Development of Gandhinagar Solar City

Final Master Plan

Supported by

Ministry of New and Renewable Energy

Government of India, New Delhi

ABBREVIATIONS AND ACRONYMS

AC: Air-conditioner

BEE: Bureau of Energy Efficiency

CDM: Clean Development Mechanism

CDP: City Development Plan

CERC Central Electricity Regulatory Commis

CFA: Central Financial Assistance

CFL: Compact Fluorescent Light

CHP: Combined Heat and Power

CNG: Compressed Natural Gas

CO2: Carbon Dioxide

CPWD Central Public Works Department

CSP: Concentrating Solar Power

DG Se Diesel Generator Sets

DISCO Distribution Company

DSM: Demand Side Management

DTS: Decentralized Waste Water Treatmen

eCO2: Equivalent Carbon Dioxide

EE: Energy Efficiency

ESCo: Energy Service Company

FITM: Feed in Tariff Mechanism

FTL: Fluorescent Tube Light

GDP: Gross Domestic Product

GHG: Green House Gases

HH: House Hold

HPSV: High Pressure Sodium Vapour

ACKNOWLEDGEMENT

EXECUTIVE SUMMARY

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

The master plan begins with the introductory city profile which encapsulates the city’s current energy demands and also the municipal corporation services which are intrinsic to the city’s growing energy demand. The 2nd chapter provides the Current Energy Scenario of Gandhinagar. Detailed analysis of the trend and pattern of electricity, petrol, diesel, kerosene and LPG consumption has been discussed and thoroughly analyzed to base the strategy development of the city. The main sources of energy in the city are electricity, petrol, diesel, LPG and kerosene.

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

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Chapter 2

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Chapter 3

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Chapter 4

4th Chapter Renewable energy and Energy Efficiency Strategies

For Gandhinagar Municipal Corporation begins with the resource availability and intensity of renewable energy resources like solar ,wind, hydro- and geothermal in the city. This chapter is the most substantial part of the master plan as it delineates the specific strategies for the city. For ease to study the city has been divided into residential , commercial, municipal and industrial sectors and both renewable energy and energy efficiency initiatives are enlisted within it. Case studies have been highlighted in the city which are 4- 5 specific sites within the city where RE and EE technologies can be showcased.

Chapter 1

1 Introduction

Gandhinagar city profile

Gandhinagar, the capital of Gujarat State, was planned as a new town in the 1960s. It is located at the bank of river Sabarmati. With 205 sq km area Gandhinagar is just 25 km away from Ahmadabad, the commercial hub of Gujarat. The city is among the few planned city of India. Gandhinagar, the capital of Gujarat State, was planned as a new town in the 1960s. It has developed into an administrative center with little economic and cultural activities. Gandhinagar is an administrative district of Gujarat with its headquarters in Gandhinagar city, the state capital. It covers an area of 2163 square kilometers. The district includes four taluks - Gandhinagar, Kalol, Dehgam and Mansa - and 216 villages. Gandhinagar is bounded by the districts of Sabarkantha to the northeast, Kheda to the southeast, Ahmedabad to the southwest, and Mehsana to the northwest.

Gandhinagar has seen rapid growth and development in eighties. The administrative centre is slowly turning into a trade centre. It has not only made its presence felt in terms of overall development nut also in its many eco drives for a sustainable future. Gandhinagar has been approved by the Ministry of New and Renewable Energy to be developed as a solar city.

Gandhinagar lies at the bank of river Sabarmati at 23.22 0 N 72.68 0 E with an average elevation of 265 feet (81 meter). Gandhinagar is made of 30 sectors with total area of 53 sq km. The city is well organized and is structured into grids. The grid is made of blocks and streets, similar to US avenues and streets. In gandhinagar maximum temperature in summer is 42-430C and the minimum temperature fluctuates between 19-27 0C during summer season. The winter season with average maximum and minimum temperature being 29 0C and 14 0C respectively. The average annual rainfall is 803.44 mm (32 inches).

As per 2001 census, the gandhinagar city municipal has a total population of 1,96,000 with sex ratio of 911 Females per 1000 Males

City Urban development

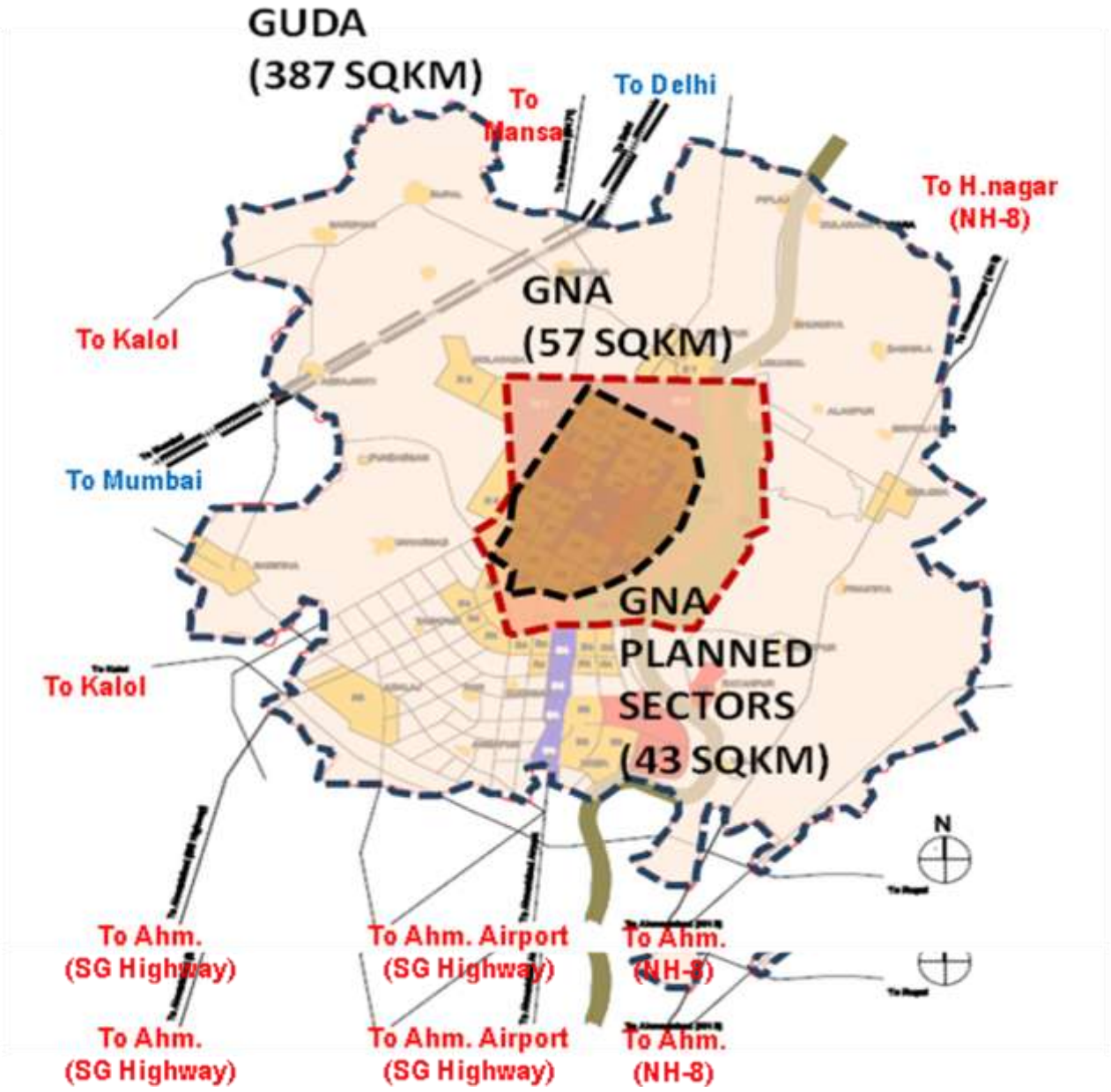
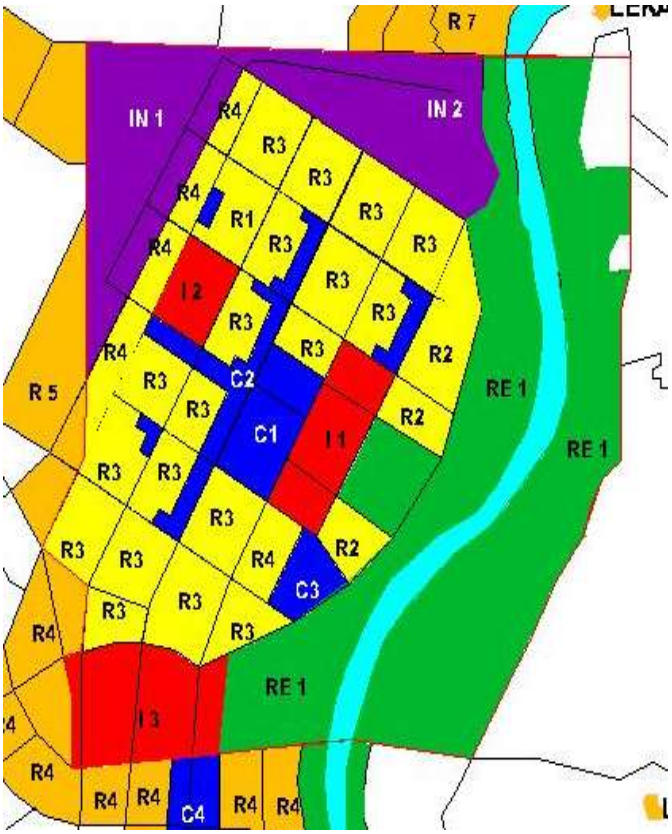


