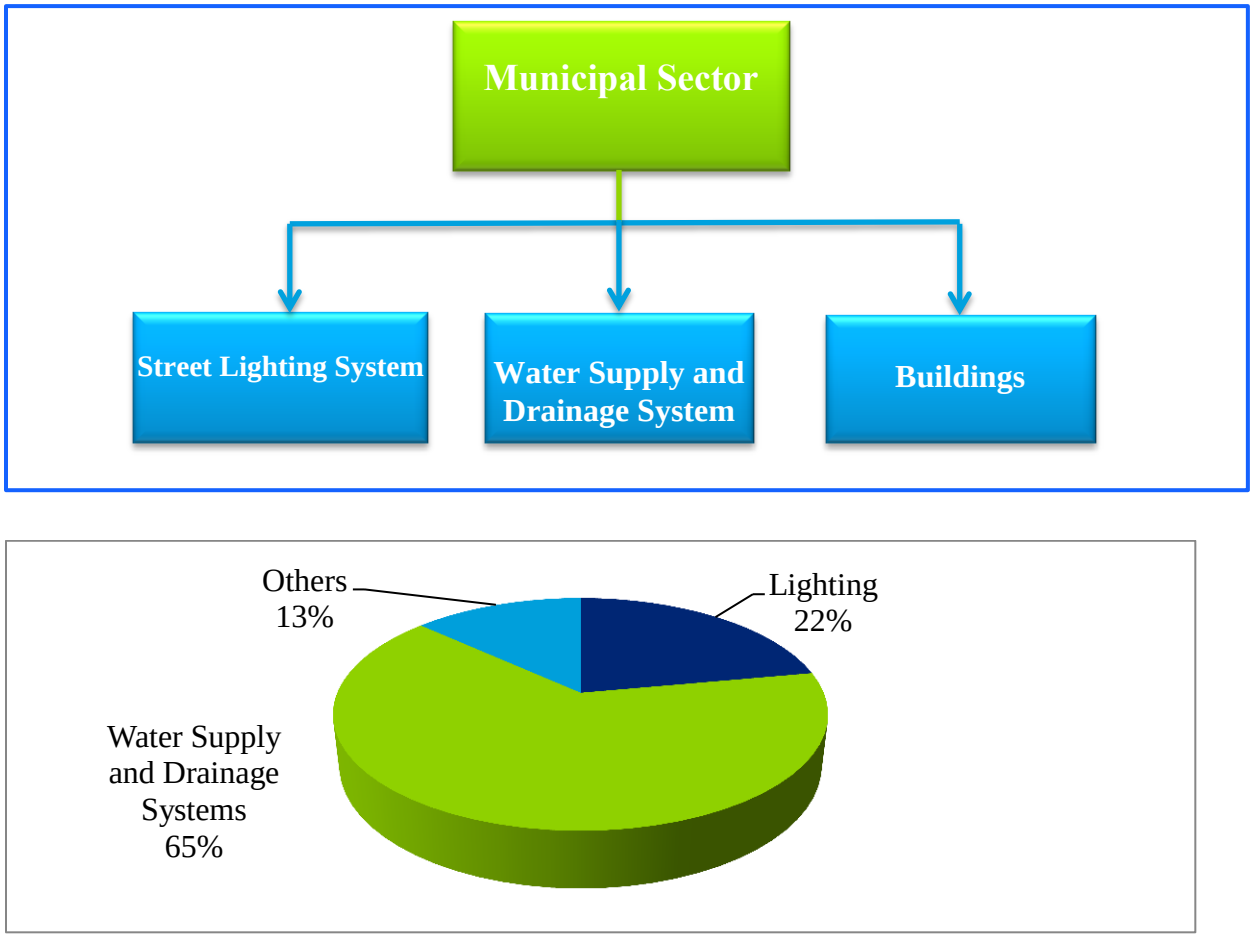


Figure 17: Energy Consumption Scenario in the Baseline year-2010-11 in Municipal Sector

5.3.1.1 Energy Conservation Strategy

Efficient Lamps: Based on the data collected/received from the SMC it has been found that existing street lighting system is modest efficient system. Existing 1 x 36 W fl luminaires and 1 x 70 W HPSV-T luminaires can be replaced by 25/ 45-50 W LED luminaires. This can be implemented in phased manner under solar city program.

Replace Existing Ballast with-Multi Tab Ballast: Existing ballast can be replaced by the multi tab ballast which varies load of the lamp according to the need. It comes with the option of setting the time. During peak hours like in the evening, timer can be set for the 100% loading of lamp and during midnight onwards it will be set for 80 -85% loading and as a result considerable amount of energy can be saved.

Installation of Tele Management Systems for Streetlights: It is a software based system which enables individual light points to be switched on or off at any given time, or to be set to any dimming level that the lamp allows, ensuring maximum flexibility for the lighting installation. For example, one section can be switched off, another dimmed to 90 percent and yet another to 40 percent, without any special electrical connections being required.

It is also possible to program scenarios so that the lighting installation modifies its output depending on

programmed times, weather sensors and/or traffic measurement devices. A good amount of energy can saved installing and synchronizing this device with the street lighting system.

Installation of Lighting Load Monitoring System: Lighting Load Monitoring system is an advanced digital light timer switch for outdoor lighting solutions which is a real time device for energy conservation is street lighting. It can save energy up to **8 %** against conventional manual operation by precisely changing ON and OFF time on daily basis.
In addition it has settable real-time based staggering facility to turn OFF streetlight / energy down mode when there is no / low traffic by late night and turn ON by early morning or full energy mode when traffic starts. This can save total energy up to 33 % depending upon staggering / energy down mode timings. This can be installed by the municipal corporation through ESCO route.

Installation of Solar Street Lights: Installation of Solar Street lighting is an interesting option. It not only saves electricity bill but also contribute to a cleaner environment by reducing the GHG emissions. Installation of 7000 (74W) solar street lighting system in the next five year in phased manner 200 installation in each zone every year will save the 7.70 MU of electricity and will reduce the emission of 6500tCO_2e.

A typical street lighting system comprises a 74 watt photovoltaic module, and 12-hour battery is available for Rs. 24,000-28000, of which Rs. 9,600 is subsidized by the Central government as Central Financial Assistance for non-commercial purposes. An additional amount of Rs.900 will take care of maintenance for five years. These are typically for most MNRE subsidized projects.

5.3.1.2 Renewable Energy Intervention:

Grid Connected SPV Plant of Various capacities of 50 kWp to 500 kWp Off-grid/ Grid Connected SPV power plant can be installed at various water works, water distribution stations, sewage treatment plants, Science Centre and offices etc. Installation of 1 MW SPV plant can generate 1.45 GWH per annum of electricity

Figure 18: RE and EE Intervention in Municipal Sector and its Expected Energy Savings

Intervention Type	Intervention Description	Target No.	Energy Savings(MU)
		Total	
EE	Replacement of inefficient pump sets(170 HP)	100	6.21
	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	10000	0.35
	Replacement of 70 W HPSV luminaires with 45 W LED luminaires	3500	0.49
	Replacement of 36 W FL luminaires with 25 W LED luminaires	40000	0.80

RE	MSW based Power Plant(10MW)	1	67.98
	MSW based Power Plant(6.25MW)	1	42.49
	Bio Gas based Power Plant(0.575MW)	4	8.06
	SPV Power Plant(100kWp)	20	3.05
	SPV Power Plant(150kWp)	20	4.58
	Solar Water Heating Systems(200LPD)	95	0.24
	Wind Power Plant(2.1MW)	10	39.74
	Total Energy Savings		134.25

Figure 19: Investment Required to Meet the Targeted Intervention

Intervention Type	Intervention Description	Total Capacity	Total Investment Required INR Million	Government Subsidy INR Million	Users Contribution INR Million
EE	Replacement of inefficient pump sets(170 HP)	17,000 HP	140.00	0.00	140.00
	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	---	4.00	0.00	4.00
	Replacement of 70 W HPSV luminaires with 45 W LED luminaires	---	17.50	0.00	17.50
	Replacement of 36 W FL luminaires with 25 W LED luminaires	---	120.00	0.00	120.00
RE	MSW based Power Plant(10MW)	10 MW	1,540.00	0.00	1,540.00
	MSW based Power Plant(6.25MW)	6.25 MW	962.50	0.00	962.50
	Bio Gas based Power Plant(0.575MW)	2.30 MW	149.50	0.00	149.50
	SPV Power Plant(100kWp)	2,000 kWp	160.00	40.00	120.00
	SPV Power Plant(150kWp)	3,000 kWp	240.00	60.00	180.00
	Solar Water Heating Systems(200LPD)	19,000 LPD	2.99	0.90	2.09
	Wind Power Plant(2.1MW)	21.00 MW	1,302.00	260.40	1,041.60
	Total Investment		**4,639**	**361**	**4,277**

5.3.2 Commercial & Institutional Sector

This segment consists of commercial establishments such as hotels, restaurants, malls, shopping complexes,

local markets and education institutes like schools, colleges, research institutes, and hospitals. Commercial and textile Complexes are spread all over the city

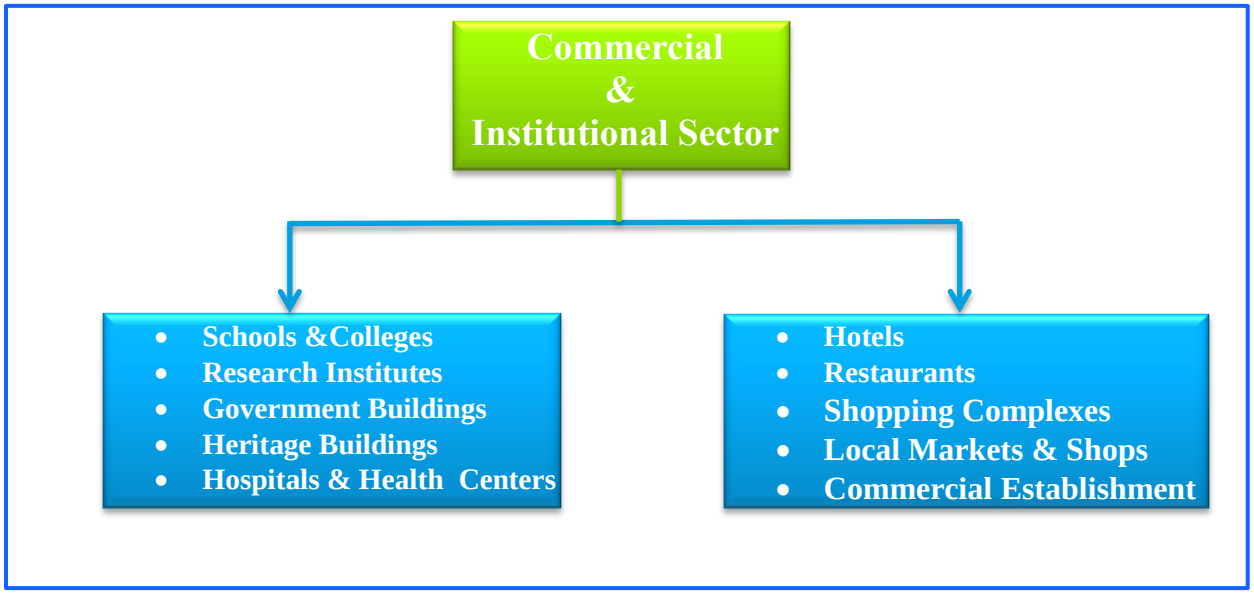


Figure 20: Overview of Commercial & Institutional Sector

The main energy load in this sector are lighting, fans, ACs, cooking, water heating and Water Pumping, During the field contact it has been found that not much attention has been paid towards the energy efficiency in this sector. There exist a significant potential to improve energy efficiency in existing Educational Buildings, Hospitals, Hotels, Government & Private office Buildings, Restaurants and subsequent reduction of commercial sector energy demand at city level. According to data received form SMC energy consumption of this sector was in the baseline year 2010-11 is 107290 MWh

5.3.2.1 Energy Efficiency Strategy

Efficient Lighting System: During the field contact it has been found that there is huge potential of energy saving in the lighting system in the commercial & Institutional sectors. Schools, Hotels, Office Buildings and Commercial complexes in the city are still using inefficient lamps like T-12 and incandescent bulbs. These must be replaced by energy efficient lamps like T-8, T-5, CFLs and LEDs.

Schools, College, Research Institute, Hotels, Restaurants, Malls, Government & Private 0ffice Buildings, Malls, Shopping Complexes, Hotels, Guest Houses which constitute of at least 50375 units and 40000[3] shops. Replacing at least one T-12 & one 40 W Incandescent bulb with T-5 & 16 W CFL respectively can save 10 MU of electricity and reduce 8657tCO_2e of GHG emission.

[3] SGCCI Pre Draft Report

Mandatory Installation of Solar Water Heating System (SWHS): During field contact it has been observed that most of the hotels, restaurants and commercial complexes in Surat presently use gas geysers or boilers to cater their hot water requirement for various use such as in the guest rooms, laundry and kitchen etc.
GEDA/SMC should frame a policy to install at least 500 LPD SWHS for all Hotels, Restaurants, Hospitals and Residential Institutes. Installation of nine thousand 100 LPD SWHS across commercial and institutional sectors will save 11 MU of electricity and will reduce emission of 9350 tCO_2e annually.

Existing AC Replacement by BEE 5* AC: During the field contact it has been found that most hotels, Restaurants, Institutions commercial complexes use AC for the space cooling purposes for 10-11 months in a year. The capacities of ACs used in the commercial and institutional sectors are from 1.5 -12 TR. Few new installations are energy efficient but 80 to 85% users are still using old and energy inefficient ACs. Assuming 85% of the total consumer in this sector the 1.5 TR window AC for 8 hours per day for 10 months and replacing it with 5* BEE rated AC can save 161 MU of electricity in the next 5 years and the corresponding emission reduction will be approximately 137000 tCO_2e.

5.3.2.2 Renewable Energy Interventions

Installation of Roof-Top SPV Panels for Power Generation: 1kWp to 50 kWp grid connected/off-grid SPV panels can be installed on the roof top of commercial and institutional buildings depending on the rooftop area available. SGEDA should make mandatory the installation of the SPV panels depending upon the size and star rating of the hotels. Installing10 kWp SPV on all commercial and institutional buildings will contribute approximately 40MU of electricity and will reduce emission of 34400 tCO_2e.

Solar Steam Cooking for Hostels/Hospitals: Solar steam cooking systems can be installed in the residential schools, colleges and hotels for cooking food. It is a proven technology and many of the religious institutes and schools have already installed this system across India. With the financial assistance of MNRE it is now commercially viable. 275 such installation of cooking capacity for 500 people can save 1.5 MU of electricity and will reduce emission of 1200 tCO2e annually.

Biogas Pant for Hostels, Hotels and Restaurants: Biogas plant ranging from 3 to 25 kW can be installed which will use kitchen waste generated from hostels, hotels and restaurants. Installation of 275 such systems will contribute 16MU of electricity and will reduce emission of 13400 tCO2e annually. Summary of total estimated saving potential of commercial and institutional sectors is given below.

Figure 21: RE and EE Intervention in Commercial Sector and its Expected Energy Savings

Intervention Type	Intervention Description	Target No.	Energy Savings(MU)
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	440,624	19.30
	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	440,624	19.30
	Replacement of Existing AC by Energy Efficiency 5* Rated	44,062	48.41
	Replacement of Existing AC by Energy Efficiency 5* Rated	4,050	4.45
RE	Solar Water Heating Systems (200LPD)	5,060	12.65
	Solar Steam Cooking for Hostels & Hotels(500 Persons)	25	1.50
	Biogas for Hostels, Hotels and Restaurants etc.	100	0.58
	SPV Power Plant(5kW)	4,160	31.72
	Total Energy Savings		137.9

Energy conservation measures for Commercial & Institutional Sector could be attempted through an Energy saving company (ESCO) model where the ESCO would make the investment for energy conservation measures and recover the investment through energy savings. This ESCO could be tried in some commercial or office complex initially for case study purpose.

Table 24: Investment Requirement in Commercial and Institutional Sectors

Intervention Type	Intervention Description				
		Total Capacity	Total Investment Required INR Million	Government Subsidy INR Million	Users Contribution INR Million
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	---	55.08	5.51	49.57
	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	---	55.08	5.51	49.57
	Replacement of Existing AC by Energy Efficiency 5* Rated	66,093 TR.	1,542.17	154.22	1,387.95
	Replacement of Existing AC by Energy Efficiency 5* Rated	6,075 TR.	141.75	14.18	127.58
RE	Solar Water Heating Systems (200LPD)	1,012,000 LPD	159.39	47.82	111.57
	Solar Steam Cooking for Hostels & Hotels(500 Persons)	12,500 Persons	35.00	21.00	14.00
	Biogas for Hostels, Hotels and Restaurants etc.	400 CM/ Hour	2.35	1.18	1.18

	SPV Power Plant(5kW)	20,800 kWp	1,872.00	748.80	1,123.20
	Total INvestment		3863	998	2865

5.3.2.3 Other Measures

Installing HVAC system instead of Window and split AC: Most of the commercial complexes, hotels, and restaurants in the city either use window AC or split ACs. HVAC can be installed in large building premises with central control system.