Figure 1 Gandhinagar City Urban Development Plan

	GUDA	387 Sq Km
	GNA	57 Sq Km
	GNA PLANNED	57 Sq Km

Land use plan for Gandhinagar



Population	1,96,000 persons
Area	5738 ha
Gross Density	34pph

Figure 2 Land use paln for GUDA

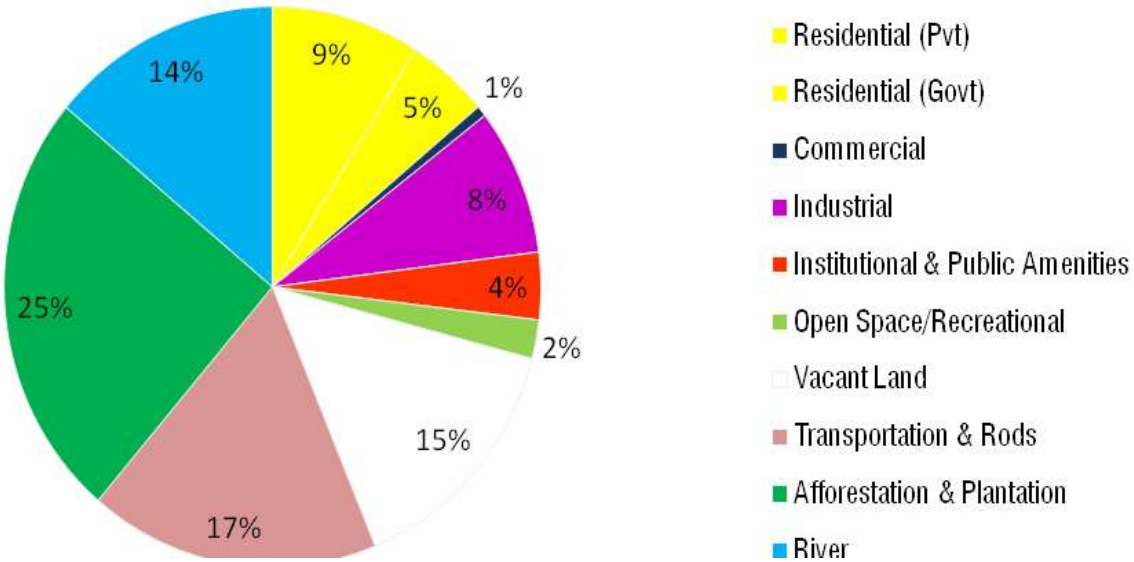
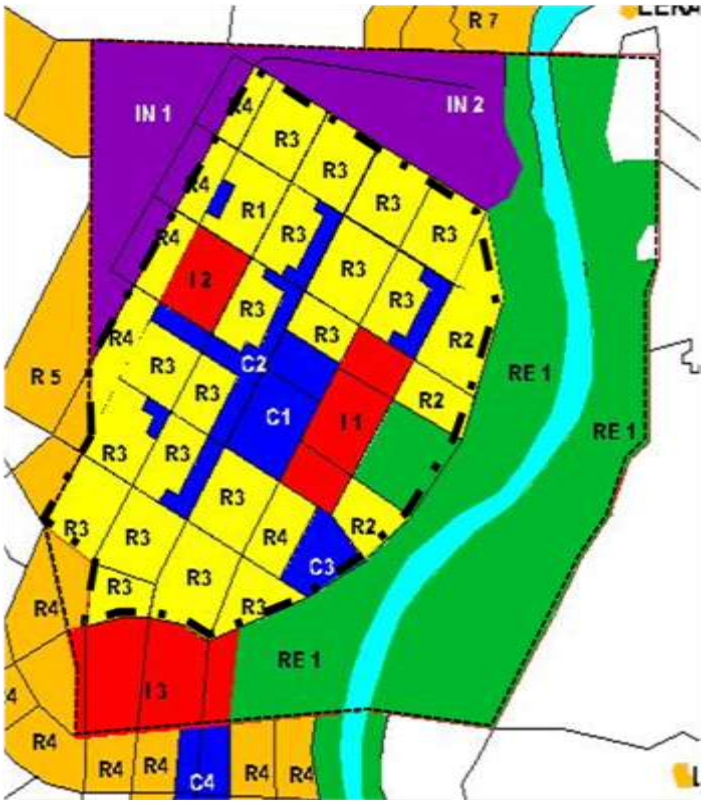


Figure 3 land use Plan for GUDA

Land use –GNA plan sector area



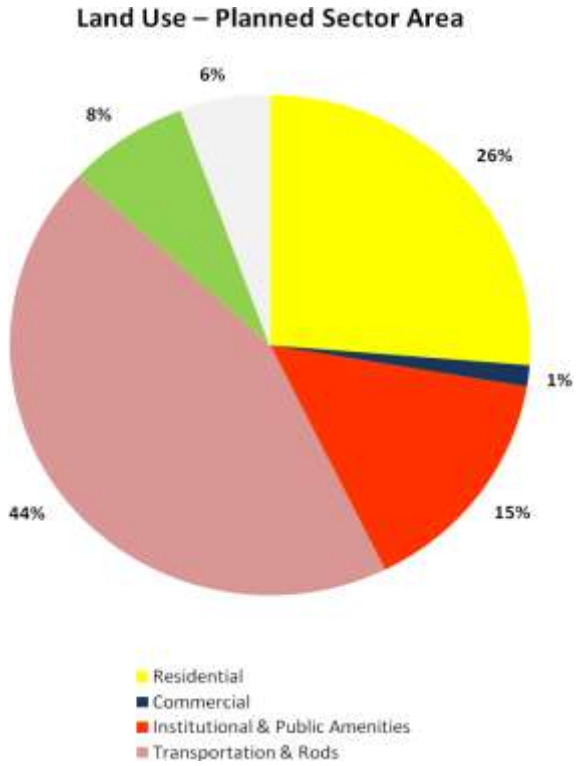


Figure 4 Land Use : Planned Sector Area GNA

Existing Plots , Dwelling Units and Estimated Population in GNA

Sector No.	Plots	Flats		Vacant plot	Under construction	Total no. of floors								Total DU	Sector pop.
		No.	DU			1	DU	2	DU	3	DU	4	DU		
1	481	0	0	200	37	29	29	107	214	108	324	0	0	567	2722
2	2788	0	0	524	108	1014	1014	1128	2256	14	42	0	0	3312	15898
3	3105	0	0	478	186	1373	1373	1068	2136	0	0	0	0	3509	16843
4	2586	0	0	1942	112	311	311	220	440	1	3	0	0	754	3619
5	781	0	0	0	223	278	278	280	560	0	0	0	0	838	4022
6	951	172	860	145	65	235	235	266	532	68	204	0	0	1831	8789
7	1463	197	985	339	36	387	387	504	1008	0	0	0	0	2380	11424
8	895	61	305	216	63	31	31	97	194	420	1260	0	0	1818	8726
9	112	22	110	20	0	70	70	0	0	0	0	7	28	180	864
12	484	65	325	1	90	103	103	224	448	1	3	0	0	879	4219
13	1259	267	1335	244	35	627	627	86	172	0	0	0	0	2134	10243
14	509	23	115	184	42	176	176	64	128	20	60	0	0	479	2299
15	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
16	345	169	845	176	0	0	0	0	0	0	0	0	0	845	4056
17	219	198	990	21	0	0	0	0	0	0	0	0	0	990	4752
18	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0
19	281	51	255	0	41	108	108	71	142	10	91	0	0	596	2861
20	391	124	620	187	4	35	35	33	66	8	24	0	0	745	3576
21	515	147	735	56	1	158	158	138	276	15	45	0	0	1214	5827
22	978	201	1005	153	17	185	185	421	842	1	3	0	0	2035	9768
23	577	148	740	218	2	64	64	132	264	13	39	0	0	1107	5314
24	2718	2170	2170	136	0	1412	412	0	0	0	0	0	0	2582	12394
25	562	0	0	89	196	268	268	9	18	0	0	0	0	286	1373
26	1355	2	10	993	53	239	239	68	136	0	0	0	0	385	1848
27	2202	124	620	0	0	2078	2078	0	0	0	0	0	0	2698	12950
28	681	190	950	245	0	127	127	119	238	0	0	0	0	1315	6312
29	1038	258	1290	521	0	95	95	162	324	2	6	0	0	1715	8232
30	1172	223	1115	455	6	355	355	118	236	15	45	0	0	1751	8405
	28448	4812	15380	7543	1317	9758	8758	5315	10630	696	2149	7	28	36945	177336

City Urban Services

1.1.1 Administrative Setup

Gandhinagar is a Government city whose development and maintenance are borne by the state government .

1.1.2 Water supply

The source of water supply in the city is mainly from River Sabarmati and ground water . There are existing three developed sources of water.

1.1.2.1 Sources of water

Si.No.	Source	Quanity of water	Remarks
1	Intake well	21MLD	Commissioned in 1969
2	Radial collector well	42 MLD	Commissioned in 1986
3	Tubewella (12 nos.)	13 MLD	
4	New Radial collector well	75 MLD	Commissioned in 1999
5	N.M.C canal water is deliv	80 MLD	Commissioned in 2001

1.1.3 Street light

1.1.4 Public Health

There are two ares of social infrastructure for higher services that can be explored for bringing diversified economic base for a city as a health hub or educational hub .

Table 1 Health Iinfrastructure in rural area .

Type	Health facilities in rural area
Civil Hospital	1
Community health centre	1
Primary health centre	8
Sub health centre	58

Table 2 Health Infrastructure In GNA in 1997

Location	Dispensaries (1/12000)	FPCs, CWCs (1/16000)	Hospitals (1/80,000)
City	18(14)	2(11)	1(2)

1.1.5 Demography for GNA

Area	2009	2016	2021	2031
Population	309684	407523	495814	733925

Table 3 census of India

Year	Growth rate in %
1971-81	159.58
1981-91	97.55
1991-2001	58.87

1.1.6 Education

Table 4 Educational Infrastrucutre In Gandhinagar Taluka in rural area. (2004)

Type /Location	District Panchayat operated	Privately operated	Total
Primary school	147	157	204
Pay centre school	14		14
Secondary school		79	79
Higher secondary		39	39
Aangan vadi	240		240
Colleges /tech school			10

Table 5 Educational Infrastructure in GNA in 1997

Location	Primary School (1/4000)	FPCs, CWCs (1/1,20,000)	Hospitals (1/80,000)
City	67(42)	24(14)	7(2)

Power Supply Network

Gandhinagar district enjoys uninterrupted 24 hour power supply.The main power station is located in Gandhinagar, the capital of Gujarat.One 400 KV service station, two 220 KV service stations and one 132 KV service station supplpower throughout the district. Also 66kv s/s across the district.