Enforce and Implement Energy Conservation Building Code: Enforce Energy Conservation Building Code for all applicable buildings. After proper implementation of the ECBC code peak load can be substantially reduced.

Energy Star Rating Program for Commercial Buildings: SGEDA & SMC can jointly launch the Star Rating Program for commercials and institutional buildings in the city based on actual performance of the buildings in terms of specific energy usage. This programme would rate office buildings on a 1-5 Star scale with 5 Star labeled buildings being the most efficient. Energy Performance Index (EPI) in kWh / sqm/ year will be considered for rating the building. EPI shall be kWh/sqm/year in terms of purchased & generated electricity divided by built up area in sqm. However the total electricity would not include electricity generated from on-site renewable sources such as solar photovoltaic etc.

Energy Efficient/ Solar Building Architecture: There should be mandatory provision for upcoming new commercial & Institutional buildings to follow the solar passive architecture. This type of design/ architecture of new commercial buildings would lead to energy conservation benefitting the consumers as well as utility.10% of the cost of the building with a maximum of Rs.10.0 lakh for each project is available as financial support from MNRE for the Construction of Solar Buildings.

Installation of Building Energy Management Systems (BEMS): A Building Energy Management System (BEMS) is a computer based centralized & integrated control and monitoring system that helps to manage controls and monitor engineering services including cooling, heating, ventilation and air conditioning within a building or group of buildings. Use of a BEMS can reduce total energy costs by 10%.

Initiate Green Building/GRIHA Programme: New commercial building must implement and integrate the various rating program. In Indian scenario GRIHA which has been developed by TERI and adopted by the MNRE is the most relevant and suitable rating system.

Benefits of following GRIHA rating system)

- Up to 30% reduction in energy consumption

- Limited waste generation due to recycling
- Less consumption of water
- Reduced pollution load & liability

Some GRIHA Rated Building are given below

- Suzlon One Earth
- CESE (Centre for Environmental Sciences and Engineering) Building
- Fortis Hospital
- Common Wealth Games
- Hindustan Lever Limited

5.3.3 Transportation Sector

Strategies for Low-energy and Clean Transportation Sector

- Establish public commuter services connecting city to the surrounding areas
- Provide advanced electric/alternative fueled public transportation
- Produce transportation fuels locally from city generated waste and other sources
- Deploy advanced electric, hybrid, plug-in, or alternative fueled vehicles for all of city owned fleet
- Use neighborhood electric vehicles as a low-speed alternative to conventional vehicles

Deploy common pool of electric bikes (e.g. Zipcar)

5.3.4 Residential Sector

Residential sector is the 3rd largest consumer of energy in Surat. The gross energy consumption in the baseline year 2010-2011 was 3145 GWh. It has been found during the field contact that the main energy load in the residential sector of Surat city is Lighting, Fan, AC, Cooking and Water Heating. Due to lack of implementation of effective energy efficiency measures residential buildings in the city give rise to significant energy wastage. The other major reason is lack of awareness about the latest technology leading to less penetration of energy efficient and energy saving devices. After proper implementation of energy saving measures and increasing the solar energy contribution, huge amount of energy can be saved. Strategy for energy savings and renewable energy interventions are discussed below.

The field contact in the residential sector was conducted and sample households were selected from different municipal zones. In each of the zones households were selected in each of the three income categories namely, Low Income Group (LIG), Medium Income Group (MIG) and High Income Group (HIG). The result of the household survey is shown in the figure below.

The refrigeration and air conditioning together accounted for the highest consumption of about 45%

5.3.4.1 Energy Saving Strategy

High Efficient Lamps: Based on the filed contact It has been estimated that about 30% of the urban households in the city still use T-12 FTL and 40-100W Incandescent bulbs. Replacing 2 T-12 (40 Watt) copper ballast tube lights with the energy efficient T-5(28 Watt) electronic ballast tube light and two 40W Incandescent bulbs by

15W CFL in the next 5 years assuming average burning of 5 hours for 365 days can save 50MU electricity and corresponding emission reduction will be approximately 42000 tCO_2e.

Light Emitting Diodes (LED) is also available nowadays which are extremely energy efficient. An LED lamp generally lasts about 5 times longer than CFLs and about 25-30 times more than GLS lamp. A possible saving of more than 80% can be expected from usage of LEDs for lighting. A comparison of various parameters pertaining to the incandescent lamp and efficient lamps is given below in table 11

Table 25: Comparative Analysis of Luminaries-I

Comparison	Incandescent Lamps	Compact Florescent Lamps(CFL)	Light Emitting Diodes(LEDs)
Light Out-put(Lumens)	800	800	800
Rated Watts(W)	60	13-15	6-8 W
Lamp Life (Hours)	1200	8000	30000-40000
Electricity used(kWh) (365*5Hours)	109.5	25.55	12.78
Energy Cost@5 Rs/kWh	547.5	127.75	63.88
CO2 Emission/year(kg)	470.83	117.92	62.92
Saving/lamps/year (kWh)	-	83.95	96.725
Direct Monetary Saving(Rs.)	-	419.75	483.63
Emission Reduction/ lamps/year (kg CO2/year)	-	352.92	407.92
Cost/Lamps(Rs.)	15-20	150-175	500-700
Return on Investment (%)	-	240	69
Payback Period (Months)	-	4-5 months	13-18 months

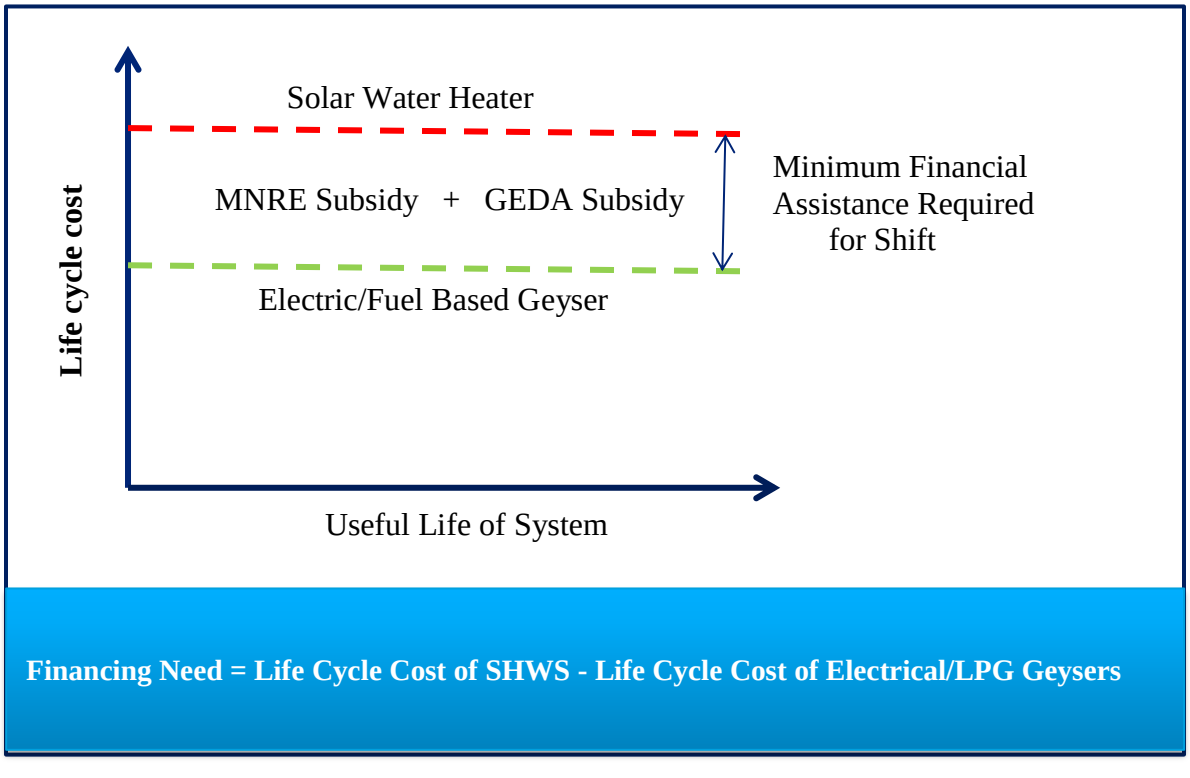
Table 26: Comparative Analysis of Luminaries -II

Characteristics	Conventional 40W FTL(T-12)	FTL (T-8)	Efficient 28W FTL(T-5)
Expected Life (hrs.)	5000	10000	20000
Energy input per hour (W)	52	36	29
Consumption in 10 hrs. per day (KW)	0.52	0.36	0.29
Annual Consumption (Units)	189.8	131.4	105.85
Yearly Energy Cost (@ Rs.5** per unit)	949	657	529.25
Annual Savings (Rs.)		292	419.75
Investment(Replacing Whole Fixture,T-12 by T-5)		300-400	450-550
Payback Period		13-17 months	12-16 months

Installation of Solar Water Heating System: Domestic consumers require hot water for approximately 7-8 months mainly for bathing purposes. Solar Water Heating Systems (SWHS) can easily heat water to temperature of 60-80° C which is even more than desired temperature for domestic uses like bathing & cleaning.
In BAU scenario the domestic consumers use LPG-Gas geysers. This can be replaced with the Solar Water Heating Systems (SWHS) in the Solar City Scenario. Installation of 2 No. of 100 LPD SWHS in 10% of the total households in the city in the phased manner in the next 5 year will save 239 MU of electricity and corresponding emission reduction will be about 2Lacs tCO_2e.

Subsidy & Financial Support: Despite financial support from MNRE (Interest rate @ 2% or a capital subsidy of Rs.850 -1100 Rs. /sq.m. of collector) & State Level Nodal Agency (SGEDA) domestic users are not shifting towards the SHWS to fulfill the hot water requirement. It has been found during the survey that lack of proper financing support/subsidy & awareness is still a barrier which is preventing mass scale uptake of SHWS. A financing strategy for making SHWS economically viable for Domestic/Non-profit sector is given below in the chart. Various financial assistance schemes by MNRE& SGEDA are attached in the annexure I.

Chart: Financing Strategy for SHWS Installation in Domestic/ Non-profit Sector



Energy Efficient Home Appliances: During the field contact it has been found that residents of high income group and higher medium class of the city use AC for the space cooling purposes for 4-5 months in a year. Most of the ACs used in the residential sector are 1.5 -2 TR and not very energy efficient. Assuming 10% of the total household using 1.5 TR window AC for 5 hours per day for 6 months and replacing it with 5* BEE rated AC can save 70MU of electricity in the next 5 years and corresponding emission reduction will be approximately 60000

tCO_2e. Apart from ACs other home appliances such as refrigerator, washing machine, TV etc. can also be replaced by BEE star labeled appliances which will save good amount of energy in the residential sector. This may be achieved by awareness generation program.

5.3.4.2 Renewable Energy Interventions

Roof-top based SPV Plant: Surat received good solar radiation throughout the year and there is vast potential to generate electricity through rooftop based SPV systems. Installing 2 kWp SPV PLANT on 5% of the total households in the next 5 years will contribute 220 MU of electricity saving and will reduce the emission of approximately 1.8Lacs tCO_2e. SMC/SGEDA should make a target of a fixed number of 2-5 KW roof top SPV system in each ward every year. Overall saving potential form all the measures is given below in table 12.

Table 27: RE and EE Intervention in the Residential Sector

Intervention Type	Intervention Description	Target Number	Energy Savings(MU)
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	1,096,116	32.01
	Replacement of Incandescent (GLS) Bulb with CFL/ T-5 lamps	1,096,116	48.01
	Replacement of Existing AC by Energy Efficiency 5* Rated (1.5 TR)	54,806	21.50
RE	Solar Water Heating Systems(200LPD)	109,612	274.03
	SPV Power Plant(1kW)	43,845	66.86
	Total Energy Savings		442

Table 28: Investment Required to Meet Targeted Interventions Expected reduction in energy consumption

Intervention Type	Intervention Description	Target No.			
		Total Capacity	Total Investment Required INR Million	Government Subsidy INR Million	Users Contribution INR Million
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	---	82.21	8.22	73.99
	Replacement of Incandescent (GLS) Bulb with CFL/ T-5 lamps	---	137.01	13.70	123.31
	Replacement of Existing AC by Energy Efficiency 5* Rated (1.5 TR)	82,209 TR.	1,918.21	191.82	1,726.39
RE	Solar Water Heating Systems(200LPD)	21,922,400 LPD	3,452.78	1,035.83	2,416.95
	SPV Power Plant(1kW)	43,845 kWp	7,892.10	3,156.84	4,735.26
	Total Investment		13482	4406	9076

5.3.4.3 Other Measurers

Apart from above tangible measures following measures can also help in saving energy in the residential sector however quantification will be difficult for these measures.

SPV Home Lighting System: It would be a very good replacement for conventional lighting system which consumes power generated from the burning of fossil fuels. Its penetration can be increased by providing additional subsidy on the basis of income of the purchasers.

Solar Lantern & Solar Cooker: Solar lanterns & solar-cooker would be a good option for lighting and cooking respectively for poor urban people who still use kerosene lamps and stove. SGEDA should provide heavy subsidy on the purchase of solar lantern and cooker to the BPL card holders. These lanterns can also be used as an emergency-light during the power failure. An awareness campaign stressing environmental benefits and subsidies available on the purchase through electronic or print media will make it popular and will increase penetration among poor and low-income group people of the city.

Geysers with Temperature and Time Control: Most of the geysers installed in the residential sector are not equipped with timer and temperature controller. There is a lot of energy wastage due to overheating of water. By installing or retrofitting a geyser timer & thermostat for temperature control immediate energy savings can be achieved. For each 10ºF reduction in water temperature there is a saving between 3%–5% in energy costs.

Installing Tank-less Water Heater System: Demand (tank-less or instantaneous) water heaters provide hot water only as it is needed. They don't produce the standby energy losses associated with storage water heaters, which can save energy and money. Demand water heaters can be 24%–34% more energy efficient than conventional storage tank water heaters.

Promoting or installing Multi-Family Water Heating Systems: Instead of individual water Heaters/geyser a centralized water heating system can be installed for supplying hot water in multifamily buildings. This concept would be very cost-effective for the government quarters, multistory apartments, existing colonies and up-coming new townships.

Solar Passive Structure for New Township: There should be a mandatory provision for the upcoming townships that all building in the township should have the solar passive structure. Developers should submit the structural details to SGEDA before the start of construction activity

ECBC /Green Building/GRIHA Rating for Upcoming Township: There should be a tax rebate for those building and township which are Green building/GRIHA rated.

Voluntary Labeling/ Certification Initiatives: A certification program namely *Energy Efficient home/Solar home/ Sustainable home* can be jointly launched by the SMC and Discoms for the existing residential buildings. A benchmark can be set for annual energy consumption or certain criteria/ parameter should be predefined by the certifying agency the certificate is given when the building has a general concept oriented towards energy

efficiency. If a building consumes less energy than the benchmark set by the SGEDA/DISCOM this certificate should be provided to them. Also a computer based data of all certified homes can be maintained by the certifying agencies for inter-departmental verification.

Following criteria can be set for getting the energy efficiency certificate

- At last one 100 LPD SWHS should be installed on roof top
- All lamps should be energy efficient (T-5 & CFL)
- All electrical home appliances should be BEE 5- star rated.
- Per capita energy consumption should be less than the benchmark set by the SGEDA
- Zero consumption of Kerosene oil.
- Should have minimum square meters of south facing area on which SPV can be installed.
- Guarantee an energy consumption which is lower than the set benchmark set by the certifying agency.

Owners of the energy certified building/homes would be benefited by holding this certificate on total energy bill or some discount on the electricity tariff. This will promote the energy efficiency in the residential building sectors.

5.3.5 Industrial Sector

Major industries which are located within the city boundary can be broadly classified under Diamond Processing, Grey Fabric Production, Dying and Printing Industry, Chemicals Dyes and Dye intermediate production, Embroidery and Jarri Grih Udyog. All these industries except for the diamond industry are the bifurcated part of integrated textile industry. These industries are run by small and big entrepreneurs who are doing step by step value additions from generation of fabric to dying, printing, Embroidery and a Jari work. Except diamond all other industries are energy intensive. Currently these industrial units are utilizing all form of conventional energy sources like Coal, Natural gas, High Speed Diesel and Electricity to meet their energy and power demand. Load of a typical industry at city varies from a 12 kW to as high as several MWs. During the field contacts and analyzing the few energy audits reports it has been found that there is ample scope for energy efficiency of existing process and energy conservation. The subsequent sections of this chapter are focused on the possible energy efficiency measures and renewable energy interventions possible in these industries.

5.3.5.1 Energy Efficiency Strategy

Grey Fabric Generation Sector: The major source of energy consumption at this industry is Motors of Power Looms, twisting machines and Lighting Load. The possible energy efficiency measures and renewable energy measures at these industries include:

- Replacement of conventional motors with energy efficiency motors for Power looms and twisting machines.
- Installation of energy efficient tube lights and CFLs.
- Improvement of power factor to > 0.98
- Optimizing the voltage of the plant

Diamond Processing Sector: The major source of energy consumption at this industry is air conditioning chillers and window ACs, Lighting load. The possible energy efficiency measures and renewable energy measures at these industries include:

- Installation of energy efficient tube lights and CFLs.
- Improvement of power factor to > 0.98
- Optimizing the voltage of the plant
- Installation of BEE 5 star rated air conditioners

Dying and Printing Sector: Dying and printing sector constitute a major contributor of energy consumption. The major source of energy consumption at this industry includes both electricity and fuel consumption. The main fuels that are being used in these industries are coal and Pressurized Natural Gas. The possible energy efficiency measures and renewable energy measures at these industries include:

- Installation of Variable frequency drives to Boiler ID and FD fans
- Installation of variable frequency drives to Boiler feed pump
- Installation of Variable frequency drives to other pumping systems
- Installation of energy efficient motors
- Installation of Automatic Power factor Controller
- Installation of condensate recovery system and monitoring the condensate recovery
- Replacement of old inefficient pumps with energy efficient pumps
- Installation of BEE 5 star rated air conditioners
- Installation of energy efficient Lighting tube lights and CFLs
- Installation of solar water heating system for meeting the hot water requirement

Chemical Sector: Chemical sector constitute a major contributor of energy consumption. The major source of energy consumption at this industry includes both electricity and fuel consumption. The main fuels that are being used in these industries are coal and Pressurized Natural Gas. The possible energy efficiency measures and renewable energy measures at these industries include:

- Installation of Variable frequency drives to Boiler ID and FD fans
- Installation of variable frequency drives to Boiler feed pumps
- Installation of Variable frequency drives to other pumping systems
- Installation of energy efficient motors
- Installation of Automatic Power factor Controller
- Installation of condensate recovery system
- Installation of BEE 5 star rated air conditioners
- Installation of energy efficient Lighting tube lights and CFLs
- Installation of solar water heating system for meeting the hot water requirement

Embroidery Sector: The major source of energy consumption at this industry is motor loads of embroidery machines and Lighting load. The possible energy efficiency measures and renewable energy measures at these industries include:

- Replacement of conventional motors with energy efficiency motors for embroidery machines
- Installation of energy efficient tube lights and CFLs.
- Optimizing the voltage of the plant
- Improvement of power factor to > 0.98

Jarri Grih Udyog Sector: The major source of energy consumption at this industry is motor loads of wire drawing machines and Lighting load. The possible energy efficiency measures and renewable energy measures at these industries include:

- Replacement of conventional motors with energy efficiency motors for wire drawing machines
- Installation of energy efficient tube lights and CFLs.
- Improvement of power factor to 0.98

5.3.5.2 Renewable Energy Interventions

Installation of Grid-Connected/Captive SPV Power plant: There are more than 14000 industrial processing units in the SMC area. State Level Nodal Agency (SGEDA) or SMC may frame a policy under which each unit will have an obligation to install at least 10-20 kWp SPV power plant depending on annual energy consumption by individual units.

Large Scale Grid- Connected SPV/ST Power Plant Dedicated to Industrial Cluster: Large scale Grid- connected SPV or Solar Thermal power plant of capacity 75 MW may be commissioned /installed out of the city boundary to offset the industrial load. Required fund may be created through the contribution of individual industrial units in the ratio of their annual turnover or annual power consumption. Individual units may be benefited by offsetting the equivalent amount of energy generated corresponding to their contribution. Project may be developed by industrial association/SGEDA/SMC. Solar power plant of this size will generate 172.5 MU of electricity annually.

Installation of captive Wind Power Plant: Industrial units should develop bundled wind power project for captive use to offset their energy consumption. In addition to generating revenue by selling power generated by projects, wind power projects will also generate additional revenue through CDM route as well as tax benefit for the project developers. Individual units will be benefited in the ratio of their financial contribution to the bundled project. Installation of 75MW in the next 5 years will generate 164MU electricity and will reduce approximately 133449 tCO_2e

Table 29: RE and EE intervention in Industrial Sector

Intervention Type	Intervention Description	Total Numbers	Gross Energy Savings(MU)
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	490,210	25.77
	Replacement of Existing AC by Energy Efficiency 5* Rated (2TR)	49,020	61.55
	Energy Efficiency improvement in various industrial processes	100	80.00
RE	Solar Water Heating Systems (500 LPD)	4,956	30.98
	SPV Power Plant(10 kWp)	4,902	74.76
	SPV Power Plant(1 MW)	50	76.25
	SPV Power Plant (5 MW)	30	228.75
	SPV Power Plant (10 MW)	10	152.50
	Wind Power Plant(0.8 MW)	80	116.05
	Wind Power Plant(1.5 MW)	80	217.60
	Wind Power Plant (2.1 MW)	80	317.88
Total Savings due to RE and EE			1382.09

Table 30: Investment Required to Meet Targeted Interventions Expected reduction in energy consumption

Intervention Type	Intervention Description	Total Capacity	Total Investment Required INR Million	Government Subsidy INR Million	Users Contribution INR Million
EE	Replacement of T-12 FL Lamps with T-8 & T-5 Fl lamps	---	49.02	4.90	44.12
	Replacement of Existing AC by Energy Efficiency 5* Rated (2TR)	98,040 TR.	1,715.70	171.57	1,544.13
	Energy Efficiency improvement in various industrial processes		1,920.00	384.00	1,536.00
RE	Solar Water Heating Systems (500 LPD)	2,478,000 LPD	341.96	102.59	239.37
	SPV Power Plant(10 kWp)	49,020 kWp	4,411.80	1,323.54	3,088.26
	SPV Power Plant(1 MW)	50,000 kWp	4,000.00	1,200.00	2,800.00
	SPV Power Plant (5 MW)	150,000 kWp	10,500.00	3,150.00	7,350.00
	SPV Power Plant (10 MW)	100,000 kWp	7,000.00	2,100.00	4,900.00
	Wind Power Plant(0.8 MW)	64 MW	4,000.00	1,000.00	3,000.00
	Wind Power Plant(1.5 MW)	120 MW	7,200.00	1,800.00	5,400.00
	Wind Power Plant (2.1 MW)	168 MW	10,080.00	2,520.00	7,560.00
	Total Investment		51218	13757	37462

5.3.5.3 Other Measures

Pump Efficiency Improvement: Pumps with overall efficiency (pump and motor combination) 75 to 80 % are available which can save around 20-25% energy annually by increasing overall efficiency (pump and motor combination). Higher efficiency can be achieved either by retrofitting in the old system or replacing low efficiency pumps with high efficiency pumps.

Use of Variable Speed/Frequency Drive (VSD/VFD): Variable speed drive for pump provides significant flexibility and improves the operational efficiency. VSD for centrifugal pumps enables maintaining fixed pressure versus changing flow condition or inverse flow versuss pressure. Significant amount of energy can be saved by installing VSD control in the water pumping system instead of throttling, bypassing or other less efficient flow control methods.

Installation of Occupancy Sensor in the Office Buildings: Occupancy sensors can be installed in the municipal

office buildings for energy savings. It is the most common device for lighting control used in office and commercial buildings today. It saves energy by automatically turning lights ON when a room is occupied and OFF when a room is vacant. Advance occupancy sensors also have option for dimming control which allows individual workers to adjust lighting levels to their own preferences, and to switch on only a few lights when they work late.

5.4 Some Pilot Projects Identified

Based on the need and feasibility of RE and EE projects in the city, following pilot project idea notes have been prepared. These shall be implemented on a pilot basis and shall find replication throughout the city in future.

5.4.1 Pilot Project 1

Project Title	Upgradation of Street lighting system
Project Description:	Replacement of existing 70 W HPSV-T luminaires with 45-50 W LED luminaires Quantity: 1000 Nos. Financial Mechanism to be replaced by Payback Period Calculation
Indicative Project Cost :	63 Lakhs
Implementation Framework:	EPC Contract
Institutional Responsibility:	SMC

5.4.2 Pilot Project 2

Project Title	Upgradation of lighting system in Mnicipal Buildings
Project Description:	Replacement of conventional T12 with T8 and T5 lamps. 10000 units across Municipal Buildings
Indicative Project Cost :	60 Lakhs
Implementation Framework:	EPC Contract
Institutional Responsibility:	SMC

5.4.3 Pilot Project 3

Project Title	Upgradation of Cooling Systems
Project Description:	Up gradation of existing air conditioning systems to more efficient (BEE 5 Star rated system) 1 unit of 200Tonnes capacity to start with on a pilot level
Implementation Framework:	Service Contract
Financing Mechanism :	Capital cost will be financed by the implementing ESCO which would be recovered by the energy saving. O&M cost will also to be borne by ESCO.
Institutional Responsibility:	SMC

5.4.1 Pilot Project 4

1 MW Solar Power Plant	
Project Title:	Installation of 1 MW Solar Power Project within the city limits.
Project Description	1 MW Grid Connected to HT distribution network (11 KV)
Project Benefits:	Estimated Annual Generation : 1.5 GWh
Capital Cost :	13 Crores Equity component: 4 Crores
Land Requirement :	2 Hectares
Implementation Structure:	Project Proponent shall enter into MOU with concerned DISCOM (DGVCL or TPL) for sale/purchase of power. Generation based incentive can also be availed.
Financing Mechanism :	Program to be supported by IREDA under JNNSM phase I
Time Frame:	2013 to 2015

5.4.2 Pilot Project 5

Project Title	Wind Power Generation
Project Description:	Additional 8.4MW wind power generation project at Porbandar with a facility to wheel power at the state grid and offset the fossil fuel based power downloaded by the grid for Municipal Consumption
Project Cost :	*About 52 Crores*
Implementation Framework	EPC Contract
Techno-commercial description	CUF: 24-25% Energy Generation: ~ 17 GWH/ annum Energy Saving: ~ Rs. 7.40 Crores/ annum Payback Period: 7-8 Years
Institutional Responsibility:	SMC

6 YEAR WISE GOAL

To meet the growing energy needs of the city, fully harnessing energy conservation and resource efficiency opportunities available across all the sectors is needed which will reduce the per capita energy demand. This entails the need for adding new renewable energy power generation which in turn will reduce the dependency on conventional power generation enabling reduced GHG emission and other pollutants in the atmosphere.

Based on the assessment of demand side management opportunities and coupled with supply side measures through renewable technologies, the following targets are proposed in order to transform it into a solar city.

Table 31: Year Energy Saving Goal Across Different Sectors

City	Goal(MU)	Intervention	Year wise Energy Saving Goals in MU Per Year					Gross Saving	% of Goal to be met
			1st Year	2nd Year	3rd Year	4th Year	5th Year		
Surat	2136	EE(MU)	0.0	37	129.34	259.34	368.15	368.15	17.2
		Municipal	0	1	1.9625	3	2	7.85	
		Residential	0	10	25.38	36	30	101.52	
		Commercial & Institutional	0	9	23	32	27.438	91.46	
		Industrial	0	17	42	59	50.196	167.32	
		RE (MU)	0.0	177	619.73	1237.73	1768.093	1768.23	82.8
		Municipal	0	17	41.53	58	50	166.12	
		Residential	0	34	85.2	119	102	340.8	
		Commercial & Institutional	0	5	12	16	13.935	46.45	
		Industrial	0	121	304	425	364.428	1,214.76	
		Total EE & RE	0.0	214	749.07	1497.07	2136.243	2136.68	
		GHG Emission(tCO2e)	0.0	179760.00	629218.80	1257538.80	1794444.12	3860961.72	

6.1 Funding and implementation strategy

Government of India (GoI) launched the Jawaharlal Nehru National Solar Mission (JNNSM) in January 2010.Under the phase I of the JNNSM there are schemes to promote off-grid and decentralized Solar applications. The scheme shall be implemented through multiple channel partners which would be used for its implementation. Channel Partners[4] shall include the following.

[4] List of channel partners accredited by MNRE for Off-Grid and Decentralized Solar Applications under JNNSM as on 25.07.2012 can be accessed through the following link :
http://mnre.gov.in/file-manager/UserFiles/list_channelpartners_st_jnnsm.pdf

- **Renewable Energy Service Providing Companies (RESCOs) :** These are companies which install, own and operate RE systems and provide energy services to consumers.

- **Financial institutions including microfinance institutions acting as aggregators:** These are the Institutions which are involved in consumer finance and ave established base of customers in rural/urban areas and outreach through self- help groups etc. They can avail credit linked capital subsidy on behalf of their borrowers from IREDA.

- **Financial Integrators:** These are entities which may integrate different sources of finance including carbonfinance, government assistance and other sources of funds to design financial products/instruments and make these available to their clients at an affordable cost. These entities would tie up with manufacturers and service providers.

- **System Integrators:** These are the companies which would provide RE systems & services to clients including design, supply, integration, and installation, O&M and other services.

- **Programme Administrators:** These include State and Central Government bodies, departments, State Nodal Agencies, NGOs etc. These entities would directly implement the scheme and access capital subsidy from MNRE

6.2 Budgetary Requirement

Based on the sector wise proposed project activity to improve the present and projected energy consumption scenario of the city, quantum of investment required for various sectors is estimated for *Solar City Development Plan* over a specified time frame to achieve the mission goals. Gross investment need is approximately 7178 Crores for next five years. The costing provided for the projects is a rough cost estimation based on similar kind of projects and vendor interaction with suitable escalation factors in each sector during the implementing period. Total Budgetary requirement as envisaged in the master plan is given in the table below.

Table 32: Budgetary Estimation for Surat City for the implementation of the Master Plan

Sector	Government Subsidy (Million INR)	Users Contribution (Million INR)	Total Budget required (Million INR)
Municipal	361	4,277	4,638
Commercial	998	2,865	3,863
Residential	4,406	9,076	13,482
Industrial	13,757	37,462	51,218
Total value	19,523	53,680	73,202
Percentage	26.67%	73.33%	100.00%

7 ACTION PLAN AND RECOMMENDATIONS

7.1 Action Plan

Implementation of the strategies suggested in the master plan requires a multilateral collaboration from all the stakeholders and key government agencies. To achieve the reduction targets key implementation points have been summarized below.

1. The established Solar City Cell shall take a lead role as a facilitator in the implementation of the master plan. An empowered committee may also be set up to provide guidance to the Solar City Cell and resolve administrative and financial bottlenecks in the implementation of the master plan.

2. The Solar City Cell may also take advantage of the national programme like Jawaharlal Nehru National Urban Renewable Mission (JNNURM) and Jawaharlal Nehru National Solar Mission (JNNSM).

3. There is provision for availing grant-in-aid being provided by Bureau of Energy Efficiency (BEE) to design a few pilot energy efficient buildings in the city, in accordance with Energy Conservation Building Code (ECBC). The Solar City Cell may take advantage of the grant-in-aid for energy consultancy as well as incremental cost of construction for a few buildings.

4. The Solar City Cell may work:
    - To get ECBC notified immediately
    - To ensure that the building by- laws are changed in accordance with it.
    - To ensure that all upcoming non-residential buildings are brought under the ambit of ECBC and to incorporate the relevant green building elements.
    - To ensure that the major new commercial and government buildings are GRIHA certified.

5. In collaboration with the CFL manufacturing and distribution companies, distribution of quality CFLs to its consumers at concessional prices or on easy payment terms can be worked out. For instance, in Delhi, BSES had promoted CFL through “Buy one get one free CFL offer”.

6. Building bye-laws shall be amended for making use of solar water heating systems mandatory in certain category of buildings. SMC may take the initiative in this direction.

7. The Solar City Cell may initiate a dialogue with Torrent Power Limited (TPL) and Dakshin Gujrat Vij Company Limited (DGVCL), the two distribution companies for introducing rebate on electricity tariff for the domestic consumers which employ solar devices.

8. Rigorous publicity campaign, training programme and business meets may be organized for various stake holders e.g. architects, engineers, builders & developers, financial institutions, NGOs, technical institutions, manufactures/suppliers, etc. so as to involve them actively in meeting the objective of solar

city. Can be organized at particular frequency by taking support of organization like Chamber of Commerce, GEDA, BEE, and SVNIT.

9. The Solar City Cell may start a sustained campaign on Solar City through print media, radio and television.

10. The Ministry has been promoting the establishment of Akshay Urja Shops in major cities of the country with a view to make solar energy products easily available and to provide after sales repair and maintenance services. The Solar City Cell may work in close conjunction with Akshay Urja Shops in disseminating information about various solar products.

11. Solar City Cell with support from GEDA, power utilities and educational institutions may launch awareness generation campaign on EE and RE to engage the public on a sustained manner.

12. Solar City Cell may work closely with associations of local traders and manufacturers to propagate use of star rated electrical appliances.

13. For commercial and institutional buildings adoption of energy efficient appliances can be encouraged through Energy Services Company (ESCOs) route.

14. As Industrial Sector is the highest energy consuming sector in Surat, SMC may enhance the present scheme for promoting energy audits in the industrial sector.

15. It is also important to generate funds from State Government and other funding organizations necessary for achieving the objective of making the city as a “Solar City”. Benefits of the schemes of Government of India shall also be availed in meeting the objectives.

16. Rebate in property tax through Municipal Corporations and Municipalities and in electricity tariff though Utilities/ Electricity Boards may be provided to the users of solar water heaters especially in domestic sector.

17. Government Order with regard to construction of energy efficient solar buildings can be issued at least in Government and public sectors in accordance with ECBC:2006 and followed up its implementation.