Population	1,96,000 (2001 Census)
No. of House holds	42,471
Average Electricity use	2.68 kWh / day / House hold
Peak Load	39 MW
Annual Consumption	192 Million Units
Industrial	67.2 Million Units (35%)
Government	66.8 Million Units (35%)
Residential	44 Million Units (23%)
Commercial	14 Million Units (6998 Consumers) (7%)
Kerosene Usage	25,000 KL p.a.
Water requirement	45 MLD

City services

1.1.7 Traffic and transportation

Ahmedabad Gandhinagar has largest share of passenger trips. At present the major means of transport between two cities is the subsidized bus service.

Gandhinagar has very weak rail linkage. There is an existing broad guage line on which daily a three coach local passenger train comes twice and supports only 10-15 percent of the total population.

1.1.8 Road Length in March, 2004 (in Kms)

Area	BSSL	SSL	SDL	SML	Total
GNA	289	93	102	82	484

Where;

BSSL – Below standard single Lane-clear carriageway of width less than 3.75m.

SSL – Standard single Lane – clear carriage way of width 3.75m to 7m.

SDL – Standard double Lane – clear carriageway of width 7m to 10.5m.

SML – Standard Multi Lane- clear carriageway of width 10.5m and more.

The pattern of the main city roads is generally rectangular forming a grid 1 km X ¾ km. The roads have been oriented to form 30º north of west and 60º north of east to avoid direct facing of morning and evening sun during journeys to and from work places. Access roads to the city center are 65 m wide. Road to the government offices from south – west to north – west and the crescent road are 100 m wide. Rests of the roads are 45 m wide.

Road Network within GNA

Sr. No.	Name of the Road	Road width / Right of way (meters)
1	"K" Road	45.00
2	"Kh" Road	65.00
3	"G" Road	45.00
4	"Gh" Road	65.00
5	"Ch" Road	100.00
6	"Chh" Road	65.00
7	"Jh" Road	91.45
8	Road No.1	45.00
9	Road No.2	45.00
10	Road No.3	45.00
11	Road No.4	100.00
12	Road No.5	45.00
13	Road No.6	45.00
14	Road No.7	65.00

As per the existing land use, the utilization is only 20.21% of planned commercial land use. There are mainly two GIDC estates in Gandhinagar Notified Area – GIDC Electronic estate and GIDC Engineering estate. There is also a GEB Thermal Power Plant and warehousing near the railway station in the city. The engineering estate covers 36 ha and electronic estate is spread over 230 ha.

1.1.9 Solid Waste

- Solid Waste management in Gandhinagar is a pressing issue and has deficiencies.
- Total estimated waste generation is 40 MT/d @ 240 gms/capita/d
- The total waste collected is 24 MT/d
- Solid waste collection is done for government owned and privately owned area.
- The agency responsible : Gandhinagar Notified Area Committee

This waste is collected by means of containers and trucks . waste collection containers have been provided in each sector. Gandhinagar has very limited number of mechanized equipment and the vehicles required as compared to their requirement . A solid waste management plan for GNA area has been prepared . A staffing pattern of 295 personnel has been proposed as a part of this proposal and a public awareness campaign has been planned.

1.1.10 Street light

Vehicle and traffic distribution in GUDA

70% of passenger trips are made for or work and education. Two-wheelers and car account 45% of total vehicles and carry 38% of passengers. Bicycle account for 10% of the vehicles and carry 3% of passenger.Buses account 5% of total vehicle and carry 43% of traffic.The goods traffic is 28%

1.1.11 Vehicular and traffic distribution in GNA

Mode of transportation	No. of vehicle	Carries passenger
Bicycle	27%	13%
Two wheeler	42%	25%
Cars	14%	
Goods traffic	4.5%	
Buses	3%	39%

1.1.12 Existing road network of GNA : Total road area of GNA – 23.19%

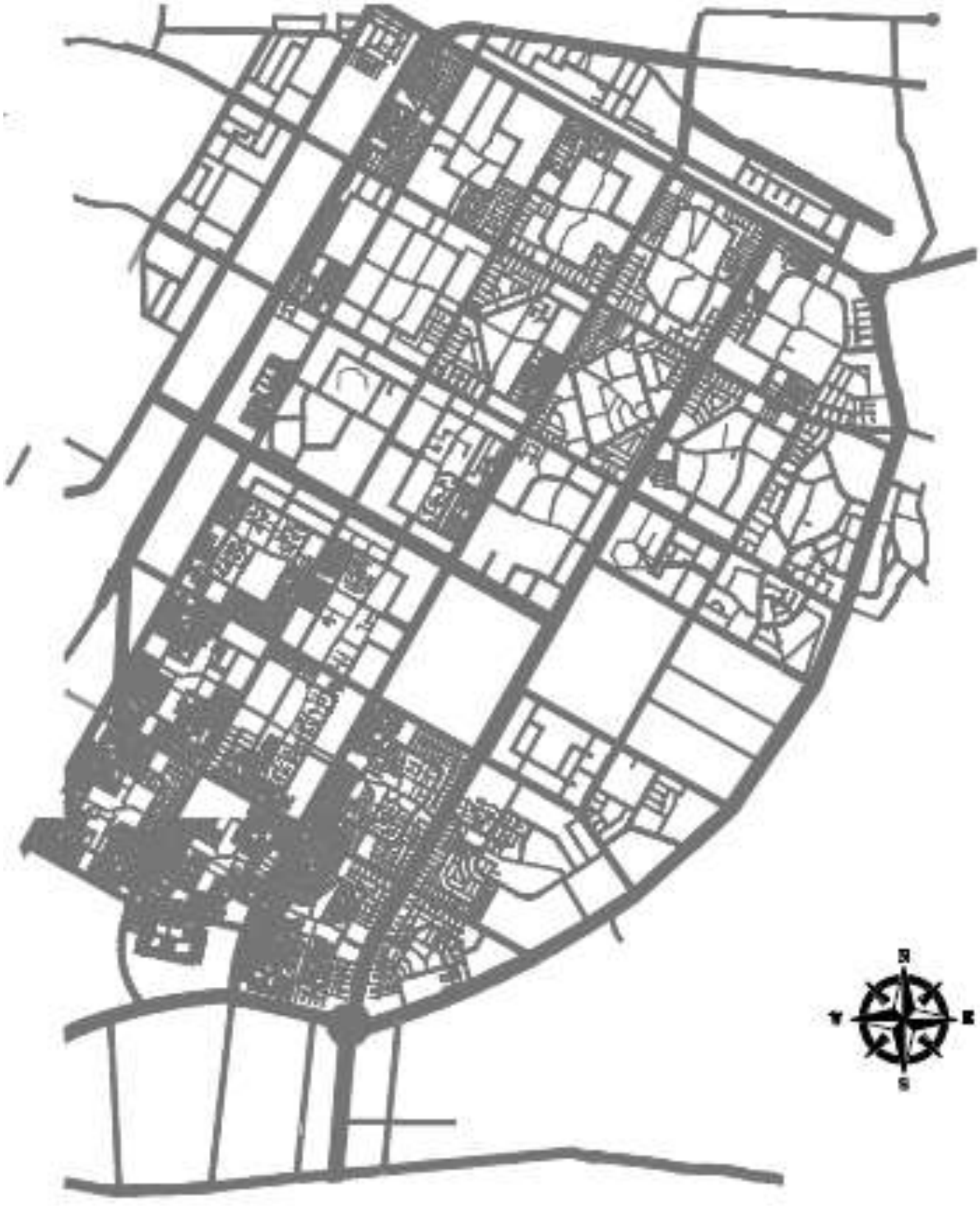


Figure 5 Existing Road Network in GNA

Developing Gandhinagar as 'Solar City'

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

1.1.13 Preparation of Master Plan for 'Gandhinagar Solar City'

The master plan preparation process is divided into six steps:

i. Preparing energy base-line for year 2008

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

ii. Demand Forecasting for 2013/2018

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

iii. Sector wise strategies

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

been prepared for use of techno economically feasible renewable energy technology options in each sector.

Year-wise goals of savings

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

iv. Action Plan

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

v. Financial Outlay and sharing of fund

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

CHAPTER 2

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

2 ENERGY BASELINE STATUS OF GANDHINAGAR CITY

Overall Energy Status

2.1.1 Energy Consumption

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

Electricity: Electricity distribution in the city is zone based and there are 3 circles in the Gandhinagar city.Based on the information available, sector wise electricity consumption data is compiled for last 4years.

	Electricity Consumption (MU)			No. of Consumers
Year	2008-09	2009-10	2010-11	
Residential	43.24	45.31	49.91	
Commercial	13.61	13.79	15.19	
Industrial	65.8	68.95	75.95	
Government	65.8	68.95	75.95	
Total	188	197	217	

Source: Torrent, Ahmedabad

The pie chart below gives the breakup of electricity consumption for different sectors. Government & Industrial sector dominates (67%) in electricity consumption and hence should be targeted for Demand Side Measures(DSM).During last four years, the residential and commercial sectors have shown higher growth in electricity consumption as compared to the municipal and industrial sectors.

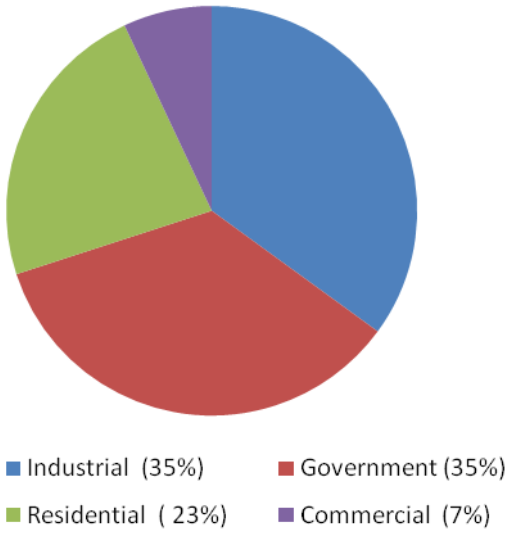


Figure 6 Sector wise Break up of Electricity Consumption

The maximum electricity consumption in Gandhinagar city is from Industrial and Government Sector which consumes about 70 % of the total electricity consumption in the city. The Sectoral Growth in last few years for residential, commercial and industrial sectors is 23 %, 7% and 35 % respectively.