18. National Rating System for construction of energy efficient Green Buildings particularly in commercial and institutional buildings shall be promoted.

19. MSW Rules 2000 notified by MoEF shall be complied and projects of suitable capacity for generating energy from the waste collected from the city/ town may be set up.

7.1.1 Capacity building and awareness generation

1. A series of training programme on green buildings and energy efficiency is required for planners, architects, electrical, HVAC, and lighting consultants, and engineers involved in the building sector.
2. Specific training series is also required for those in the supervisory role, for effective monitoring of energy demand, enabling them to take preventive/ corrective actions in time.
3. Public awareness and education are central to successful implementation of the master plan. So, it is imperative to engage public through sustained awareness campaigns and communicate the benefits of RE and EE to various user groups.
4. An aspect of awareness creation campaign would be to catch school children's attention towards energy-efficiency and clean future. Campaign for school children may include inter-school essay and drawing competitions, inter-school quizzes, workshops and seminars, exhibitions and demonstrations, field trips, etc.

7.2 Recommendations

(I)

Industrial sector contributes about 60% to the overall energy consumption of the city. The industrial sector mainly consists of a large number of small and medium enterprises (SMEs). In the baseline year, the industrial sector consumed 1,500,000 Tonnes of coal. The same amount of coal has to be delivered to the very decentralized industrial consumers. Hence, apart from being a very inefficient resource, coal has a huge impact on local emissions and on Surat's air quality.

The aims of a fuel switch from coal to district heating are to:

- Increase the efficiency of heat supply by 40%
- Reduce local emissions by 100% by shutting down decentralized coal boilers and switching to a central heating plant outside of town
- Reduce overall CO_2 emissions by up to 100% (in the case of renewable energy use)
- Reduce traffic caused by transport of coal to decentralized consumers

A feasibility study to assess the practicalities of a fuel switch and accurately quantify the possible impacts needs to be carried out.
A business model can be designed for implementation in PPP model (defining the role of municipality and others, defining funding requirements, incentive for consumers to get connected, outlining the pricing model etc.)

Benefits of recommendations above

- One measure can reach thousands of consumers
- The project could significantly contribute to the overall energy reduction targets of the Solar City master plan
- Reduction of local emissions (direct and indirect through reduced traffic)
- Reduction of energy consumption in the industrial sector
- If local biomass was used for heat generation, the value chain remains a local

(II)

The Bureau of Energy Efficiency (BEE) launched the Energy Conservation Building Code (ECBC) in February 2007. The code is set for energy efficiency standards for design and construction with any building of a minimum conditioned area of 1,000m² and a connected demand power of 500 KW or 600 KVA. The energy performance index of the code is set from 90kWh/m²/year to 200kWh/m²/year where any building that fall under the index can be termed as an 'ECBC Compliant Building'. Moreover, in February 2009, the BEE launched a 5 star rating scheme for office buildings operated only in the day time in 3 climatic zones: composite, hot and dry, warm and humid. The star rating programme for buildings is based on the actual performance of a building in terms of its specific energy usage in kWh/sqm/year. This programme rates office buildings on a 1-5 star scale, with 5 star-labeled buildings being the most efficient. The scheme is propagated on a voluntary basis and the label provided under it is applicable for a period of 5 years from the date of issue. The star rating programme provides public recognition to energy efficient buildings, and creates a 'demand side' pull for energy efficiency. Various categories of buildings such as office buildings (day use and business process outsourcing (BPOs)), shopping malls, hotels, hospitals and IT parks in the five climatic zones of the country have been identified under the scheme. The code already exists and many government and semi-government buildings are proposing buildings for a BEE star rating. SMC can develop an incentive scheme for the institutional sectors to implement this, for example a property tax rebate or subsidized water and electricity to the buildings which quality for a minimum BEE star rating of, for example, three. Implementing the rating system in institutional sectors will help considerably to reduce energy consumption. Energy efficiency and conservation measures can be incorporated during the inception/conceptualization stages of new projects

(III)

Buildings are the major source of energy consumption. A huge amount of energy is consumed in heating, cooling and lighting of the building spaces, hence effective passive design measures must be used to develop energy efficient buildings. Reducing the energy consumption of buildings has become a major concern because of increasing energy demand, rising energy costs, and the need to reduce environmental damage. The 'building envelope' (the building shell) is a connecting link between various (external) dynamic conditions and the indoor (static) conditions. Design of the building envelope has significant implications on the interior working environment and comfort of the occupants. Therefore, it is very important to incorporate passive design strategies and high performing building material to achieve energy efficiency as well as maintaining human comfort.

Thermal energy loss is one of the largest expenses in a building budget. To maintain comfort in winter, the heat lost must be replaced by the heating system; and in summer, the heat gained must be removed by the cooling system. Therefore, improvement in the thermal performance of the building envelope is a prerequisite for energy conservation in buildings. Thus passive heating and cooling design strategies appropriate for the specific climatic conditions is vital for the construction of energy efficient buildings. Incorporating passive lighting techniques like clerestory windows, atriums, courtyards, light shelves, light reflectors and other façade and core area integrated design elements can help reduce artificial lighting energy load of the building.

Specifically taking the case of a hot and dry climate (characterized by a mean monthly maximum temperature above 30^{o}C) as appropriate to Gujarat, it is imperative to control solar radiation and the movement of hot winds.

The building design criteria should, thus, provide appropriate shading, reduce the exposed area, and increase thermal capacity. This can be achieved by passive design strategies including:

- Placing the longer façade on North-South orientation and least exposure on West helps reduce solar heat gains
- The 'store and wash' buffer areas act against intense solar radiation and should be provided in over-exposed areas.
- Insulation is an essential component of passive design. It improves building envelope performance by minimizing heat gain through walls, roof and floors etc
- High thermal mass, dense, externally-insulated materials like concrete, bricks and other masonry are used in passive design to absorb, store and re-release thermal energy. This moderates internal temperatures by averaging day/night (diurnal) extremes, therefore increasing comfort and reducing energy costs
- Windows and glazing are a very important component of passive design because heat loss and gain in a well-insulated home occurs mostly through the windows
- Use easily operable windows at low levels with high level clerestory windows to create stack effect cooling
- Shading of glass is a critical consideration in passive design. Unprotected glass is the single greatest source of heat gain in a well-insulated home. Shading requirements vary according to climate and house orientation. East- and West-facing windows require different shading solutions to North-facing windows. In climates where no heating is required, shading of the whole home and outdoor spaces will improve comfort and save energy
- Plant shade trees, and build artificial shade structures such as arbors and trellises
- Install awnings and use window shades
- Seal cracks in building envelope
- Repaint the building with a lighter color and treat the roof with reflective material like china mosaic tiles
- Incorporate radiative cooling methods like the use of a water body. The exterior water wall and roof pond systems are also very effective summer cooling strategies. The cool ponds act as 'thermal sponges', absorbing room heat conducted through the interior ceiling (metal deck) supporting them. At night panels are rolled back, exposing the ponds to the black body of the night sky and to the cooler night air and breeze. The ponds lose heat by radiation to the night sky and by natural convection to the air. Roof pond systems are particularly effective in regions of low humidity and with clear summer nights
- Designing for natural ventilation,
- In addition to above concepts, there are many other solar passive techniques such as wind towers, earth air tunnels, curved roofs and air vents, which can be incorporated according to the building requirements
- Well-positioned and high quality skylights can improve the energy performance of home and bring welcome natural light to otherwise dark area.

When passive design is emphasized in bye-laws, the city's buildings would begin to move towards increased energy efficiency

Passive building design and the use of efficient building products is continually gaining importance. The National Building Code (NBC) addresses all issues of passive design and the latest edition of the NBC will also include a

chapter on sustainability. This revision, to be released in early 2012, is expected to include requirements on green and efficient building products, and green building technology. A workshop on the NBC and sustainability for all major architects and SMC engineers will help create awareness, leading to the inclusion of NBC requirements, which will support the design and construction of energy efficient buildings.

(IV)

The Bureau of Energy Efficiency (BEE) and some other organizations work in the field of energy conservation and energy efficiency to help educate the citizens particularly the economically weaker section on energy conservation, and its benefit to them as well as to the whole city. Small workshops and competitions can be organized in primary and secondary schools, like essay competitions, debates or painting competitions, to raise awareness among young people. Awareness campaigns on retrofitting including case studies can be organized for shops and communities to educate consumers

(V)

Several variants of solar water heaters are commercially available in the market today. While this idea holds tremendous merit, one of the challenges in the wide-scale implementation of is how to identify and quantify energy savings targets. Equally important is to understand the financial incentive for the end-users. The possibility of implementing a community-based solar water heating system can be explored, where one installation can be utilized by at least 4 houses. Such a model will be particularly relevant to areas with smaller sized housing units, or in densely populated areas. Mid-rise housing complexes can also be suitable candidates. This will, however, call for an additional cost for plumbing, maintenance, working out a suitable financial pooling mechanism. .

A successful water management *program* starts with a comprehensive water management *plan*. This should be included in the design phase of new projects and can also be extended to existing plants. Water management plans should provide clear information about how a facility uses water from the time it is piped in to its ultimate disposal. Knowing how water is used and what it costs will enable appropriate water management decisions.

Rainwater Harvesting is an easy and effective method of water recycling and water re-use. For all group housing societies, there should be a mandatory requirement to provide rainwater harvesting at institutional users' sites. Rainwater harvesting captures rainwater for underground (aquifer) recharge or may be stored for later use. Captured rainwater, needing no treatment of saline or other mineral components, is often used in landscaping. It is also useful in attracting and providing water for wildlife. Rainwater harvesting can also help prevent flooding and erosion, turning storm water problems into water supply assets by slowing runoff and allowing it to soak into the ground for recharge of aquifers.

Re-use of grey water**:** sanitary grey water is generated by bathroom sinks, showers, and clothes washing machines (which can contain pathogens). Non-sanitary grey water is generated by industrial processes or equipment such as reverse osmosis reject water and cooling tower condensation (which can contain chemicals, minerals, and solids). In a typical grey water recycling system, water that would normally be discharged for municipal sewage treatment is collected, treated to remove suspended solids and contaminants, and re-used. On-site wastewater recycling applications are useful in all arid, semiarid, and other water-deficient areas that have experienced water shortages, as well as major urban areas where sewage treatment plants are overloaded and expansion is constrained. The recycled water is typically used as flush water for toilets and urinals, landscape

irrigation, supply water for ornamental ponds, and make-up water for cooling towers.

At its most basic, grey water treatment consists of removing suspended solids from the water. Filtering with no additional treatment may be applicable for rinse water from laundries or car washes and air handler condensation. At its most sophisticated, treatment may consist of biological treatment with membrane filtration, activated carbon, and ultraviolet light or ozone disinfection to destroy pathogens. The basic grey water system includes storage tanks, color-coded piping, filters, pumps, valves, and controls.

7.2.1 Other Recommendations

- Set goals such as Zero Energy Buildings or 20-30% Savings
- Establish Zero Energy Community and Commercial Zones
- Apply Advanced Technologies in SMC's Operations and by Using Green Procurement Policies and Incentives
- Learn from best practices of national and international experiences (e.g. DOE/BNL promoted US-India Cities Partnership)
- Support R&D/businesses to foster new industry and green jobs

7.2.1.1 Encourage Energy Efficiency and Ecological Symbiosis in Industries

- Encourage industries for eco efficiency, energy efficiency and green accounting at a firm/industry level
- Reduce the energy intensity of industrial production by 30-50% with the help of advanced energy efficient and cogeneration technologies (Industrial cogeneration costs Rs. 4-5 crore/MW)
- Promote industrial symbiosis within the city based industries as well as at regional level for inter-industry/sector integration/cogeneration/reuse of various resources and byproducts

7.2.1.2 Performance Evaluation and Improvement Frameworks

- Establish management frameworks for effective operation of urban infrastructure and services
- Design performance evaluation matrix for benchmarking operational efficiencies compared to the planned capacities
- Develop frameworks for continuous improvements in the plans based on the performance of actual systems
- Create a high powered committee to implement the Energy Plan/Policy (Low Carbon Policy Steering Committee)
- Develop a plan to continuously monitor the progress and provide improvements to the Energy Plan/Policy
- Provide incentives to city officials for energy efficiency (Champions Awards to Departments, Zones and Individuals)
- Institute and expand peak load management and improved metering
- Tackle urban heat island issues (green/white roofs, other paved surfaces, urban forestation)

7.2.1.3 Sustainable Energy Plan for Surat – Renewable Energy:

- Work with energy providers and all City Departments (associated with Energy) to provide sustainable energy in Surat and create Energy Plan for 2030 (Stakeholder/Advisory Committee)
- Innovative features such as Geographic Information System (GIS), energy audit, and disaster management must be an integral part of future development plan
- Prioritize five key areas for targeted incentives

    1) Provide incentives to city officials for energy efficiency (Champions Awards to Departments, Zones and Individuals)
    2) performance based incentives to buildings and facilities
    3) provide incentives to new green developments (floor-space, development rights, tax incentives, city plaques)
    4) Incentives to new constructions using city based green products, contractors, services

- Institute and expand peak load management and improved metering
- Tackle urban heat island issues (green/white roofs, other paved surfaces, urban forestation)
- Allocate 100% of organic waste (food/garden waste/cellulosic biomass) generated within the satellite town for electricity or energy production, with the help of bio-refineries, methane to CNG conversion,

gasification or biofuel conversions

- Utilize all methane generating from the waste water treatment plants for energy/electricity/biofuels production
- Exploit geothermal energy for heating/cooling applications or power generation, with possible integration of waste water treatment plants as heat sinks

ANNEXURE 1: Project Idea Note

Project Idea Note: 1

Hospital Name	Care Hospital
No. of Bed	110
Approximate Hot Water Requirement	1000-1500 LPD
Project Title:	Installation of Solar Water Heating System in Care Hospital.
Project Description	Installation of 3 -4 Solar Water Heating System each of capacity 500 LPD at Care Hospital for meeting the hot water requirement.
Project Benefits:	Energy Saving
	Improvement in Environmental Conditions
Gross Project Cost :	2.10 Lakhs
GEDA Subsidy	60%
Cost to Hospital	80,000 INR
Implementation Structure:	Hospitals Management/Administration and SMC with technical support from and technology provider.
Financing Mechanism :	Capital cost to be financed by Hospitals. 60 % subsidy would be provided by state Nodal Agency (GEDA).
Time Frame:	2012 to 2014
Institutional Responsibility:	Hospitals Management/Administration
Preparatory Activity for Implementation:	Vendor Interaction
	Preparation of DPR

Project Idea Note: 2

Hotel Name	Lord Plaza
No. of Room	150
Minimum Hot Water Requirement	7500 LPD
Project Title:	Installation of Solar Water Heating System at Hotel Lord Plaza.
Project Description	Installation of 15 Solar Water Heating System each of capacity 500 LPD at Hotel Lord Plaza for meeting the hot water requirement for the guest.
Project Benefits:	Energy Saving
	Improvement in Environmental Conditions
Gross Project Cost :	10.00 Lakhs
GEDA Subsidy	60%
Cost to Hospital	4,00,000 INR
Implementation Structure:	Hotel Management/Administration and SMC with technical support from and technology provider.
Financing Mechanism :	Capital cost to be financed by Hotel. 60 % subsidy would be provided by state Nodal Agency (GEDA).
Time Frame:	2012 to 2014
Institutional Responsibility:	Hotel Management/Administration
Preparatory Activity for Implementation:	Vendor Interaction
	Preparation of DPR

ANNEXURE 2: Some Renewable Energy Technologies

Community Solar Cooking

Project Title	Community Solar Cooking System (Indoor cooking)
Project Description:	Installation of Community Solar Cooking System. • *Technology:* Elliptical dish shape known as Scheffler reflector. Dish made of multiple pieces of reflecting mirrors • *Area Required per Dish :* 7.0 - 9.5 Sq.m • *Temperature attained :* upto 250 °C • *Cooking per Dish* : 40 – 50 Persons • *Cooking time* : 60-90 Minutes • *Expected Life :* 15 years. Reflecting mirrors may require replacement early. • *Other Material requirement:* Frame & support structure, Tracking mechanism, Secondary Reflector.
Project Cost :	• *Total Cost: Rs.* 50000 • *MNRE Subsidy*: 60 % of the Capital Cost • *Cost to the Developer:* Rs 20000 • *Payback period:* 4-5 years
Applicability	Community kitchens especially at religious places, hostels, ashrams, Govt. circuit houses and industrial canteens.
Implementation Framework:	Installed and commissioned by the supplier.
Financing Mechanism :	Funds to be raised through grant under Solar City Project (MNRE) and loan from different renewable energy project financing institution such as IREDA.

Family Type Biogas Plant

Technology

The process of biogas generation involves methanogenesis. It is a microbial process, involving many complex and differently interacting species, but most notably, the methane-producing bacteria. The process involves three stages – Hydrolysis, Acidification and Methane Formation.

In the first stage, the extracellular enzymes of microbes, such as cellulase, protease, amylase and lipase externally enzymolize organic material. Bacteria decompose the complex carbohydrates, lipids and proteins in cellulosic biomass into more simple compounds.