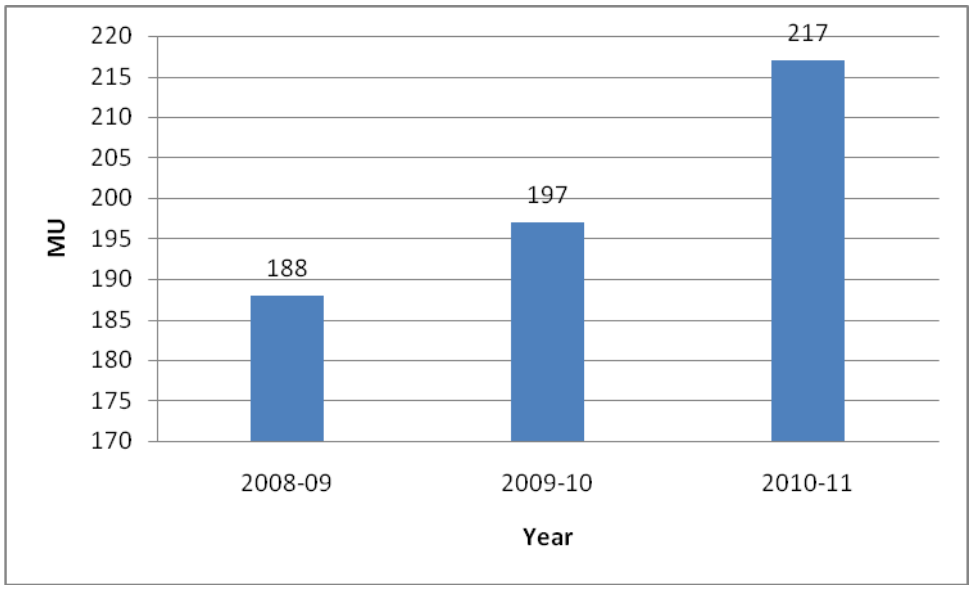


Figure 7: Growth in Electricity Consumption (Million kWh)

i. LPG

On the available data, LPG consumption (in MT) is summarized in Table given below. Most of the consumption would be in residential sector. There may be some consumption in commercial sector as well. However, sectoral break up is not available.

Table 6 LPG Consumption Data in Gandhinagar City

2005-06	2006-07	2007-08	2010-11
15696240 kg	15910963 kg	16128643 kg	16800318 kg

Source: IOCL, Ahmedabad

ii. Petrol:

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

Table 7 Petrol Consumption Data in Gandhinagar city

2010-11	2011-12
16272 kl	17292 kl

Source: IOCL, Ahmedabad

iii. Diesel :

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

Table 8 Diesel consumption Data in Gandhinagar city

2010-11	2011-12
16763 kl	20124 kl

Source: IOCL, Ahmedabad

iv. Kerosene :

Based on the available data, kerosene consumption (in kL) is summarized in Table given below. Most of the consumption would be in residential sector; however, it might include the supplyto commercial and industrial sector which are not falling under ANN area. Sectoral break up ofkerosene consumption is not available.

Table 9 Kerosene Consumption Data in Gandhinagar City

2011
7937.32

Source: Food and civil supply, Gandhinagar

v. CNG:

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

Table 10 CNG Consumption Data in Gandhinagar City

2010-2011	2011-2012
9526 tons	9720 tons

Source: Food and civil supply, Gandhinagar

Supply Side Energy Balance

Based on the available data for these 6 energy sources, the supply energy scenario for year 2008-09 is developed. It is assumed that the SWH penetration in the city is 0.73%, i.e. 0.73% of the households use SWH in the city. Other renewable have very low penetration and are too small a percentage to be reflected here. The table and figure give contribution of these energy sources in the overall energy supply.

Source	Consumption	Unit	Consumption (MU)
Electricity	217	MU	217
LPG	16800318	Kgs	244.26
Petrol	17292	KL	159.60

Diesel	20124	KL	185.74
Kerosene	7937.32	KL	73.26
CNG	9720	Kgs	0.14
		Total	880

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

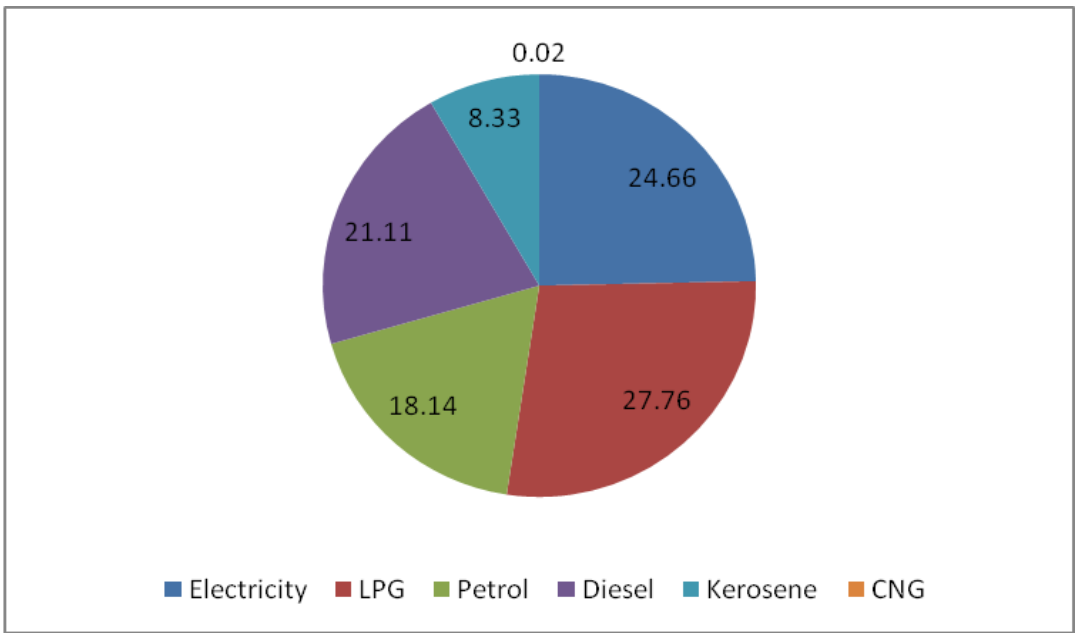


Figure 8: Shares of Fuels in Supply Side Energy Balance

The above mentioned pie-chart gives the break up in percentage for supply side energy balance for the 2011.

Residential Sector

2.1.2 Energy consumption

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

Table 11 Residential sector energy consumption

Sources	2010	2011

Electricity(MU)	45.31	49.91
LPG (kg)		16800318
Kerosene (kL)		7937.32

Energy balance for the sector for the year 2011.

Table 12 Energy balance for Residential sector

Source	Consumption	Consumption (MU)
Electricity	49.91	49.91
LPG	16800318	244.26
Kerosene	7937.32	73.26
	Total	367.43

LPG is the main source of energy in residential sector as it contributes 66.48% of the total whereas electricity contributes 13.58% and kerosene contributes 19.94%.

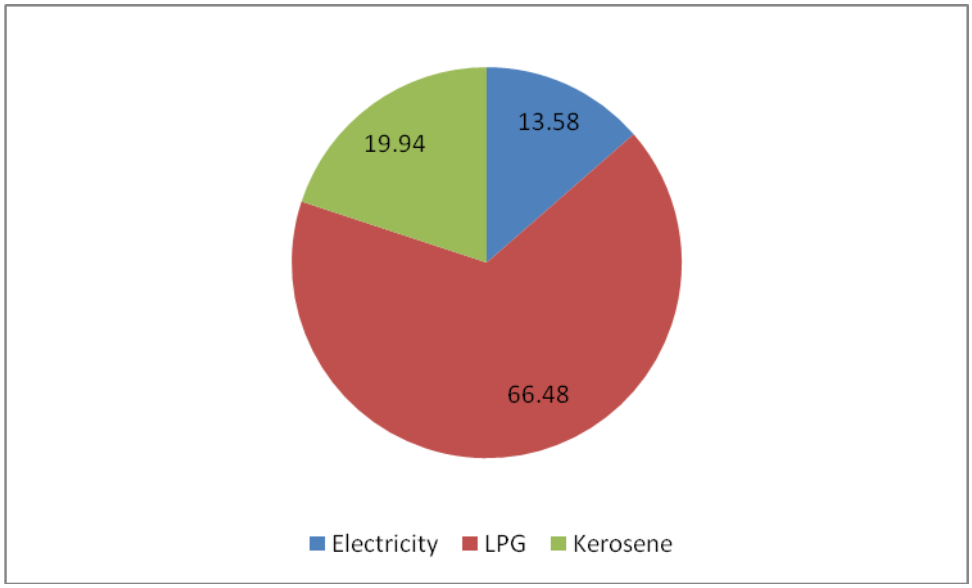


Figure 9: Supply Balance in residential sector

Results of sample survey

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

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

2.1.3 Household classification and general details

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

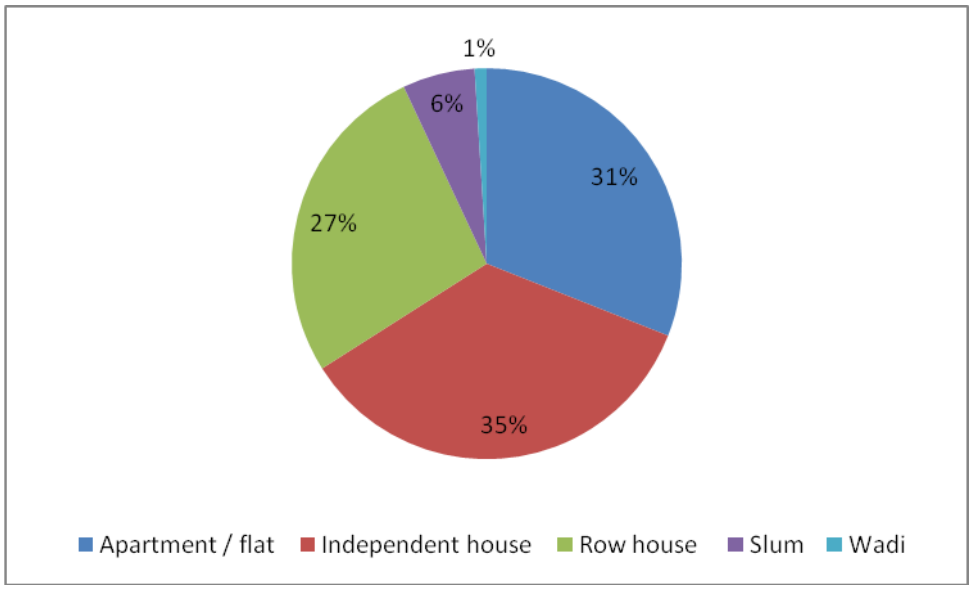


Figure 10: House hold classification

Building type (GNA):

- Apartment / flat – 31%
- Independent house – 35%
- Row house – 27%
- Slum – 6%
- Wadi – 1%

As the data show that the primary sources of energy consumption in the residential sector are: Electricity, LPG and Kerosene, we will try to find out the consumption behavior of these energy sources in the residential sector.

Energy Consumption Pattern

As the data show that the primary sources of energy consumption in the residential sector are: Electricity, LPG and Kerosene, we will try to find out the consumption behaviour of these energy sources in the residential sector.

Table 13 Summary of sample survey

End Use	Type of Appliances	% of surveyed HHs owning the appliance	Average number of appliances per surveyed HHs	Average Usage/day	Average Wattage
Lighting	Incandescent				
	CFLs				
	Fluorescent -long				
	Fluorescent - short				
	Others				
Space Conditioning	Air Conditioner				
	Room heater				
	Fans -Ceiling, Table P				
	Desert cooler				
Water Pumpi	Electric Water Pump				
Water Heatin	Geyser				
Refrigeration	Refrigerator				
Others	Television				
	Others				

Fuel usage:

Average monthly fuel consumption:

- LPG
- Kerosene

Primary fuel used for cooking

- LPG/PNG
- Kerosene
- Fuel wood
- Electricity
- Others

Primary fuel used for water heating

- LPG/PNG
- Kerosene
- Fuel wood
- Electricity
- Other

Awareness of EE & RE technologies amongst masses:

Graphs showing percentage of awareness of Electricity saving Appliances (for the residential sector)

Commercial Sector

2.1.4 Energy Consumption

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

Table 14 Commercial Sector Energy Usage

Source	2008-09	2009-10	2010-11
Electricity (MU)	13.61	13.79	15.19

Table 15 Energy Balance for the Sector in 2011

Source	Consumption	Unit	Consumption	Unit
Electricity	15.19	MU	15.19	MU
		Total	15.19	MU

2.1.5 Details of commercial establishments in the city

Table 16 summary of commercial establisnment /Institutes in Gandhinagar

Educational Institutes	
Primary Schools/ Nursery	81
Intermediate & High schools	35
Universities/ colleges/ Technical Institutes	24
Hospitals	
Small hospitals and nursing homes with less than 50 beds	11
Hospitals with 50-100 beds	
Large hospitals with more than 100 beds	6
Medical college hospital with about 1000 beds	0
Dispensaries/ day care center/ micro surgery clinic/ dental	55
Microbiology/Pathology/Diagnostic Lab	
Hotels	
5 Star category hotels with 100 + guest rooms	

3 Star category hotels with less than 100 guest rooms	4
Budget hotels / lodge	6
Restaurants – 27 (total)	
Large Restaurants	
Medium Restaurants	
Small Restaurants	
Food Cart	

Results of sample survey

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

Consumer classification (kWh/month)

Chart showing break up of energy used by consumer

- BLP
- 100 KWh
- 100-300 KWh
- < 300KWh

Table 17 Summary of sample survey in commercial sector

End Use	Type of Appliances	% of surveyed establishment ow appliance	Average number of applian surveyed HHs	Average Usage/day	Average Wattage
Lighting	Incandescent				
	CFLs				
	Fluorescent Tube				
	Others				

	Air Conditioner				
Space	Room heater				
Conditioning	Fans -Ceiling, Table,				
	Desert cooler				
	Geyser				
Water Heatin	Refrigerator				
Refrigeration	Cooking Equipment				
Cooking	Laundry Equipment				
Laundry	Office Equipment				
Office Equipn	Computers				
	Electric driven air con				
Others	Lathe Machine				
	Other major elec. equ				

2.1.6 Fuel used:

- Electricity -
- LPG -
- Diesel -
- Other -

2.1.7 Average monthly fuel consumption

Chart showing electricity consumption and lighting technologies used by the consumers

Chart showing awareness of energy efficient technologies in the city

2.1.8 Cooking and other appliances

Consumers having cooking appliances in their premises: 11.54%

Appliances used for cooking (%age of consumer using):

- LPG/PNG stove
- Any other

Average LPG consumption

Hot water use : Fuel used for water heating

Interest shown for SWH installation

Table 18 Interest Shown By consumer for solar water heater Installation

Yes	
No, it would be too expensive	
No, it would be impractical for this facility	
No, it is too risky and unproven	

Industrial Sector

Services in the public sector, Electrical & Electronics, Textiles, Food Processing, IT/ITeS, Ceramics and Office Stationery are some of the major vocational and industrial activities in Gandhinagar.There are approximately 8,000 small scale industries (SSIs) in Gandhinagar providing employment to over 36,000 persons .Electronics and Textiles have been the main sectors of investment and employment in Gandhinagar district since the late 1980s.The Food Processing industry of the district is well developed because of the proximity to agricultural districts such as Mehsana, Sabarkantha, Ahmedabad, Kheda, Anand, etc

Infrastructure development is another sector that has opened up new opportunities for investment and employment. There are at present 330 medium and large scale industries in Gandhinagar, most of which are concentrated in Kalol Taluka (203 units).

2.1.9 Major companies operating in the District:

Name of Company	Taluka	Production
Pramukh Agro Foods Pvt. Ltd.	Kalol	Refined Rapeseed Oil and Cottonseed Oil
Multimedia Frontiers Ltd.	Gandhinagar	Compact Disks
Gen Tek Technology	Gandhinagar	Wiring Harness
AT & T Switching Systems	Gandhinagar	Telephonic and Telegraphic Switching Appara
Mother Dairy	Dehgam	Milk Products
Parekh Platinum Ltd.	Dehgam	Gold Plating
Shah alloys ltd.	Kalol	rolled MS Sheets
Indian Farmers Fertiliser Cooperative	Kalol	Urea, Ammonia
Sintex Industries Ltd.	Kalol	Prefabricated Houses, Water Storage
Arvind Mills	Kalol	Textile Goods

2.1.10 Industries In Rural GUDA

Non polluting and non chemical types of industries , which consumes less water ,are encouraged . The main industries in the village of gandhinagar urban development area are kilns, saw mills , dairy , oil mils, cloth weaving and printing , cement products, warehousing and so on . the number of industries in gandhinagar notified are and 38 villages are 196 employing 10,083 persons.

LOCATION	NUMBERS OF INDUSTRIES	TYPE
SECTOR 15,25,26	350 (2011)	Electronics industries
SSECTOR 26 ,30	274 ,25	Engineering Industries

2.1.11 Number Of Industries / Establishment In Gna As Registered Under Factories Act, 1995

Sr. No.	Location	Functioning Units	Non – Functioning units
1	Sector 11	1	0
2	Sector 21	1	0
3	Sector 22	1	0
4	GIDC Electronic Estate	85	9
5	GIDC Engineering Estate	21	2
6	Sector 29	1	0
7	Sector 30	1	0
8	Charedi Water works	1	0
9	GEB Plant Workshop	1	0
	Total	113	11

2.1.12 Energy consumption

Table 19 Industrial Sector Energy Consumption

	2008-09	2009-10	2010-11
Electricity (MU)	65.8	68.95	75.95

Table 20 Energy Balance for Industrial Sector

Source	Consumption	Unit	Consumption	Unit
Electricity	75.95	MU	75.95	MU

2.1.13 Results of sample survey

- **Number of working people in the industry ranges from to with an average of 21.**
- **Area for the industries ranges from ft² with an average of ft².**

Table 21 Energy used in Industrial Sector

	% of consumer
Electricity	
LPG	
Furnace oil	
Diesel	
Coal	
Other	

2.1.13.1 Major use of electricity

	Average (%)	Min. (%)	Max. (%)
Motors & drives			
Air conditioning			
Lighting			
Refrigeration			
Process equipment			
Other			

2.1.13.2 Cooling Appliances Inventory and Usage

	% of consumer	Avg. stock per cons	Avg. use (hr/day)
Fans			
Desert coolers			
Central plant			
Packaged rooftop units			
Window AC			
Split AC			

2.1.13.3 Lighting inventory and usage

	% of Consumer	Avg. Stock per Consumer	Avg. use (hr/day)
Incandescent bulb			
CFL			
Fluorescent lamp (long)			
Others			

2.1.13.4 Awareness and usage of energy efficient lighting technologies

	% of Consumer Aware of	% of Consumer Using
Compact Fluorescent Lamps		
Energy-Efficient Fluorescent Tubes (36-Watt T8)		
High-Efficiency Fluorescent Tubes (28-Watt T5)		
Low-Loss Magnetic Ballasts		
Low-Loss Electronic Ballasts		
Reflectors		
High Pressure Sodium Lamps		
Skylights and Day lighting Controls		

Municipal Sector

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

Table 22 overall Municipal Sector Energy Consumption (MU)

	2008-09	2009-10	2010-11
Municipal Buildings	65.8	68.95	75.95
Pumping Station			3.54
Waste Water Treatment Plant			
Street lights			

2.1.14 Water Pumping

Table 23 Electricity Consumption in Water Pumping (MU)

Location	Capacity	No. Of equipment	Year (2005-06)
Charedi water works	30 MLD	9	2.22
Sarita Udyan water works	15 MLD	3	1.32

2.1.15 Waste water treatment plant

Table containing energy consumption in waste water treatment plant (MU)

2.1.16 Street Light

Table containing energy consumption in streetlight (MU)

2.1.17 Municipal Building

Table containing energy consumption in Municipal Building (MU)

City Wide Green House Gas Inventory

2.1.18 City level Emission

The first step to determine emission load has been to identify significant CO2, CH4 and N2O emission sources within each identified sectors. Second, the availability of CO2, CH4 and N2O emission data or to apply an estimate of the CO2, CH4 and N2O emissions based upon scientific and engineering principles. The GHG emission estimation was carried out for all land uses and the emissions were grouped by their source and their estimated tCO2e emissions. The inventory of emission sources and components has been based on TERI-GRIHA and IPCC list. The quantified carbon emissions from the various uses have been presented in Table 5-1. It is evident from the findings that the major GHG emission in the GNA and rest of GUDA area is from the industrial sector (68.43%), which is largely due to the presence of the Gandhinagar Thermal Power Plant (GTPS) followed by the transportation sector (23%).