During the second stage, acid-producing bacteria convert the simplified compounds into acetic acid (CH_3COOH), hydrogen (H_2), and carbon dioxide (CO_2). In the process of acidification, the facultatively anaerobic bacteria utilise oxygen and carbon, thereby creating the necessary anaerobic conditions necessary for methanogenesis.

In the final stage, the obligatory anaerobes that are involved in methane formation decompose compounds with a low molecular weight, (CH_3COOH, H_2, CO_2), to form methane (CH_4) and CO_2.

The resulting biogas, sometimes referred to as 'gobar' gas, consists of methane and carbon dioxide, and perhaps some traces of other gases, notably hydrogen sulphide (H_2S). Its exact composition will vary, according to the

substrate used in the methanogenesis process, but as an approximate guide the resulting gas will be between 55-66% CH_4, 40-45% CO_2, plus a negligible amount of H_2S and H_2.

Models Available

Following are the different types of biogas plant models available. The choice depends upon the convenience of operation and other conditions.

KVIC Floating Drum Type Biogas Plants having digester made of bricks or stones.	1 to 10 cubic metre
KVIC Type Biogas Plants with Ferro cement digester	1 to 10 cubic metre
KVIC Type Biogas Plants with Fibre Glass Reinforced Plastic (FRP) Gas holder	1 to 10 cubic metre
Deenbandhu Model (i) Brick masonry (ii) In ferrocement with in-situ technique	1 to 6 cubic metre
Pre-fabricated RCC fixed dome model	2 & 3 cubic metre
'Flxi' model Bag digester type plant made of rubberised nylon fabric manufactured by Swastik Rubber Products Ltd., Pune.	1 to 6 cubic metre

Source: MNRE

Following are some estimates of requirement of raw material and capital cost according to size of the plant.

Size of plant	Quantity of cattle dung required daily	Estimated cost*
1 m^3	25 kg	Rs.7,000/-
2 m^3	50 kg	Rs.9,000/-
3 m^3	75 kg	Rs.10,500/-
4 m^3	100 kg	Rs.12,500/-

Source: MNRE

The cost indicated above is higher by about 30% to 50% in hilly states and North-Eastern states of India.

Financing Mechanisms Available

Financial support in the form of subsidy is available for Family Type Biogas Plants in India. The details of the subsidy available are as follows:

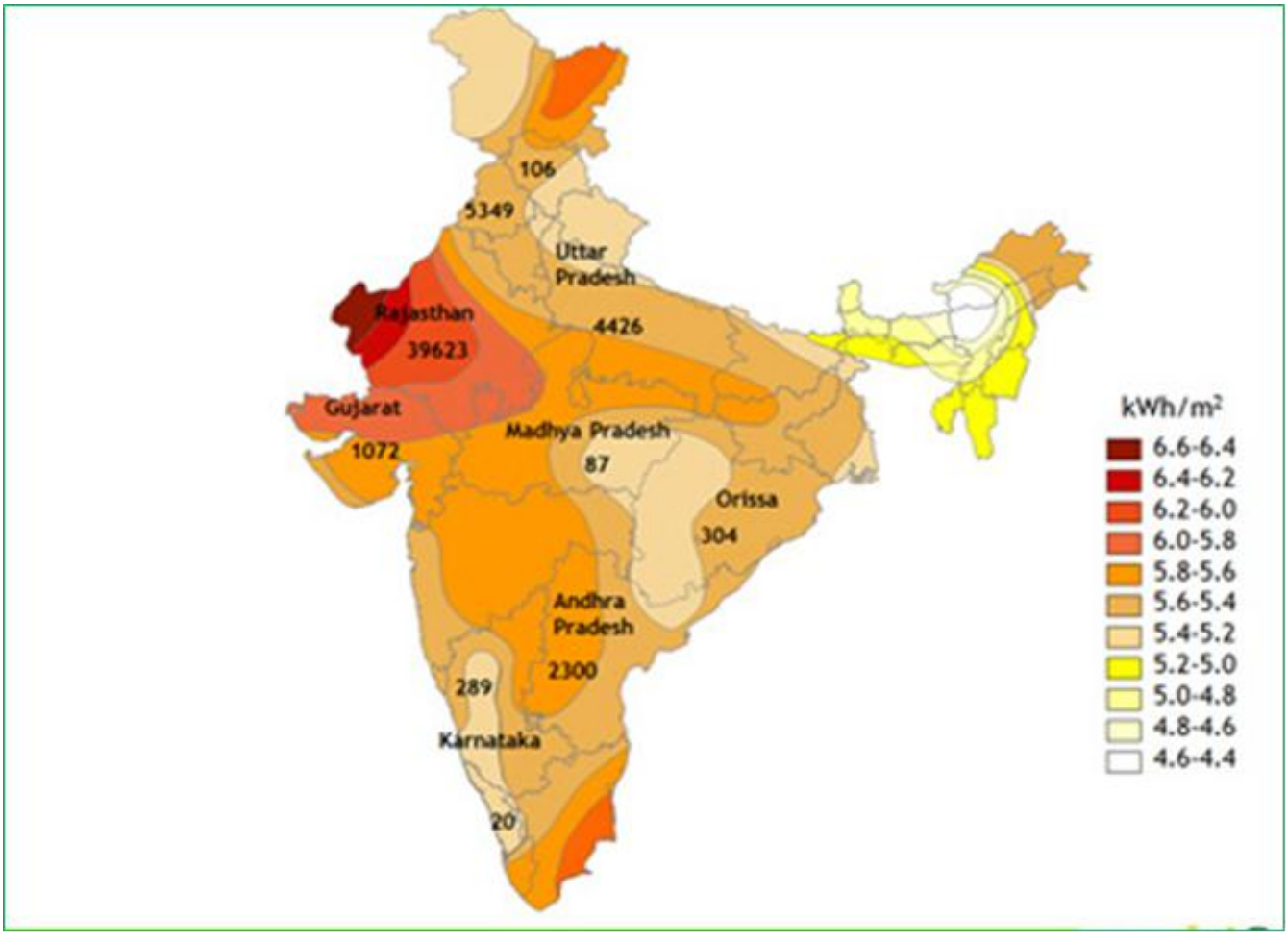
CFA for different capacity plant	
1 cubic meter (fixed dome)	2-6 cubic meter
7.2.1.4 Rs.2,700/-	7.2.1.5 Rs.2,100/-

Source: MNRE

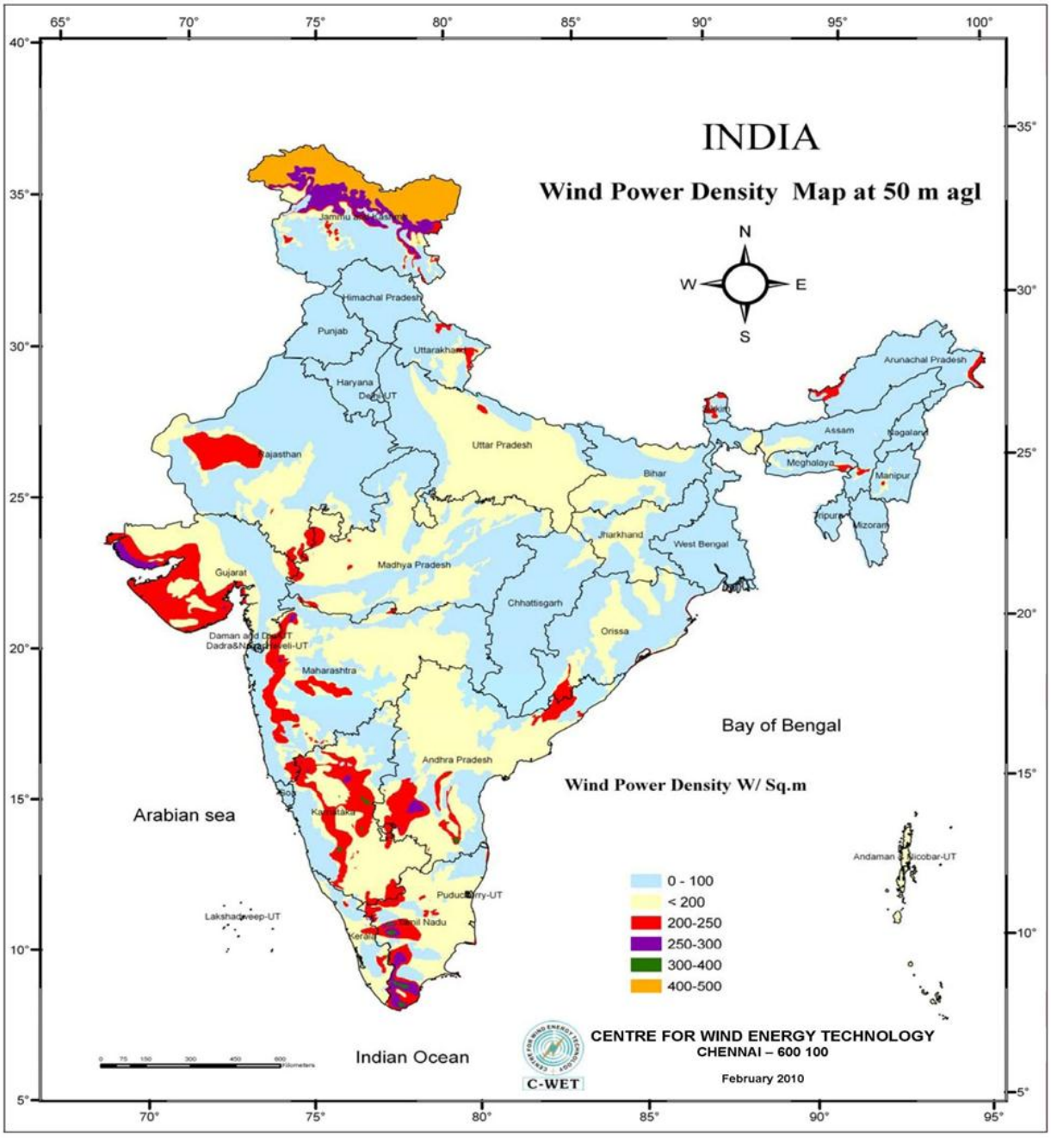
Reserve Bank of India and National Bank for Agriculture and Rural Development provide refinancing facility for the biogas plants. Commercial and Cooperative banks provides loans and insurance for the biogas plants.

According to studies conducted for the already installed biogas plants, the payback period for one m^3 size fixed done Deenbandhu model was 6.17 years. The payback period for all other sizes of plant was less than four years.

ANNEXURE 3: Solar Insolation Map of India



ANNEXURE 4: Wind Potential Map of India



ANNEXURE 5: Conversion Factor for Different Types of Fuel

S. No.	Energy Type/year	Units	Conversion Factor(tOe)
1	Electricity	MWh	0.086
2	LPG	MT	1.13
3	LNG/PNG	Smc	0.0009
5	CNG	Tones	1.06
6	Kerosene	Kiloliters	0.85
7	Petrol	Kiloliters	0.78
8	Diesel	Kiloliters	0.86
9	Furnace Oil	Kiloliters	0.91
10	Coal(Lignite)	Tones	0.33
13	Fire Wood/Biomass	Tones	0.35-0.38
15	Cow dung cake	Tones	0.31
16	Biogas	Tones	0.50

ANNEXURE 6: Some Areas Identified for Intervention

Town Planning Schemes of SMC

For the implementation of the Development Plan of the city at micro level, SMC has initiated the preparation of Town Planning Schemes. A total of 63 T.P. Schemes have been prepared by the Corporation, which comprise almost 90 percent of the total SMC land area. This includes schemes prior to the formation of SUDA, out of which the government has already finalized 16 T.P. Schemes. The entire area within the SMC, thus is covered by T.P.Schemes. The remained portion is river, creek, areas wholly under industrial houses or Housing Board/govt. land, which cannot be put under Town planning scheme.

Areas Identified for project implementation

Science Centre, Museum And Art Gallery

The SMC has planned the Science Centre, Museum and Art Gallery Complex in the posh City Light area of the city on an 18,420 sq. m. site. **Trade Center**

The SMC has planned the ultra modern Trade Center on around 10000 sq.m. area **Slaughter House**

In order to improve the existing slaughter house area, SMC is proposing a new slaughter house with updated utilities, space for live stock marketing and other facilities. **Multidisciplinary Aquarium**

SMC is proposing a multidisciplinary aquarium comprising freshwater, brackish water and marine aquarium near the Jagdishchandra Bose garden, in T.P. 10, F.P. 690-703, Adajan, Surat having 15000 sq mt area.

ANNEXURE 7: List of Manufacturers and Dealers[5]

Solar PV

List of Manufacturers empanelled under Capital Subsidy scheme implemented through NABARD as on 19.10.2012	
S. no	**Name of the manufacturer**
1	TATA BP Solar India Limited
2	Sun Energy Systems, Anand, Gujarat
Note: - This list is applicable for Capital Subsidy Scheme Implemented through NABARD only and has no relevance with any other existing scheme of Off Grid Solar applications. The Beneficiary is free to choose out of these depending upon the price, quality, service etc. and is not to be forced by anyone.	

List of All India distributers /dealers of manufacturers empanelled under Capital Subsidy Scheme implemented through NABARD as on 19.10.2012

1. **Ammini Solar Pvt Ltd**

Company Name with Complete Address and contact details:	Ammini Solar Pvt Ltd Plot No. 33-37, KINFRA Small Industries Park St. Xavier's College Post Trivandrum 695 586, Kerala Ph : 0471-3060200, Fax : 0471-3060201 Email : solar@ammini.com Web : www.ammini.com Toll Free (Within Kerala) : 1800 300 00 600
Contact Person of the company for any type of customer	Mr. Rajesh, Customer Executive Ph: 0471-3060200 Mr R S Byjuraj, General Manager byjuraj@ammini.in Mr. KG Madhu, Managing Director madhu@ammini.in
Grievance related to dealer with contact details	Mr R S Byjuraj, General Manager byjuraj@ammini.in Ph: 0471-3060260
Details of Dealer/Service network	List Given below

[5] Source: Ministry of New and Renewable Energy (MNRE)
List of Manufacturers and Dealers of Renewable Energy Technologies can be obtained by following the link below
http://www.mnre.gov.in/information/manufacturesindustriesarchitectsconsulting-organisation/

1	Gujarat	Vadodara	Shree Duttatray Sales Corp Near Dashalad Wadi, Lakkadpitha, Char Rasta Road-390001	Mitali	09825303701
2	Gujarat	Vadodara	Bright Powers A-2, Jagannath Puram Society A-2, Gorwa Refinary Road Behind Panchvadi Jakathnaka Gorwa 390016	Manvinder Singh	9978855777

2. Emmvee Toughened Glass & Photovoltaics Pvt Limited

Company Name with Complete Address and contact details: _Emmvee Photovoltaics power Pvt Ltd. , International Airport Road , Bettahalasur ,Bengaluru

Contact Person -Mr. Bipin chintamani , Pune

Details of Dealer/Service network

No	Name of the Manufacturer	Name & Address of Dealer/ Service Center	Districts covered	Contact Person	Mobile No
1	Emmvee Photovoltaic Power Private Limited	PAN ASIA INC # 5, Tushar Society, Opp.Ghelani Petrol Pump, Nizampura, Vadodara 390002, Gujarat, India	Gujarat	Sanjay Shah	0265-2792416

3. **Gautam Polymers**

Company name with complete address and contact details: Gautam Polymers, Plot no.114, SIDCUL, Haridwar (U.K.)