Table 24 GHG's emission in Gandhinagar

Sr. no.	Sectors	GHG's (tCO_2e)	Sources of emision
1	Residential	83772.01	64% from electricity and 22.5% from cooking gas
2	Commercial	34644.74	52.7% from electricity and 43% from CNG
3	Industrial	5288145.16	99% from coal (GTPS)
4	Government	18187.21	

Source : LEA associates, Gandhinagar

Figure summarizing the city green house gas (GHG)

2.1.19 Government Emission

Figure summarizing GHG emission in Government Sector Building

Chapter 3

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

3 ENERGY DEMAND FORECAST FOR GANDHINAGAR

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

Forecasting Based on Population Growth Population projection for Gandhinagar urban development Area has been done by EPC by component method.

Table 25 Population projection of GNA

Area	2009	2016	2021	2031
Population	309684	407523	495814	733925

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

Table 26 Growth rate for GNA

Year	Growth rate in %
1971-81	159.58
1981-91	97.55
1991-2001	58.87

Forecasting for the year 2013/2018

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

Table 27 population projection for Gandhinagar 2013 & 2018

2009	2013	2018
309684	31.59	21.66

Table 28 Energy Consumption Projection

	2008	2013	2018
Population	309684	407523	495814
Electricity (MU)	188	200.71	213.42
LPG (MT)	16128643 kg		
Diesel (kL)			
Petrol (kL)			
CNG (kg)			
Kerosene (kL)			

Forecasting Based on Past Data

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

Table 29 Table showing energy consumption projection for Gandhinagar city

								Projected data	
Year	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2013	2018
Electricity (MU				188	197	217			
LPG (kg)	15696240	15910963	16128643	16800318					
Petrol (kL)						16272	17292		
Diesel (kL)						16763	20124		
CNG (kG)						9526	9720		
Kerosene (kL)							7937.32		

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

Table 30 : Energy Consumption Forecast for Gandhinagar City (MU)

Year	2008	2013	2018
Electricity consumption			
LPG			
Kerosene			
Total			

3000

Goal for the year 2013

Detail are required for 2013 . based on the population growth and past data

CHAPTER 4

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

4 RENEWABLE ENERGY STRATEGIES FOR GANDHINAGAR

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

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

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

- Solar Water Heaters
- Solar Cookers
- Solar Lanterns
- Solar Home System
- Solar PV system for Home Inverters
- PV for replacement of DG/ Kerosene Generator sets
- Renewable Energy Systems for Residential Housing Complexes

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

i. RE Strategy for Hotels - 5 star, 3 star and budget

ii. RE Strategy for Restaurants - Large, medium, small, food cart

iii. RE Strategy for Hospitals - 250-1000 bedded, 100-250 bedded, 50-100 bedded, Dispensaries/ dental clinic/ microsurgery

iv. RE Strategy for Educational Institutes - Primary, intermediate, colleges, engineering colleges, medical colleges, Computer Institute, Polytechnics, ITI

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

Industrial Sector is divided in to ten categories based on technology and products. Case studies have been made for each category of industry and suitable renewable energy options have been recommended for each category of industry.

(i) Food processing Industry including Petha Industries

(ii) Beverage, Toba and Toba products

(iii) Hosiery and Garments

(iv) Paper products and Printing Industry

(v) Wood Product

(vi) Leather industries including shoe making industries

(vii) Rubber and plastics

(viii) Chemical and chemical products

(ix) Non metallic mineral products

(x) Metal products

(xi) Machinery & Parts except electrical

(xii) Electrical machinery & apparatus

(xiii) Foundry

(xiv) Miscellaneous manufacturing

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

(i) Buildings - Municipality building and other Office Buildings

(ii) Markets - General markets, vegetable markets

(iii) Parks - Municipality Parks

(iv) Outdoor lighting Road safety- Street light, monuments, road blinkers,

(v) Advertisement hoardings - Large and small hoardings

(vi) Municipal Solid Waste

(vii) Sewage Treatment Plant

Renewable Energy Resource Assessment

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

4.1.1 Solar radiation

Gandhinagar (Latitude 23.13 N, Longitude 72.41 E) receives good amount of solar radiation as the average annual solar radiation for Gandhinagar is presented in the below table.

Table 30: Monthly Averaged Insolation Incident on a Horizontal Surface (kWh/M²/Day)

Source	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annua
NASA SSE Satellite													
MNRE Solar													

----------GRAPH----------

4.1.2 Wind Energy

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

Table 31: Monthly averaged wind speed above earth surface for terrain similar to airports (m/s)

Height	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
10 m												
50 m												

4.1.3 Biomass Resource

Biomass resource for Gandhinagar is not available separately. However, the data is available at district level and presented below in the Table. Major agricultural product of the district are _____and other cereals. Though the potential of power generation for biomass is estimated to be ___MWe for the entire district, apparently there is no potential of power generation from biomass within the Gandhinagar city.

Table 32: Biomass Resource

District	Area	Crop Production	Biomass	Biomass	Power	Biomass
Gandhina						

4.1.4 Waste generation

Waste generation data for Gandhinagar municipal corporation area for the last 5 year is presented in the table given below.

Table 33: Solid Waste Generation Data (Metric Tonnes)

Year	Solid Waste Generated
2003-2004	
2004-2005	
2005-2006	
2006-2007	
2007-2008	

4.1.5 Liquid Waste from Sewage Treatment Plant

Gandhinagar has three Sewage Treatment Plants with aggregate capacity of _____MLD

STP	Capacity in MLD
SPT - I	
STP -II	
STP - III	

RE Strategy for Residential sector

With projected population of _____ lakh (2013) and _____lakh households, the residential sector is the major energy consumer in the Gandhinagar city. The residential sector consumes 57% of total electricity consumption of _____+MU in Gandhinagar city. The sector consumed _____ MU of energy, which includes primarily electricity, kerosene, and LPG. Electricity is the major fraction (____%) of energy consumed by the residential sector. Use of renewable system to cater a part of energy demand in residential sector can substantially reduce fossil fuel consumption and green house gas emission. Different renewable energy options have been proposed on technology available and economic feasibility. Only those renewable energy devices are recommended which are technically proven, commercially available and attractive in terms of financial benefit from energy savings.

(i) Installation of Solar Water Heating System

COMPULSION OF SOLAR ENERGY SYSTEM FOR ALL NEWLY CONSTRUCTED BUILDINGS FOR HEATING WATER AS GEYSERS AND WATER HEATERS.

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

Table 34: Target for SWHs installation in Gandhinagar City

Single Household		Unit
Average size of domestic SWH (2 sqm collector area)		LPD
Total energy saved per year		kWh
Indicative cost of installation		INR
MNRE Subsidy @Rs.1100.00 per sqm		
Cost of energy savings		INR
Payback period		Years
Target for entire city		
Total Residential household		Nos.
Residential household using geysers	_____%	
Target to replace electric geyser by SWH in 5 years	_____%	

Average size of domestic SWH (2 sqm collector area)		LPD
Number of SWH to be installed in 5 years plan		Nos.
Total collector area in sqm		Sqm
Total energy saved per year		MU
Indicative cost of installation		Lakh
MNRE Subsidy @Rs.1100.00 per sqm		Lakh
Cost of energy savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

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

Both box type solar cooker and dish type solar cooker can be promoted in the urban areas. Box type solar cooker is an ideal device for domestic cooking during most of the year, except for the monsoon season and cloudy days. It however cannot be used for frying or chapatti making. It is durable and simple to operate. On the other hand, dish type solar cooker can be used for indoor cooking. The stagnation temperature at the bottom of the cooking pot could be over 300^{o}C depending upon the weather conditions. The temperatures attained with this cooker are sufficient for roasting, frying and boiling. Regular use of a box type solar cooker may save 3-4 LPG cylinders per year. The use of solar cooker to its full capacity may result in savings up to 10 LPG cylinders per year at small establishments. Setting a target of 5% residential consumer to adopt solar cooker (75% box type and 25% dish type) in the 5 years period, a total of 0.30 million kg of LPG could be saved by reducing _____ tonnes of GHG from Gandhinagar City (considering specific emission from LPG as 0.24 kg CO2 per kWh).

Table 35: Target for introducing solar cooker in Gandhinagar City

Solar Cooker for residential use		Unit
Total Residential household		Nos.
Household having facility to install a solar cooker	_____%	
Target for introducing of solar cooker in 5 years	_____%	
Number of Solar Cooker to be installed in 5 years plan		Nos.

Average savings of LPG domestic cylinder per year (14kg)		Nos.
Total LPG saved per year		kg
Total energy saved per year		MU
Indicative cost of installation (75% box type & 25% SK-14)		Lakh
MNRE subsidy for solar cooker @30%		Lakh
Cost of energy savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

(iii) Solar lanterns to replace kerosene lamps

Solar lantern has the average capacity of providing three hours of continuous light from a single charge per day, and can work as source of light for poor families without electricity. Kerosene is the main source of burning light in poor families in Gandhinagar particularly during load shedding hours and survey results reveal that ____% of population use kerosene lanterns during load shedding to illuminate their houses. Average consumption of kerosene per household is 13litres per month. Assuming a household uses 3-4 lanterns, consumption of one lantern will be about 3 litres per month. Targeting 20% of population to replace at least one kerosene lantern with solar lantern out of ____% of total population who uses kerosene lamps a ____ million litres of kerosene could be saved reducing ____ tonnes of GHG per year. Detailed techno commercial is provided in the table below.

Table 36: Target for introducing solar lanterns in Gandhinagar City

Solar lanterns to replace kerosene lamps		Unit
Single Household		
Capacity of Solar Lantern		Wp
Number lights per Solar Lantern		No.
Number of Kerosene lamp replaced by Solar Lantern		No.
Consumption of kerosene per household/month (survey result)		Litre
Cost of kerosene per litre in the market		INR
Cost of kerosene per year per household		INR
Indicative cost of installing a Solar Lantern		INR
MNRE Subsidy @50%		INR
Payback period when replacing the kerosene lamps		Year
Target for Entire City		
Total Residential household in the city		Nos.
Residential household use kerosene lamps	____%	
Target to replace kerosene lamp in 5 years	___%	
Number of Solar Lantern to be installed in 5 years		Nos.
Total kerosene lamp replaced		Nos.
Indicative cost of installation @Rs.3000.00 per Solar Lantern		Lakh
MNRE Subsidy @50%		INR
Kerosene saved		KL
Cost of kerosene savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

(iv) Use Solar Home Systems (SHS)

A Solar Home System is a fixed indoor lighting system and consists of solar PV module, battery and balance of systems. Capacity of such system could be of 18Wp, 37Wp and 74Wp for different configuration. The luminaries used in the above systems comprise compact fluorescent lamp (CFL)

of 7 W / 9 W / 11 W capacities respectively. The fan is of DC type with less than 20 W rating. One Battery of 12 V, 40 / 75 Ah capacity is also provided with SPV modules of 37Wp / 74Wp as required. The system will work for about 4 hours daily, if charged regularly. The Solar Home Lighting systems have been proposed to replace kerosene lamps used by ____% population in Gandhinagar Municipality Corporation area during load shedding hours. A 74Wp Solar Home System can replace 3-4 kerosene lamps with 4-5 hours backup hence replacing entire need of kerosene, which is estimated at an average of 13litres per month per household. Assuming ____% replacement in the planned 5 years period an estimated amount of _____ million litres of kerosene could be saved reducing _____ tonnes of GHG emission from the city. The potential of kerosene replacement with Solar Home Systems and financial implication thereon is indicated in the table below.

Table 37: Target for introducing solar home system in Gandhinagar City

Single residential household		Unit
Capacity of residential Solar Home System		Wp
Number lights per Solar Home System		Nos.
Number of Kerosene lamp replaced by SHS		Nos.
Consumption of kerosene per household/month (survey result)		Litres
Cost of kerosene per litre in the market		INR
Cost of kerosene saved per year per household		INR
Indicative cost of installing a SHS		INR
MNRE subsidy @50%		INR
Payback period when replacing the kerosene lamps		Years
Target for the Entire City		
Total Residential household		Nos.
Residential household use kerosene lamps	___%	
Target to replace kerosene lamp in 5 years	___%	
Number of SHS to be installed in 5 years plan		Nos.
Total kerosene lamp replaced		Nos.
Indicative cost of installation		Lakh

Kerosene saved		KL
Equivalent energy savings in MU		MU
Cost of kerosene savings		Lakh
MNRE Subsidy @50%		Lakh
Payback period		Years
Emission reduction per year		Tonnes

(v) Using Solar PV for Home Inverters

Use of solar panels to charge Home Inverter system could be an attractive option as standby power supply system during load shedding hours. About ___% of residential consumer use inverters during load shedding hours. Assuming that ___% of HH who are already using inverters will adopt the 250 Wp solar PV systems to charge their inverter battery, an aggregate of _____MWp solar PV systems could be installed in the residential buildings, which will generate ____ MU green energy per year and reduce the load demand and emission by _____ tonnes per year. It is assumed that MNRE will provide ____% subsidy for these system. The potential of energy savings, green house gas emission reduction and budgetary financial implication is indicated in the table below.

Table 38: Target for introducing Solar PV for Home Inverters in Gandhinagar City

Solar PV for Home Inverters		Unit
Capacity of solar PV system for Home Inverter	250	Wp
Indicative cost of incorporating Solar PV to Home Inverter	30000	INR
Total Residential household		Nos.
Residential household use Inverter during load shedding	___%	
Target to introduce solar charger for inverter in 5 years	___%	
Number of solar inverter to be installed in 5 years plan		Nos.
Total PV capacity installed		kWp
Energy generated by PV arrays per year		MU
Cost of energy saved		Lakh
Indicative cost of installation		Lakh

MNRE subsidy @50%		Lakh
Payback period		Years
Emission reduction per year		Tonnes

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

EXPLAIN THE TABLE

Solar PV for replacement of DG/ Kerosene Generator sets		Unit
Capacity of solar PV system	1	kWp
Indicative cost of Solar power pack	2.00	Lakh
Total Residential household		Nos.
Residential household use generators during load shedding	___%	
Target to introduce solar power pack in 5 years	___%	
Number of solar power pack to be installed in 5 years plan		Nos.
Total PV capacity installed		kWp
Energy generated by PV arrays per year		MU
Typical generator set used		kW
Average fuel consumption per day for 4-6 hours load shedding		litres
Amount of diesel saved per year for entire city		KL
Cost of Diesel saved		Lakh
Indicative cost of installation		Lakh
MNRE subsidy @50%, subject to maximum of Rs.1.00 Lakh per kW		Lakh
Payback period		Years
Emission reduction per year for replacement of diesel		Tonnes

(vii) RE systems for residential Apartments/ housing complexes

Gandhinagar has more than ___ residential apartment complexes in the city with average number of apartments ___ in each complex. Solar water heaters and solar PV power plants are considered to be most viable renewable energy devices for the existing and well as new residential complexes.

Table 39: RE system for residential apartments

Number of Residential Apartments to Introduce RE system		
Average number of Residence in each apartment		
Solar Water Heater System		
Average size of Solar water heaters		LPD
Total capacity of SWH to be installed in 5 years plan		LPD
Total collector area in sqm		Sqm
Total energy saved per year		MU
Indicative cost of installation		Lakh
MNRE subsidy @Rs.1900.00 per sqm		Lakh
Beneficiary/ State/ ANN share		Lakh
Cost of energy savings		Lakh
Payback period		years
Emission reduction per year		Tonnes
Solar PV Power Plant for Back up power		
Capacity of solar PV system for single apartment of 50 Residence		kWp
Indicative cost of incorporating Solar PV to Home Inverter		Lakh
Total capacity of PV systems for targeted apartments for 5 years		kWp
Energy generated by PV arrays per year		MU
Cost of energy saved		Lakh
Indicative cost of installation		Lakh
MNRE subsidy @50%		Lakh
Beneficiary/ State/ ANN share		Lakh
Payback period		years
Emission reduction per year		Tonnes

(viii) Summary of RE strategy for Residential Sector

Implementation of renewable energy projects as proposed above will save ___MU energy per year, which will reduce GHG of ____ tonnes per year. When achieved the target, residential sector strategy will meet ___% of total target for energy savings for the city as per mandate of development of solar city. The entire target could be achieved with a total investment of about Rs._____cr in the 5 years period where contribution from MNRE will be about Rs._____cr with existing schemes and balance fund could be met from users, state or other funding agencies. It is recommended that promotion of solar water heaters in residential sector should be given higher priority, as energy savings from solar water heaters is the highest.

Table 40: Summary of RE Strategy for Residential sector in Gandhinagar City

RE Strategy for residential sector	Units of Target	Target Capacity	Investment (Lakh)	MNRE subsidy (Lakh)	User's contribution (Lakh)	Energy Saved per year (MU)	Emissions Reductions (Tonnes)
Installation of Solar water Heaters (100/125LPD)	Nos.						
Use of solar cookers	Nos.						
Use of Solar Lantern	Nos.						
Use of Solar Home Lighting System (74Wp)	Nos.						
Use of Solar Home inverter (250Wp)	Nos.						
Use of PV for replacing DG s	Nos.						
(1kWp)							
Solar Water Heaters for Residential Apartment Compl	LPD						
Solar PV Power Pack for Residential Apartment Compl	kWp						

RE Strategy for Commercial and Institutional Sector

The commercial and institutional sector is the second highest consumer of energy in Gandhinagar city. The sector consumes about ____% of total electricity consumed in the city with its _____ educational institutes, _____ medical service facilities, ____ hotels and ____ odd restaurants. Different strategies are prepared for different categories of consumers based on type and quantum

of energy consumed and availability of resource and space to generate renewable energy in their premises. While preparing the strategy, only techno economically viable and commercially available renewable energy options are considered.

4.1.6 RE Strategy for Hotels

The city has __ five-start category hotels, ___ three-star category hotels and more than ____ budget hotels and other commercial accommodations facilities. Three case studies are made to assess renewable energy and energy conservation measures in each of these categories. Major energy requirement such as hot water and electricity during load shedding hours could be met by solar energy. Solar thermal system can be used to generate hot water or steam for cooking. Solar PV power plant can be used to reduce or eliminate use of diesel generators which are being used during load shedding hours. Apart from that hotels also generate bio waste which can be used to produce biogas through bio-methanation process. Solar pumps and solar garden lights can be used for sprinkling water and beautification.