Contact person of the company for any type of customer – Sourabh Singh / Ram Asre

S No	State	District	Adress	Contact Person	Phone No.
1	Gujrat	Ahmedabad,	Green energy & motion 511, golden tringal, s.p. Road ahmedabad	Mr. Anil patel	932727290

2	Gujrat	All Districts	Grass root trading network baunaskantha dwacra, mahila sewa association, radhanpur,distt. Patan gujrat	Mrs bahan	079-2657488
3	Gujrat	Gandhinagar	Bright solar pvt.ltd. pushpraj complex nr. Jashodanagar cross road vatva road ahmedabad	Mr. kumar	0982495620
4	Gujrat	Raopura	Solar best,106 ramway plaza jambujet,kharvav road gpo lane dandia bazar-raopura	Mr.mitesh mehta	931331406
5	Gujrat	Vadodara,	Aisa battery services 1st floor sulemani complex, pratapnagarh road vadodara	Mr. Kassimi	931126307

4. SELCO Solar Light (P) Ltd.
   #742, 15th Cross, 6th Phase, J P Nagar, Bangalore – 560078, India.
   Vikshut Mundkur – Manager, Projects. Ph no: 9972420922
   vikshut@selco-india.com

Contact Person of the company for any type of customer grievance related to dealer with contact details:

S No	State	District	Address	Contact Person	Phone No
1	Gujarat	Ahmedabad	SELCO, Inside Shree Mahila Sewa Sahakari Bank Ltd. (Urja Vibag), SAKAR 2 Complex, Near	Lakshmi	09228435900

5. **Details of Dealer/Service network**
   SUN ENERGY SYSTEMS
   C-1/411 ,GIDC, VITHAL UDYOGNAGAR -388121,ANAND,GUJARAT , INDIA
   MOBILE – 09825328298 , EMAIL – sesin2009@gmail.com , www.sunenergysystems.in

S No	State	District	Address	Contact Person	Phone No

1	GUJARAT	AHMEDABAD	STAR ELECTROMECH; SHOP NO -14, UMIYANAGAR SOCIETY, NR. CANAL , AT – NICOL GAM ROAD , AHMEDABAD – 382350	MADUKANT	09426700212
2	GUJARAT	BHAVNAGAR	HARDIK SOLAR , PLOT NO -394 , BHAVNAGAR	HARDIK	09824191184
3	GUJARAT	GANDHINAGAR	TROM SOLAR GIDC ELECTRONIC ESTATE , GANDHINAGAR	PANKAJ	09099911678
4	GUJARAT	SURAT	SUJLAM ENTERPRISE , HG-24 , MUJARA GATE , SURAT	SUJAL	09727764110
5	GUJARAT	ANAND	SUPER NOVA TECHNOLOGY , PLOT NO -129 , GIDC, VITHAL UDYOGNAGAR – 388121	SURESHBHAI	09427857984
6	GUJARAT	BHUJ	S.K.ELECTRICAL PLOT NO-1, NR. SANSKARNAGAR , BHUJ	SURESHBHAI	09879393617

6. Conergy Energy Systems (India) Pvt. Ltd

(Formerly Suntechnics Pvt. Ltd)

Details of Dealer/Service network

SNo	State	District	Address	Contact Person	Phone No
1	Gujrat	Bharuch	Gopi Solar & Plumbing, SG - 9, Turth Complex, Nr. Lions, School, GIDC, Ankleshwar, Bharuch - 02, Gujarat,	Mr.Praveen Nakum	02646-221024, 9825760120

7. TATA BP Solar Pvt Ltd.

S No	State	District	Address	Contact Person	Phone No
1	Gujarat	Jamnagar, Rajkot, Surendranagar, Junagadh, Bhavnagar, Amreli & Porbandar, Kutch.	Hitech Industrial Corporation, Kalptaru complex, Indira Circle, Rajkot.	Mr. Tushar Trivedi	9824213426.
2	Gujrat	Jamnagar, Rajkot, Surendranagar, Junagadh, Bhavnagar, Amreli & Porbandar, Kutch.	Khodiyar Enterprise 203, Shyamal Plaza Near Raiya Crossroad Raiya Circle Rajkot	Mr. Mahendra Nakum	9825162853
3	Gujarat	Ahmedabad, Mehsana, Gandhinagar, Patan, Banaskatha, Sabarkatha	Solar Tech System B-2, Nr. Lotus school, Lalita Co. Op.Hsg. Society, Isanur Ahd.	Mr. R.N. Patwari	9825411692 079-25391584
4	Gujarat	Tapi, Valsad, Navsari, Dang, Narmada, Vadodara	SOM Energy System F-102, Kalindi Appartment, 11 B, Vrundavan park, Nr. Jivan chetan school, New sama road, Vadodara.390008	Ms. Smita S. Palva	9099036907
5	Gujarat	Dahod, Panchmahal, Bharuch, Vadodara & Narmada	Gujrat Traders 3802, Mullaji Bazar, PB no 125, Dahod	Mr. Hunaid Jambugodawala	9825098969

6	Gujarat	Surat,Tapi, Navsari,Valsad & Dang	Techno Precision Engineer &Consultants 204-205, Sai-Maya Complex, Udhna Darwaja, Surat.-395002	Mr.Mehendra Desai Mr. Hemant Rajjoshi	9824113515 0261-2343484
7	Gujarat	Bharuch, Surat, Narmada, Godhra, Vadodara	Saroj Urja services Co. A-14, Navjvan Society,Dahej By Pass road,Bharuch	Mr.Mihir Bhatt	9824475574 9725018418
8	Gujarat	Bhavnagar	Sigma Engg. Madhav Darshan, Waghawadi Road, Bhavnagar	Mr. Yogesh Vyas	982505934
9	Gujarat	Kutch	Electron Engineers, Plot no.427, Opp. Andhra Bank, Gayatri Mandir Road, Oslo circle, Gandhidham, Kutch. 370201	Mr. Prakash Morabia	9427208984 9825164767
10	Gujarat	Baroda, Panchmahal, Dang	Som Energy System F, 102, Kalindi Appartment, 11,B Vrundavan park, Near Jivanchetan school, New sama road, Baroda - 390008	Mr. Bhavik chauhan	8511208883
11	Gujarat	Kutch, Bhuj	Electron Engineer Plot no. 427,Opp. Andhra Bank, Gayatri temple road,Nr. Oslo circle, Kutch, Gandhidham	Mr. Prakash Morabia	9825164767

8. Vimal Electronics

Company Name& Address : Vimal Electronics
Plot No:E-49,G.I.D.C
Electronics Estate,
Sector : 26, Gandhinagar, 382028
Gujarat.
Contact Person : C.G. Patel
Contact Details : 98250 08943
: 079 - 23287571 / 73

Sr. No.	State	District	Dealer Name	Contact Person	*Contact no.*
1	Gujarat	Ahmedabad	Monish Telecom, Nr. Water tank, Vatva Gam, Vatva, Ahmedabad.	Mr.Vinodbhai	*9825239898*
2	Gujarat	Mehsana	Voltex Industries 32, GIDC, Highway Road, Mehsana	Mr. Alpeshbhai	*9879104213*
3	Gujarat	Rajkot	Sunshine Energy Systems 111, Arthik Bhavan, Nr. Bombay Garage Petrol Pump, Gondal Road, Rajkot.	Mr. Regalbhai	*9825632875*
4	Gujarat	Jamnagar	Halar Drip Irrigation & Solar Vijay Cinema Road, Devasis Bilding, Nr. Nimavat Clinic, Jamkhambhaliya, Di. Jamnagar.	Mr. Nandaniyabhai	*(02833)277281*
5	Gujarat	Anand	Arihant Distributors, B-36, Pooja Estate, Vallabh Vdhyanagar	Mr. Mukesh Shah	*9825017847*
6	Gujarat	Kutch	Varsani Auto & Electric Centre Station Road, Bhuj	Mr.Rameshbhai	*9825225425*
7	Gujarat	Bhavnagar	Perfect Solar Agency, Bhairavpura Opp. Khakhchowk mandir, Palitana, Dist. Bhavnagar.	Mr. Laxmighar Khomeja	*9426246224, 9427246700*
8	Gujarat	Amreli	Patel Electric & Solar, 10, Khodiyar Market, Opp. Nursery , At&PO:Dhari, Dist. Amreli	Mr. Hareshbhai	*9925295833,*
9	Gujarat	Ankleshwar	Milind Engineers 21 – SardarPark, 2nd Floor, Gattu School, GIDC, Ankleshwar.	Mr.Maheshbhai Panchal	*9428026778*
10	Gujarat	Rajkot	Redson, At. Gandal, Dist. Rajkot	Mr. Regal	*9825632875*
11	Gujarat	Navsari	K.K.Enterprise 10, Shantiniketan H. Society, Dhanori Road, Gandevi, Dist : Surat	Mr.Kamal Kapdia	*02634-262065*
12	Gujarat	Valsad	Chanchal Printers near Tower, At&Po: Vansada, Dist: Navsari	Mr.Harishbhai	*9426881265 ,222326*

9. Name of the company: Thrive Energy Technologies Pvt Ltd

Address: 121/3, Eastern, Phase II, Sector 1, Lane 9, IDA Cherlapally, Hyderabad – 500051
Website; www.thriveenergy.co.in
Email: info@thriveenergy.co.in
Contact Persons for any type of customer: K.Dhanumjaya/ John William Myle
Contact Nos: 09949325007/09849639995 or 040 – 32901212/ 27261212

Details of Dealer/Service network:

1	M/s. Tinaplanet Build Green Pvt Ltd., 1, Aviraj, Prahlad Nagar, Satellite, Ahmedabad, 380015	Ahmedabad (for Hyderabad, AP also)	Gujrat	Ram Narayan/George	8511589306/9985123537
2	Green Solution Foundation	Vadodara	Gujrat	Uday Dalal	0265-6552530,
Muni Seva Ashram,					
GF – 12, Blue Chip Complex,					
Near Stock Exchange					
Sayaji gunj, Vadodara – 390 005.					
Ph No.0265-6552530, 09974094154 Mr. Uday Dalal					

10. **Jain Irrigation System Ltd**			
Address: Jain Energy Park, Shirsoli Road, P.O Box.20, Jalgaon -425001 India.			
Tel: 0257- 2260288 Fax:0257 - 2261155			
Web Site: www.jains.com			
Contact Person	**Mobile No.**	**Mail Id**	**Working Area**
Sau. Deepika Chandurkar	9422776942	Solar@jains.com	Maharashtra
Shri. Manoj Sutawane	9422776944	solarmktg@jains.com	Maharashtra
Shri Tushar Pagariya	9403695827	oscoord.solar@jains.com	Other than Maharashtra

SNO	**State**	**District**	**Address**	**Contact Person**	**Phone No.**
1	GUJARAT	AHMEDABAD	THE INTEGRATED SUPPLIES & SCO,AHEM 304 "ARTH" B/h. L.G. SHOPEE, NAVRANPURA 380001	MR.RISHABH JAIN	9879002613
2	GUJARAT	VADODARA	WAB ENGINEERS OFF OLD PADRA ROAD GF/48-49,D WING,AVISKAR COMPLEX OPP.SHREE SHAKTI SOC VADODARA 390001	MR.HEMANT DESAI	9898996676

3	GUJARAT	AHMEDABAD	JINESHWAR MARKETING 529,BHATTHINI BARI, FARNANDIS BRIDGE (UNDER),KHADI BAZAR AHMEDABAD 380001	MR.SANKESH BHANDARI	9377716669
4	GUJARAT	BHAVNAGAR	HARSH COMMUNICATION BHAVNAGAR S-5,KESHAV COMPLEX,NEAR MADHAVDARSHAN WAGHAWADI ROAD BHAVNAGAR 364001	MR.CHINTANBHAI	9367822288
5	GUJARAT	SURAT	NANDANI ENTERPRISE SURAT BHIKHABHAI COMPOUND ,NR POLICE STATION KAMREJ 395003	MR.RAJUBHAI	9825305268
6	GUJARAT	SABARKANTHA	SHAMS SOLAR OPP.AURVEDIC HOSPITAL HIMATNAGAR 383001	MR.ABIDALI BHURA	9924440429
7	GUJARAT	SURAT	M/S.SPECTRA ENGINEERING WORKS L-18,SAVERA COMPLEX, OPP.KRISHNA PETROL PUMP,SURAT SURAT 395003	MR.NAYEEM	8866966020

List of Manufacturers of Evacuated Tube Collector Based Solar Water Heating Systems

Category 1 : Manufacturer making hot water storage tank and the balance of system in-house (as per list below)
Category 2 : Manufacturers procuring some of the components of the solar water heating systems indigenously. However, ownership of such systems for the purpose of guarantees/warrantees will remain with the manufacturer. (as per list at page 13)

CATEGORY – 1

1	M/s. Om Energy Equipment, Plot No.G-2065, Opp. To Esser Steel Depot, Kishan Gate Road, MetodaGIDC, Metoda, Rajkot (Gujarat)	Tel : 09879049493 e-mail: info@deltasolars.com website: www.deltasolars.com	Water-in-glass	1800 1800 2100 1800 2100	47/37 47/34 70/54 58/47 58/47	30-09-2013 30-04-2014 30-04-2014 30-06-2014 30-06-2014
2	M/s. Patel Engineering, 9, New Nehrunagar, Dhebar Road South (Atika), Rajkot – 360002.	Tel: 0281-2323239, 09825735178 e-mail: gangasolar@yahoo.com website: www.gangasolar.com	Water-in-glass	1500	47/37	30-09-2013
3	M/s Kosol Hiramrut Energies Pvt. Ltd. Plot No.148& 127, GIDC-II, Jamwadi, Gondal – 360311, Dist. Rajkot	Tel: 02825-224272, 224824 Fax: 02825-240472 E-mail: info@sunray.co.in Web-site: www.sunray.co.in	Water-in-glass	1500 & 1800& 2100	47/37 47/37 70/54	30-09-2013
4	M/s Redren Energy Pvt. Ltd., Plot No.2625, Road D/5, Kranti Gate, GIDCMetoda, Rajkot – 360 021	Tel: 02827 287281, Fax: 02827 287381 E-mail: info@redrenewable.com Web Site: www.redrenewable.com	Water-in-glass	1500 1800 1800 2100	47/37 58/47 47/37 70/54	30-09-2013 30-09-2013 30-04-2014 30-04-2014

5	M/s Farmson Enviro care Plot No.3704, Phase –VI, GIDC, Vatva, Jasodnagar – Memdavad Road (East), Ahmadabad – 382445	Tel: 079-256840913 E-mail: info@solarsystemindia.com	Water-in-glass	1500 & 1800	47/37 58/47	30-09-2013 30-09-2013
6	M/s Electrotherm Renewable A Division of Electrotherm (India) Ltd. Plot No. 414/1 GIDC Phase II, Vatva, Ahmadabad– 382445	Tel:91 79 25895711, 66186500 Fax:91 79 25895703, E-mail : renewables@electrotherm.com	Water-in-glass	1500 & 1800	47/37 58/47	31-03-2013
7	M/s. M.G. Rama Energy Pvt. Ltd. Regd. Offie: 204 Ajanta Com. Complex, Opp. Bombay Hotel, Gondai Road, Rajkot – 360 002	Tel. 09909915451, 09377755648, 0281-2467675 Email.mgramaenergy@gmail.com	Water-in-glass	1800	58/47	30-09-2013
8	M/s Jay Khodiyar Manufacturers Plot no 30, Rani Industrial Estate, Survey no 17, B/H Parin Furniture, Gondal Highway, Vavdi, Rajkot 360004	Tel: 08140077400 e-mail: info@jaysun.in; www.jaysun.in	Water-in-glass	1500 1800 1800 2100	47/37 58/47 47/37 70/54	30-09-2013 30-06-2014 30-06-2014 31-07-2014
9	M/s Steam Power Enertech Pvt Ltd 7/10, Sorathiyawadi, Kothariya Main Road, Rajkot - 360 002.	Tel: 0281-2372692, Fax: 0281-2375252 Cell: 09428037577, 09924419318 Email: steampowersolar@gmail.com http://www.steampowerenertech.com	Water-in-glass	1500 1800 1800 2100	47/37 58/47 47/37 70/54	30-09-2013 30-04-2014 30-06-2014

10	M/s Redsun Solar Industries Plot no 35,Somnath Industrial Area, Opp. Jamwadi Village, Gondal, Rajkot	Tel: 09825632875, 09428462301, Fax:- 02825-223272 Email: info@redsunin.com www.redsunin.com	Water-in-glass	1800	58/47 47/37	30-09-2013
11	M/s Mamata Energy Pvt Ltd 858, Kothari Industrial Estate, Behind Hutch Tower, Rakanpur-Santej Road, Santej	Ph: 02764-286506 Fax:02764-268 328 e-mail: info@mamataenergy.com www.mamataenergy.com	Water-in-glass ETCs(Heat pipe)	1800	58/47	30-12-2013
12	M/s NRG Technologists Pvt Ltd 989/6, GIDC, Induatrial estate, Makarpura, vadodara 390010	Ph: 0265-2642094, 2656167, 9904796074 purchase@nrgechnologists.com www.Nrgtechnologists.com	Water-in-glass	1500 & 1800	47/37 58/47	30-06-2013
13	M/s Star Coating Services 9, Ankur comm. Center, Opp. Gurukul, Gondal, Rajkot	Tel: 0281-3012366 Mobile:09374771572 E-mail: info@standardsolar.com www. standardsolar..com	Water-in-glass	1800	47/37 58/47	30-04-2014
14	M/s Lubi Electronics Sardar Patel ring Road, near Bright school/P.T.C. College, near Karai gam Patia, Nana Chiloda, Dist Gandhinagar-382 325	Tel: 079-3984 5300 Mobile:08306910881 Fax:079-3984 5599 E-mail: info@lubielectronics.com www. lubielectronics.com	Water-in-glass	1500	47/37	30-04-2014

15	M/s Akshar Technology N.H. 8-B, Jamwadi, G.I.D.C. -2, Plot No. 60 Godal, Dist. Rajkot	Mobile:098250 73217 E-mail: aktechno123@gmail.com www.aksharsolar.com	Water-in-glass	1800	47/37	30-04-2014
16	M/s Jai Ganga solar Energy Pvt. Ltd., Kailashpati Society, Nehru Nagar, 80 Feet Main Road, Rajkot-360 022	Tel: 0281-2323239, M: 09909323239 E-mail: info@jaigangasolar.com www.jaigangasolar.com	Water-in-glass	1500	47/37	30-06-2014
17	M/s Green Energy Solar 216 Krishna corn arch-2, godown Road corner, Tagore road, Rajkot-360 002	Tel:0281-2468410 Mob:9428010202 E-mail:greenenergy123@gmail.com Website:www.ecogreensolar.co.in	Water-in-glass	1800	58/47 47/37	30-06-2014
18	M/s Harsiddhi Engineering Works Ho. Mahuuva Road Opp. Gadhiya Patrol Pump Savarkundla-324 515	Tel:09428342940, 9824313740 E-mail:harsiddiengineering@yahoo.in	Water-in-glass	1800	47/37	30-06-2014

CATEGORY – 2

No.	**Manufacturer/ Supplier**	**Contact Details**	**Type of ETC**	**Major Specifications**	**Date of Validity**
Length (mm)			**Outer/ Inner Tube Dia $ (mm**		

1.	M/s Sun Free Heat Industries Plot – 301, Phase-1, Nr.old Tele. Exchange,G.D.I.C., Vitthal Udyognagar– 388121	Tel: 02692-230423 ,9428799552 E-mail: sunfree230423@yahoo.com	Water-in-glass	1500	47/37	30-09-2013
2	M/s Warm Stream, P.B. No.22, AnandSojitra Road, Vithal Udyognagar – 388 120	Tel: 02692-231316, 232309, 09825735536 Fax: 02692-236478 E-mail: jap@warmstream.co.in, warmstream@warmstream.co.in	Water-in-glass	1500	47/37	31-03-2013
3	M/s NRG Technologists Pvt Ltd 989/6, GIDC, Induatrial estate, Makarpura, Vadodara 390010	Tel: 0265-2642094, 2656167, 9904796074 sales@nrgtechnologists.com, nrg.cyardi@gmail.com www.Nrgtechnologists.com	Water-in-glass	1500	47/37	30-06-2013
4	M/s Vishwakarma Refrigeration 1-Udaynagar, 10/11 corner, opp. Sukhsagar Dairy, Mavdi main road Rajkot	Tel:02827-287281/287381 Mob:09825154522/09979873994	Water-in-glass	1800	58/47	30-06-2014
5	M/s Sun Energy Systems G/90, Raka Industries, GIDC Vitthal Udyognagar-388 121	Tel: 02692-230317, 09825328298 Fax:- 02692-231216 Email: sesin2009@gmail.com	Water-in-glass	1800	58/47	31-12-2013
6	M/s Sun Gold Enterprise 511, World Trade Center, Nr. UdhnaDarwaja, Ring Road, Surat	Tel: 0261-6592355 , Mob: +91-9825194488 E-mail: sungoldindia@gmail.com	Water-in-glass	1800	58/47	30-09-2013
7	M/s SLT Energy Ltd. E-30, G.I.D.C. Electronics Estate Sector 26, Ghandinagar-382 028	Tel: 079-23287461 to 68, 9825787429 Fax:079-23287470 E-mail: mayank@ sltenergy.com info@sltenergy.com www. sltenergy.com	Water-in-glass	1500 1800	47/37 58/47	31-02-2014

8	M/s Yogi Solar Industries Neel Dhara Complex Near Gundala Railway Crossing Gundala Road Gandal-360 311 district: Rajkot	Tel: 09377202220 E-mail: yogisolar@indiatimes.com www. royalsolar.in	Water-in-glass	1800	58/47	31-07-2014

List of Wind Turbine manufacturers

List of Wind Turbine Manufacturers can be obtained by following the link below.

http://www.cwet.tn.nic.in/html/information_ml.html

ANNEXURE 8: Policy Review

Policy Review

In the current plan (XIth plan) total budgeted plan outlay for renewable energy is Rs 10,460 crore which includes Rs 1500 crore for research and development only. This budget also includes Rs 200 crore for MNRE's demonstration GBI program facilitating installation of 50 MW for solar projects installation. Furthermore, with the recent launch of the Jawahar Lal Nehru National Solar Mission, under the National Action Plan for Climate Change, the Ministry's of New & Renewable Energy as well as Power target the development of 20 GW of solar projects installation as well as 4- 5 GW solar equipment manufacturing by 2022.

Institutional Framework for Renewable Energy Technologies in India

The Indian Renewable Energy Development Agency (IREDA) under MNRE and the Rural Electrification Corporation under the Ministry of Power (MoP) have been designated as financing institutions for renewable energy projects. NTPC Vidyut Vyapar Nigam Ltd (NVVN), a trading company under the Ministry of Power, has been entrusted as the sole buyer of solar energy generated in country under the National Solar Mission. NVVN shall subsequently sell the energy to states under the mechanism explained in following chapters.

Table 15: Role of institutions in the promotion and regulation of renewable energy

S. No	Policy Making Institution	Classification	Role
1	The Ministry of New and Renewable Energy	Centre	MNRE is responsible for policy making for the RE sector at the national level in India. MNRE is also responsible for administering the RE sector and promoting RE Investments through its financing arm IREDA, facilitating R&D for the adoption of new RE technologies, capacity building and awareness generation.
2	The Central Electricity Regulatory Commission (CERC)	Centre	CERC is responsible for setting a target for procurement of energy from Renewable Energy at the national level. It is also responsible for providing directions to SERCs on adopting methodologies for the development of feed in tariffs and developing a mechanism for trading of Renewable Energy Certificates.
3	The State Governments	State	State governments are responsible for developing the states RE policies. These policies provide state objectives and targets for RE investment and the mechanisms as well as the incentives for RE investment in the state.

4	State Electricity Regulatory Commissions (SERCs)	State	SERC's are the bodies responsible for fixing the Feed in Tariffs for different RE technologies for the state and also fixing the minimum Renewable Purchase Obligation which may or may not be technology specific.

The Central Electricity Regulator - The Central Electricity Regulatory Commission (CERC)

CERC's initiatives: CERC has taken up a number of initiatives, in the recent past, to streamline regulatory formulation with regards to renewable energy promotion. With the intent to bring in uniformity in tariff determination approach CERC has come out with renewable energy tariff regulations and off late has announced implementation framework and pricing of renewable energy certificates. CERC has also determined tariff for solar energy projects under the National Solar Mission.

The State Electricity Regulatory Commissions (SERC's**)**

The most proactive support being provided to renewable energy developers at state level is through the State Electricity Regulatory Commissions. The SERC's have chosen a host of measures and instruments to promote renewable energy including solar energy development.

Tariff: The State Electricity Regulatory Commissions across the country have undertaken various steps for promoting non-conventional/renewable sources of energy like the feed in tariffs. As mandatedby the Electricity Act 2003 and the National Tariff Policy, more than 17 states have issued tariffs facilitating procurement of power by grid from non-conventional sources. The step taken by SERC's of issuing tariff orders has opened up the market for renewable energy in these states.

Renewable Purchase Obligation (RPO): SERCs are also mandated to specify a percentage of renewable based procurement by utilities of the total consumption of electricity in the area of a licensee. 19 states have issued target under RPO for utilities. Some of the states like MP and Rajasthan have gone one step further by specifying RPS wherein all forms of renewable based technologies are offered assured purchase.

Third Party Sales through Open Access (OA): Section 39 of the Electricity Act 2003, directs the State Government to set up a State Transmission Utility (STU), which shall own the transmission network in the state and provide non-discriminatory Open Access to its network. Similarly, Section 42 of the Act directs the Distribution Licensee to provide non-discriminatory open access to its distribution network to eligible customers (as notified by the ERC) on payment of wheeling charges and other applicable surcharges. When a consumer enters into an Open Access agreement, such a consumer would come under the purview of Balancing and Settlement Code (BSC) however it is exempted in the case of renewable energy. The provision of Open Access regulation in states has provided renewable energy developers the option of trading the power generated by them, through sales to a third party, especially in the states with higher HT tariff.

Renewable Energy Certificates: After the issuance of implementation framework and the price setting

for renewable energy certificate by CERCs, state commissions are required to accept these as instruments for meeting the renewable purchase obligation by RE developers in their respective states within the framework designed by central commission. For this matter, each state commission must put in place a regulation and designate an agency which shall operationalize the REC mechanism within the state and coordinate with national agencies concerned with REC operationalization in the country. The table 2 below highlights the status of the REC process in country.

Table 16: REC framework implementation status in India

SERCs	Draft Regulation	Final Regulation	Designation of State Agency
Assam	✓		
Bihar	✓		
Gujarat	✓	✓	✓
Haryana	✓		
Himachal Pradesh	✓	✓	✓
Jharkhand	✓	✓	✓
Kerala	✓		
Madhya Pradesh	✓		
Maharashtra	✓	✓	✓
Orissa	✓		
Rajasthan			✓
Tamil Nadu	✓		
Tripura	✓		
Uttarakhand	✓		
Uttar Pradesh	✓	✓	
JERC for Manipur &	✓	✓	

However at times it has been felt that this institutional framework lacks coordination due to no single piece of legislation and the same time there exist a number of situations where institutions due to lack of institutional capacity have not been able to do justice to their role.

Legal, Policy and Regulatory Framework for Renewable and Solar Energy in India

India has a number of legislations, policies and regulations which have been put in place to govern the electricity sector in the country including areas such as renewable sources, sustainable development, energy efficiency and conservation etc are covered under these framework. Some of these have been covered below.

National Electricity Legislative Framework

Electricity Act 2003

The Electricity Act 2003 was a landmark legislation in the promotion of RE at the National Level. The act specifically emphasises on power generation through various Renewable Energy Technologies (RETs).

Some of the key provisions have been highlighted below:

- Section 4 of the EA 2003 requires the Central Government to notify a national policy permitting stand-alone systems including those based on the non-conventional sources of energy.

- Section 61(h) of the act specifies the tariff regulations. It requires that the appropriate commission (Central/ State) will be guided by the principle of promotion of cogeneration and generation of power from renewable sources of energy while determining the tariffs.

- Section 81(1) (e) talks of the functions of the SERCs formed under section 82 of the act. One of the functions of the SERCs includes the promotion of cogeneration & generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any entity.

- Section 62 states that state discoms shall be required to purchase a percentage share of electricity to be purchased from RE sources, as decided by the SERC. This shall be progressively increased as prescribed by the SERCs.

- Non-conventional sources of energy could be setup both where grid connectivity exists & where it does not exist, stand-alone systems could be based on such sources.

- The act also specifies that any power procurement by the State utilities shall be done by competitive bidding under Section 63 of the EA 2003 within suppliers offering energy from same type of non-conventional sources (Competitive bidding amongst RE sources however, has not been enforced by most of the SERCs).

- As per act, Decentralized Distributed Generation facilities with local distribution network may be based either on conventional or non- conventional methods depending on suitability and cost. Non-conventional sources could be used with grid connectivity as well till the time it is cost effective.

National Electricity Policy (NEP 2005)

The NEP 2005 reasserts the Government's intent to promote RE. Select extracts from the NEP are presented hereunder:

- "Feasible potential of non-conventional energy resources, mainly small hydro, and wind and bio-mass would also need to be exploited fully to create additional power generation capacity. With a view to increase the overall share of non-conventional energy sources in the electricity mix, efforts will be made to encourage private sector participation through suitable promotional measures."

- "Non-conventional sources of energy being the most environment friendly there is an urgent need to promote generation of electricity based on such sources of energy. For this purpose, efforts need to be made to reduce the capital cost of projects based on non-conventional and renewable sources of energy. Cost of energy can also be reduced by promoting competition within such projects. At the same time, adequate promotional measures would also have to be taken for development of technologies and a sustained growth of these sources."

- "Percentage for purchase of power from non-conventional sources should be made applicable for

the tariffs to be determined by the SERCs at the earliest. Progressively the share of electricity from non-conventional sources would need to be increased as prescribed by State Electricity Regulatory Commissions. Such purchase by distribution companies shall be through competitive bidding process. Considering the fact that it will take some time before non-conventional technologies compete, in terms of cost, with conventional sources, the Commission may determine an appropriate differential in prices to promote these technologies."

National Tariff Policy (NTP 2006)

The policy states the importance of the RE generation and their subsequent benefits for the country. Some key extracts are presented below:

- "Tariff fixation for all electricity projects (generation, transmission, and distribution) that results in lower Green House Gas emissions than the relevant base line should take into account the benefits obtained from the Clean Development Mechanism into consideration, in a manner so as to provide adequate incentives to the project developers."

- "The Appropriate Commission shall fix a minimum percentage for purchase of energy from such sources taking into account availability of such resources in the region and its impact on retail tariffs."

- "Such procurement by Distribution Licensees for future requirement shall be done as far as possible through competitive bidding process under section 63 of the Act within the suppliers offering energy from same type of non conventional sources."

The Integrated Energy Policy 2006

The IEP states the following with regards to the promotion of RE:

- Need to phase out capital subsidies by end of Xth Plan
- Design incentive structures that are linked to energy generated
- Regulators to mandate feed-in laws for RE, where appropriate.
- Environmental subsidy for RE through cess on conventional energy generation
- Publication of an annual RE report
- FI's should be encouraged to set-up Capital Funds for RE entrepreneurs.
- Need to auction sites on public property for wind energy development
- To encourage solar thermal a higher premium of feed-in tariff needs to be provided

Energy Conservation Act 2001

The Energy Conservation Act, 2001 came into force with effect from 1st March, 2002. The Act empowers the Central Government and in some instances the State Governments to integrate energy efficiency measures with clean renewable energy interventions:

- Notify energy intensive industries, other establishments and commercial buildings as designated consumers

- Establish and prescribe energy consumption norms and standards for designated consumers
- Prescribe energy conservation building codes for efficient use of energy and its conservation in commercial buildings
- Direct owners or occupiers of commercial buildings to comply with the provisions of energy conservation building codes
- Direct mandatory display of label on notified equipment and appliances
- Specify energy consumption standards for notified equipment and appliance
- Prohibit manufacture, sale, purchase and import of notified equipment and appliances not conforming to standards

National Regulatory Initiatives for Renewable Energy

RE Tariff Regulation including Solar PV

The Central Electricity Regulatory Commission (CERC) has recommended tariff as well as regulations for all the renewable energy technologies including solar PV and CSP. The tariff is applicable to central projects or projects under Jawahar Lal Nehru National Solar Mission (JNNSM). The recommendations or financial structure adopted by CERC can be followed by State Electricity Regulatory Commissions or SERCs for setting tariff in their respective states.

Norms for Solar Photovoltaic (PV) power under these regulations are applicable for grid connected PV systems that directly convert solar energy into electricity and are based on the technologies such as crystalline silicon or thin film as may be approved by MNRE.

REC Regulation & Pricing

As discussed above, the renewable purchase obligation (RPO) mandates the state electricity regulatory commissions to set a percentage of renewable energy purchase by their state. However, the repercussion of the same is an increased financial burden on the state due to an increased overall power purchase cost. Furthermore, such an obligation provides no incentive (financial) to states having enough RE potential, to tap the unharnessed potential beyond the RPO target.

In light of the above, REC mechanism has been introduced with the basic objective of harnessing renewable energy technologies efficiently, without increasing the financial burden of states, especially those having unharnessed potential.

As explained in the previous section, Renewable Energy Certificates or RECs, as they are commonly referred to, are tradable instruments. These are issued to states, against the power generated from RE sources in excess of their specified RPO. The cost of generating this extra power is recovered by selling them to states failing to meet the RPO target for a pre-determined price. This way the mechanism not only facilitates optimal division of financial burden but also provides motivation states to harness the renewable potential, where ever it exists, beyond their RPO requirement.

The pricing mechanism has two components including the energy content (or power content) and the environment content. The energy content or the power is sold to the discoms in the state having renewable potential at the average power purchase or pool price of the state.

The environment content attached to the certificate is priced at market determined price based on the supply and demand of the certificates. The forbearance (maximum) price and the floor (minimum) price are already determined. The forbearance price ensures that only prudent financial burden of

encouraging renewable energy is imposed on the general public and floor price ensures that project developers meet their obligations. The equilibrium price or market determined priced is calculated between these two points.

This Regulation do not restrict any sale of power within or outside State, which shall be subject to applicable state regulations and shall be governed by prevalent regulatory framework. The project developer can sell the energy generated from RE projects either to a licensee or to any other third party, subject to the Regulations specified by the Appropriate Commission in this regard.

National Policies for Promoting the Manufacturing of Solar PV in India

The Government of India (GoI) has developed a scheme for the promotion of solar PV manufacturing units set up in country. Under this scheme, incentives in the form of a capital subsidy are available for Solar PV manufacturers. These incentives may be provided directly by MNRE, but are governed and facilitated by it. These incentives include the following:

- Special Incentive Package Scheme (SIPS) - to encourage investments for setting up semiconductor fabrication and other micro and nano-technology units.
- SEZ policy – to encourage export oriented manufacturing

Special Incentive Package Scheme (SIPS)

SIPS was formulated to encourage investments for setting up of semiconductor fabrication and other micro and nano-technology manufacturing units, including solar PV manufacturing. SIPS is applicable for a 'fab unit' (fabrication unit) as well as an 'ecosystem unit'.

A threshold limit for minimum investment was set at Rs. 2,500 crore (approx US$ 625 million) in case of a fabrication unit and Rs. 1,000 crore (US$ 250 million) in case of an ecosystem unit. This amount was calculated on the basis of net present value and needs to be made during the first 10 years of the date of application.

Under this scheme, the Central Government or its pertinent agencies will provide capital either a subsidy, an investment grant or interest subsidy. The capital subsidy would be 20% for units set up in SEZs and 25% for units set up in non-SEZ areas.

The government can also take up equity in the project, not exceeding 26% and would be based on the value of the incentive package. The government would also get an exit option, which it would exercise at a suitable time after the project goes on stream.

This scheme was available for units applying till March 2010 and 26 proposals worth Rs 2, 29, 000 crore were received out of which 13 were technically qualified and later on only six were able to reach at financial closure by March 2010.

Indicative (not yet available in public domain) plans of firms reaching financial closure are as follows:

- Bhaskar silicon base for Polysilicon shall start production in 2011 with capacity of 2500 Tonnes per annum capable of generating 250 MW of solar power
- KSK Energy Venture has plan to set up 80 MW of PV modules based on thin film technology
- Lanco has plans to set up base for 3500 Tonnes per annum of polysilicon and capacity for 80 MW of wafer production.
- Solar Semiconductor has to set up base for around 60 MW of crystalline technology based PV

Modules

In addition Moser Baer has plans to set up manufacturing base outside the SIPS policy as well.

SEZ Policy

The SEZ Policy also covers the manufacturing of solar PV components including trading, servicing and manufacturing of solar PV components exported or imported or procured from the Domestic Tariff Area (DTA) by a solar PV unit in the SEZ. These units are entitled for all applicable fiscal and non-fiscal benefits highlighted under the SEZ policy.

The manufacture of solar PV in SEZs shall be exempt from payment of taxes, duties or cess including excise duty, CST, service tax, security transaction tax and import duty.

SEZ units will be given certain exemptions from income tax for 15 years. These exemptions are structured in a way that a SEZ unit can avail 100% income tax exemption for the first 5 years, 50% for the next 5 years and rest 50% of the reinvested profits ploughed back into the business for the next 5 years. But no income tax is exempted if 10 years IT benefit is already availed by the beneficiary firm.

The SEZ policy allows 100% foreign direct investment in the manufacturing sector and gives flexibility to make overseas investment out of export earnings in foreign currency.

The units in the SEZ have to be net foreign exchange earners but they need not be subject to any pre-determined value addition or minimum export performance requirements.

State Policies for Promoting the Energy Generation and Manufacturing- Solar PV in India

Solar Power Generation Policies

Few of the states in India has announced or in the process of announcing solar specific policies outlining the benefits that state government would provide to developers of solar energy. Gujarat was the first state to announce solar policy in year 2009 and Rajasthan and Madhya Pradesh have issued draft policies which shall be finalized short while. This section highlights these final and draft policies.

Gujarat Solar Policy

Gujarat announced its Solar Policy in 2009, with the objective of promoting solar energy in the state and tapping its huge potential. The policy has an operative period of 2009-2014 and sets a target for capacity addition of 500MW by 2014. This policy was separate from the central policy GBI demonstration scheme. The main provisions of the policy are:

- The Policy will support solar power generation for 500 MW capacities during 2009-10 to 2013-14.
- The minimum capacity of any plant should not be less than 5 MW.
- The developer would be allowed to sell power to third parties by paying 2% wheeling charge
- 50 % of Gross CDM benefits to be passed on to Distribution licensee
- GEDA & GPCL are nodal agencies for solar project development that will facilitate in getting all the clearances – although no single window clearance mechanism was proposed under this policy.

Promotional Programs for Solar Energy Development in India

Jawaharlal Nehru National Solar Mission (JNNSM)

The National Action Plan for Climate Change (NAPCC) in India was released by the Prime Minister's Council on Climate Change. In context of solar energy NAPCC states that "India being a tropical country, where sunshine is available for longer hours per day and in great intensity, solar energy, has great potential as a future energy source. It also has the advantage of permitting the decentralized generation and distribution of energy, thereby empowering people at the grassroots level".

In light of the above, the Jawaharlal Nehru National Solar Mission (JNNSM) was launched to promote power generation from solar energy in the country. The objective of the Jawaharlal Nehru National Solar Mission is to create conditions, through rapid scale-up of capacity and technological innovation to drive down costs towards grid parity. The Mission aims at achieving grid parity for solar by 2022 and parity with coal-based thermal power by 2030.

The Mission has adopted a 3-phased approach, spanning the remaining period of the 11th Plan and first year of the 12th Plan (up to 2012-13) as Phase 1, the remaining 4 years of the 12th Plan (2013-17) as Phase 2 and the 13th Plan (2017-22) as Phase 3. The mission lays down the targets that need to be achieved in the years to come so that India can tap its solar potential to the fullest. The targets set by JNNSM have been summarised in table 1 below

The following targets have been set under the Mission, for the country, in order to tap the available solar potential and to achieve the following objectives:

Project Development

- To create an enabling policy framework for the deployment of 20,000 MW of grid interactive solar power capacity by 2022.
- To ramp up capacity of grid-connected solar power generation to 1000 MW within three years i.e. by 2013
- To add an additional 3000 MW by 2017 through the mandatory use of the renewable purchase obligation by utilities backed with a preferential tariff.
- To more than quadruple this capacity during the third phase – reaching 20,000MW installed power by 2022.
- The target to be set for 2022 of 20,000 MW or more, will be dependent on the 'learning's' of the first two phases and whether these phases are able to achieve success in scaling up and providing grid-competitive solar power.
- The transition could be appropriately up scaled, based on availability of international finance and technology.
- To promote programs for off grid applications, reaching 1000 MW by 2017 and 2000 MW by 2022.
- To achieve 15 million square meters solar thermal collector area 2017 and 20 million by 2022.

- To deploy 20 million solar lighting systems for rural areas by 2022, i.e. the Mission plans to provide solar lighting systems under the ongoing remote village electrification program of MNRE to cover about 10000 villages and hamlets.

Manufacturing

- To create favourable conditions for solar manufacturing capability, particularly solar thermal for indigenous production and market leadership.

- To take a global leadership role in solar manufacturing (across the value chain) of leading edge solar technologies and target a 4-5 GW equivalent of installed capacity by 2020, including setting up of dedicated manufacturing capacities for poly silicon material to annually make about 2 GW capacity of solar cells.

Financing Schemes proposed under JNNSM to facilitate the achievement of targets

In order to achieve these targets, the JNNSM has recognized the need for access to adequate funds at attractive interest rates. To ensure that these funds are available for access, it has proposed the following:

- Provide a soft re-finance facility through Indian Renewable Energy Development Agency (IREDA) for the banking community (for their lending to solar) for which Government will provide budgetary support.
- IREDA in turn to provide refinancing to NBFCs and commercial banks on condition that they on-lend to consumers at an interest rate of not more than 5 per cent.
- Provide an annual tranche for building up a corpus through which at the end of ten years, funds can be transferred to IREDA as capital and revenue grants for on-lending to future renewable energy projects.

Application Segment	Target for Phase-I (2010-2013)	Target for Phase-II (2013-2017)	Target for Phase-III (2017-2022)
Grid Solar Power	1100 MW	4000 MW	20000 MW
Off-Grid Solar Applications	200 MW	1000 MW	2000 MW
Solar Collectors	7 million sq mts	15 million sq mts	20 million sq mts

Propositions under JNNSM

The following propositions made under the JNNSM with regard to tariffs and PPAs:

- CERC has announced tariffs for 2009-10 and 2010-11:
  - Solar PV- Rs 17.91 per unit (2010-11)
  - CSP- Rs 13.45 per unit (2010-11)
- NTPC Vidyut Vyapar Nigam Ltd. (NVVN), a wholly owned subsidiary of NTPC, has been designated as the nodal agency by the Ministry of Power (MoP) for entering into a Power Purchase Agreement

(PPA) with Solar Power Developers

- NVVN shall enter into PPAs with developers willing to set up Solar Projects over the next three years (i.e. up to March 2013). These projects shall be connected to the grid at 33 KV level and above and the PPAs shall have validity for 25 years

- Under the scheme, the GoI shall allocate for every MW of solar power set up an equivalent amount of MW capacity from the unallocated quota of NTPC stations

- The power from thermal and solar shall be bundled and sold to utilities at a rate fixed by CERC

- The CERC is also mooting the idea (as highlighted by the JNNSM) of introducing a solar specific RPO for the states. This RPO shall be limited to 0.25% in 1st phase and would be gradually increased to 3% by 2022

- The schematic highlighting the overall transaction structure under this phase has been shown in the graphic below.

MNRE Programs and Support Functions

Programs specific to solar PV applications

(A) The **Solar Lantern Program** was initiated in 2006-07 with the objective of deploying solar lanterns in un electrified villages and hamlets in special category states including north eastern states and also UT islands of India. Central financial assistance is provided under this program by MNRE.

(B) **Scheme on "Demonstration and Promotion of Solar Photovoltaic Devices/ Systems in Urban Areas & Industry"** was initiated in year 2008-09 and shall be continued at least till the end of 11th plan. The program was initiated with the aim of promoting the use of solar PV in the commercial segment. This was to be done through demonstration projects in urban areas and industry.

- Solar lighting has a host of applications in urban areas. These applications serve the twin purpose of saving electricity and reducing the consumption of diesel and fuel oil. A few of these applications that were specifically targeted under this program were:
  1. Systems used mainly for electricity conservation
     - Solar street lights
     - Solar traffic signals
     - Solar blinkers
     - Solar power packs/inverters
     - Solar illuminating hoardings/ Bill boards
     - Other systems of community use as felt necessary by Implementing Agencies

  2. Systems for abatement of diesel & other fuel oil
     - Roof top SPV systems with or without grid interaction

(C) **Support to R&D Programs -** The Ministry of New and Renewable Energy (MNRE) has made certain policy guidelines to facilitate faster approvals of R&D projects by Ministry of Finance. This mechanism is to take up good quality RD&D projects to achieve the goals set under the plans. Subsequently with announcement with Jawahar Lal Nehru National Solar Mission and to have more technology focus and to cater to the needs of Mission, it was decided that the policy guidelines are reviewed and modified.

S No	Category	Target	Power Purchase Agreement Guidelines
1	Under MNRE Generation Based Incentive Scheme	Two power projects of 5 MW capacity sanctioned to 2 Power Producers for setting up their Solar Power Plant by 2010-11	The PPA will be executed between the concerning Discom and the Solar Power Producer on the tariff as determined by the RERC as per the guidelines of MNRE.
2	Projects migrated to National Solar Mission	The State has sanctioned 66 MW solar power projects in compliance of the RERC's orders. The projects sanctioned by State Govt. have now been migrated to National Solar Mission. Hence all guidelines applicable to power plants and power purchase under NSM shall be applicable here.	PPA shall be executed between NVVN and the Solar Power Producer as per guidelines of MNRE and tariff order of the CERC. The State Discom shall enter into PPA with NVVN for purchase of solar power generated from these power plants along with equivalent MW of conventional power as per the mechanism provided in NSM phase 1.
3	Projects under competitive bidding mode	100 MW of solar plant (50 each for PV and thermal) shall be developed through this mode, having solar plant to be installed within state and equivalent MW capacity conventional plant to be installed anywhere in country. The pooled power is to be sold at competitive bid price.	The State Discom shall enter into PPA with successful bidder for purchase of solar power generated from these power plants along with equivalent amount of MW capacity of conventional power as per the mechanism provided in bidding documents on the lowest tariff arrived after tariff based competitive bidding process and approved by the RERC.
4	Solar Power Plants under National Solar Mission (NSM)	The State will promote deployment of utility grid power to be connected at 33 kV & above level. The power produced from the power plants commissioned in phase-1 of National Solar Mission shall be sold to NVVN as per the guidelines issued by MNRE/NVVN. NVVN will subsequently sell this power along with equivalent amount of MW capacity of conventional power from unallocated	For the projects sanctioned under phase-1 of NSM, the Power Purchase Agreement shall be executed between the NVVN and the Power Producer as per guidelines of MNRE and the tariff as agreed with NVVN. The NVVN shall sell the solar power generated from these power plants along with equivalent amount of MW capacity of conventional power as per the mechanism provided in NSM Phase-1 to the States distribution utilities. The power purchase agreement for projects sanctioned in phase- 2 &3 of NSM will be as per guidelines

		quota of NTPC stations to the States for meeting their RPO.	issued by MNRE
5	Solar Power Plants in Rajasthan for direct sale to distribution utilities of Rajasthan	The total capacity under this category shall be distributed equally between SPV and CSP based power plants. The total maximum capacity under this category for phase-1 (up to 2013) and phase-2 (2014- 2017) would be 100 MW and 250 MW (additional) respectively.	The Power Purchase Agreement shall be executed between discoms and successful bidders as per the provisions of bid documents on the tariff arrived by the process of tariff based bidding and approved by RERC.
6	Utility Grid Power Projects for Captive use /direct sale to 3rd Party/other States through Open Access and sale through RE Solar Certificate mechanism for promotion of investment in Rajasthan	The State shall promote Solar Power Producers to set up power plants of **unlimited capacity** for captive use or sale through RE Solar Certificate mechanism or sale of power to 3rd party/States other than Rajasthan.	In case of third party sale/captive use/sale to other States, the Power Purchase Agreement shall be executed between the Power Producer and the procurer on mutually agreed rates. In case of sale through Renewal Energy Certificate (Solar) mechanism, the PPA shall be signed as per the guidelines/orders of appropriate commission.
7	Setting up of Rooftop PV and other Small Solar Power Plants connected to LT/11kV Grid under National Solar Mission (RPSSG Programme)	The State will promote deployment of Roof top and other Small Solar Power Plants connected to LT/11kV Grid as per guidelines of MNRE under NSM and orders of appropriate Regulatory Commission. The power purchased from these solar power projects shall be over and above the RPO prescribed by RERC.	Under this scheme, the Power Purchase Agreement shall be executed between the concerned Discom and the operator of small solar power plant as per guidelines of MNRE/IREDA and tariff orders of RERC. A generation-based incentive will be admissible to the Discom to cover the difference between the solar tariff and base price as per the guidelines issued by MNRE and orders of appropriate Commission.

Preferential Tariff and other incentives across states

With the initiatives of the Central Government in the direction of solar power, various state governments have become active in promoting generation through solar energy. Several states, through their nodal agencies and state utilities are providing incentives for the promotion of the use of solar power in their states. Most of these incentives are in the form of higher tariffs (set by the respective SERCs) for power generated through solar energy, over and above the GBI announced by MNRE. Among other states, the following states have been in the forefront of promotion of solar power generation. These include, Rajasthan, Gujarat, Tamil Nadu, West Bengal, Uttar Pradesh, Haryana, Orissa and Punjab.

Gujarat have gone a step ahead and have introduced a full-fledged solar policy to promote solar power and its applications. The tariffs set by SERCs in the state of Gujrat for the promotion of solar power have been highlighted in the table below:

Table: Summary of tariffs for solar photovoltaic power plants commissioned between 29 January, 2012 and 31 March, 2015. Period	**29 Jan. '12 to 31 Mar. '13**	**1 Apr. '13 to 31 Mar. '14**	**1 Apr. '14 to 31 Mar. '15**
For megawatt-scale photovoltaic projects availing accelerated depreciation			
Levelized Tariff for 25 years	9.28 per kWh	8.63 per kWh	8.03 per kWh
For first 12 years	9.98 per kWh	9.13 per kWh	8.35 per kWh
For subsequent 13 years	7.00 per kWh	7.00 per kWh	7.00 per kWh
For megawatt-scale photovoltaic projects not availing accelerated depreciation			
Levelized Tariff for 25 years	10.37 per kWh	9.64 per kWh	8.97 per kWh
For first 12 years	11.25 per kWh	10.30 per kWh	9.42 per kWh
For subsequent 13 years	7.50 per kWh	7.50 per kWh	7.50 per kWh
For kilowatt-scale photovoltaic projects availing accelerated depreciation			
Levelized Tariff for 25 years	11.14 per kWh	10.36 per kWh	9.63 per kWh
For kilowatt-scale photovoltaic projects not availing accelerated depreciation			
Levelized Tariff for 25 years	12.44 per kWh	11.57 per kWh	10.76 per kWh

Source: GERC order no 1, 2012

*[**Note for clarification:** The applicable tariff gets fixed at the time of commissioning of the plants. For example, if a megawatt-scale solar photovoltaic power plant gets commissioned between 29 January, 2012 and 31 March,2013, then the applicable tariff shall be ` 9.98 for the first 12 years shall and ` 7.00 per kWh for the subsequent 13 years. Similarly, if another megawatt-scale photovoltaic power plant gets commissioned between 1 April, 2013 and 31 March, 2014, then the applicable tariff shall be ` 9.13 per kWh for the first 12 years and ` 7.00 for the subsequent 13 years.]*

ANNEXURE 9: Web link of important webpages

S No	Description	Web link
1	Ministry of New and Renewable Energy	http://www.mnre.gov.in/
2	List of Manufacturers and Dealers of Energy Technologies	http://www.mnre.gov.in/information/manufacturesindustriesarchitectsconsulting-organisation/
3	Central Electricity Regulatory Commission	http://www.cercind.gov.in/
4	Gujarat Electricity Regulatory Commission	http://www.gercin.org/
5	The Indian Renewable Energy Development Agency (IREDA)	http://www.ireda.gov.in/
6	Centre for Wind Energy Technology (C-WET)	http://www.cwet.tn.nic.in/
7	Strategic Plan For New And Renewable Energy Sector For The Period 2011-17, of MNRE	http://mnre.gov.in/file-manager/UserFiles/strategic_plan_mnre_2011_17.pdf
8	Jawaharlal Nehru National Solar Mission (JNNSM): Schemes and Documents	http://www.mnre.gov.in/solar-mission/jnnsm/introduction-2/