(i) Renewable Energy Systems for 5 star category Hotels

EXPLAIN – CASE STUDY OF A 5 STAR HOTEL

Location of the Hotel	Gandhinagar	
Suits, Deluxe rooms and other rooms		Nos.
Total premise area		sqm
Built up area		sqm
Connected Load		kW
Average Load Shedding per month		Hours
Average Electricity bills paid per month		Lakh
Monthly LPG consumption for cooking		kg
Standby Power Supply:		
Propane operated steam turbine		KVA
Power supplied by PG set per year		kWh
Propane consumption per hour		kg
Propane consumption per year		kg
Electrical Energy Demand: Fixed Load	Total Load	Unit

Chiller Attachment		kW
Lobby Lighting and Power		kW
TG auxiliaries with Pump and Trace Heater		kW
Kitchen		kW
Health Club		kW
Restaurant		kW
Laundry		kW
External Lighting		kW
Swimming Pool filtration/Rear water body		kW
STP		kW
Kitchen Exhaust		kW
Laundry Exhaust		kW
Kitchen TFA		kW
Laundry TFA		kW
Kitchen Air Washer		kW
Laundry Air Washer		kW
Guest Corridor Lightings		kW
Plant Room		kW
Anarkali		kW
Front Water Body		kW
BOH Light		kW
Elevators		kW
TOTAL		kW
Daily average consumption		kWh
Annual average Consumption		kWh

Recommended Renewable Energy System:

Based on the energy consumption pattern in the 5 star hotel the following suggestions for renewable energy systems have been made. The techno-economics of installing the RE system has also been provided for the particular site.

Solar Water Heating system	5000	LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1400.00 per m2		Lakh
Energy savings per day average		kWh
Savings per year		kWh
Annual cost savings from saving electricity		Lakh
Payback period		Years
Emission reduction per year		tonnes
Rooftop PV system for diesel abatement	100	kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE subsidy for diesel Abatement @75.00/Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced	___%	
Amount of propane saved per year		kg
Electricity saved per year		kWh
Cost savings from propane per year		Lakh
Cost savings from electricity per year		Lakh
Annual O&M Cost of Turbine Generator sets		Lakh
Payback period		Years
Emission reduction per year		tonnes

Biogas system		
Organic Waste from kitchen and other services per day		kg
Biogas plant recommended		CuM
Investment		Lakh
MNRE subsidy @50%		Lakh
User's share		Lakh
LPG saved per year		kg
Energy in terms of MU savings per year		MU
Cost savings per year		Lakh
Payback period		Years
Emission Reduction per year		Tonnes

(ii) Renewable Energy Systems for 3 star category Hotels

The nest category of hotel chosen for assessing energy consumption and proposing Re system is a 3 star hotel called Hotel _____. The general information and the energy consumption portfolio of the 3 star hotels are given in the table below. 50 % occupancy has been assumed for the calculations mentioned below.

Table 41: Case Study of 3 star category hotel

Location of the Hotel	Gandhinagar	
No of rooms		Nos.
Roof Area available		sqm
Common area		sqm
Average Load Shedding		Hours/day
Monthly LPG consumption for cooking		kg
Standby Power Supply:		
Diesel Generator 1 (off peak load)		KVA
Diesel Generator 2 (peak load)		KVA

Diesel consumption per day		Liters

Table 42: Electrical Energy Demand

Electrical Appliances	Nos.	Operating Hours	Watt/ unit	Load (kW)	Energy consumption /day at 50% occupancy (kWh)	Utilization /year	Energy Consumption per year (kWh)
Guest Rooms							
Ceiling Fans							
Air Conditioner							
Electric Geyser							
Television							
Refrigerator							
Incandescent (Bulb)							
Compact Fluorescent							
Fluorescent Tube							
Common area and other facilities							
Ceiling fans							
Air conditioner							
Compact Fluorescent							
Fluorescent Tube							
Incandescent (Bulb)							
Refrigerators/ Freezer							
Television							
Water pump							
Fluorescent Tube							
Computers							
Printer							
Microwave Oven							

The assessment of the energy consumption scenario in the 3 star hotel leads to the following RE systems recommendations. The techno-economics for installing the renewable energy systems has also been provided.

Recommended Renewable Energy System		
Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE Subsidy @1400.00 per sqm collector area		Lakh
Energy savings per day average		kWh
Savings of electricity per year		kWh
Savings of LPG per year		kg
Annual cost savings from saving electricity		Lakh
Annual cost savings from saving LPG		Lakh
Total savings		Lakh
Payback period		Years
Emission reduction per year		tonnes
Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.75 per Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		liters
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		Lakh
Payback period		Years
Emission reduction per year		tonnes
Biogas system		

Organic Waste from kitchen and other services per day		kg
Biogas plant recommended		CuM
Investment		Lakh
MNRE subsidy @50%		Lakh
User's share		Lakh
LPG saved per year		kg
Energy in terms of MU savings per year		MU
Cost savings per year		Lakh
Payback period		Years
Emission Reduction per year		Tonnes

(iii) Renewable Energy Systems for Budget Hotels

EXPLAIN – CASE STYDY BUDGET HOTEL

Table 43: Case Study of Budget Hotel

Location of the Hotel	Gandhinagar	
No of rooms		Nos.
Roof Area available		sqm
Shadow free open space at ground		sqm
Average Load Shedding		Hours/day
Monthly LPG consumption for cooking		kg
Standby Power Supply System:		
Diesel Generator 1 (off peak load)		KVA
Diesel Generator 2 (peak load)		KVA
Energy supplied by DG sets		kWh
Average consumption of diesel per day		liters/ day

Electrical Appliances	Nos	Operating Hours	Watt / unit	Load (kW)	Energy consumption /day at 50% occupancy (kWh)	Utilization per year	Annual average energy consumption (kWh)
Guest Rooms							
Ceiling Fans							
Air Conditioner							
Electric Geyser							
Television							
Coolers							
Incandescent (light Bulb)							
Compact Fluorescent							
Fluorescent (Tube)							
Common area and other facilities							
Ceiling fans							
Air conditioner							
Compact Fluorescent							
Fluorescent (Tube)							
Incandescent (light Bulb)							
Refrigerators / Freezer							
Television							
Water pump							

Computers							
Printer							
Total energy consumption							

The renewable energy systems proposed for the budget hotel in Gandhinagar are enlisted in the tables below. The techno - economics of installing the RE systems has also been provided.

Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1400.00 per sqm of collector area		Lakh
Energy savings per day average		kWh
Savings of electricity per year		kWh
Savings of LPG per year		kg
Annual cost savings from saving electricity		INR
Annual cost savings from saving LPG		INR
Total savings		Lakh
Payback period		Years
Emission reduction per year		tonnes
Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		INR
MNRE Subsidy @Rs.1.00lakh per kWp		INR
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		liters
Cost savings from diesel per year		INR

Annual O&M Cost of DG sets		INR
Payback period		Years
Emission reduction per year		tonnes
Biogas system		
Organic Waste from kitchen and other services per day		kg
Biogas plant recommended		CuM
Investment		Lakh
MNRE subsidy @50%		Lakh
User's share		Lakh
LPG saved per year		kg
Energy in terms of MU savings per year		MU
Cost savings per year		Lakh
Payback period		Years
Emission Reduction per year		Tonnes

(iv) Summary of RE strategy for Hotels

The study of different hotel categories in Gandhinagar has shown the diverse energy consumption portfolio in the hotel sector. The higher the star rating of a hotel the higher is the energy consumption scenario. Electricity consumption is the main source of energy consumption in the hotels. Solar water heater and solar PV systems are strongly recommended for potential energy savings in the hotels. Biogas system can be built in those hotels which produce sufficient amount of food/organic waste. The case studies in these hotels will give the generic picture for similar consumption patterns in hotel types across the country and the assessment of potential savings that could be achieved in this sector if policy mandates are framed to bring about mandatory installment of Renewable energy systems. Under the solar city programme, ____% hotels will be targeted for introduction of RE systems. On achievement of this target hotels will save ____ MU of energy per year and reduce emission of _____ tonnes per year.

Table 44: Summary of RE strategy for Hotels

Hotels	Numbers	RE System Proposed			Energy Savings (MU)	Total Emission reduction (tonnes/ year)
		SWH/SC system (LPD/No)	PV system (kWp)	Biogas/ Biomass system (cum)		
5 Star category hotels with 100 + guest						
3 Star category hotels with less than 10						
Budget hotels / lodge						
Aggregate						
Targeting 25% implementation						
Investment (Lakh INR)						
MNRE subsidy @Rs.1400.00 per sqm						
Beneficiary/state/ANN contribution						

4.1.7 Renewable Energy Systems for Restaurants

Gandhinagar has a number of restaurants and eateries. The city has more than _____ restaurants and which are categorized as large restaurant, medium restaurants/Dhabas and small restaurants. Solar water heaters can easily be introduced in these restaurants to meet their hot water demand for cooking and utensil cleaning. Since all the restaurants are using DG sets as standby power supply source during load shedding, PV power plant will be an attractive and profitable option for the restaurants Cart food is very popular in Gandhinagar. These carts serve piping hot traditional North Indian food and hence are preferred by all. There are hundreds of food cart which use kerosene or gas operated lights for illumination. Solar Lanterns will be a profitable and attractive option for these food cart operators.

(i) RE strategy for Restaurants

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

Table 45: Case Study of Restaurant

Location of the Restaurant	Gandhinagar	
Roof Area available		sqm
Connected load		kW
Average Load Shedding		Hours/day
Monthly LPG consumption for cooking		kg
Monthly LPG consumption for Gas based geysers		kg
Organic waste generated		Kg/day
Standby Power Supply:		
Diesel Generator		KVA
Average consumption of diesel per year		kL

Electrical Energy Demand:							
Electrical Appliances	Nos.	Operating Hours	Load (W)	Total Load (kW0	Energy consumption /day (kWh)	Use per year	Energy Consumption per year (kWh)
Ceiling Fans							
Air Conditioner for restaurant							
Micro oven							
Milk Chiller							
Deep Freezer							
Compact Fluorescent							
Air conditioner for cold room							
Television							
Water pump 1							
Water pump 2							
Computers							
Printer							

OTG							

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

Recommended Renewable Energy System		
Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE Subsidy @R.1400.00 per sqm		Lakh
Savings of LPG per year		kg
Annual cost savings from saving LPG		Lakh
Payback period		Years
		tonnes
Rooftop PV system for diesel abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.75.00 per Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		liters
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		Lakh
Payback period		Years
Emission reduction per year		tonnes
Biogas system		
Organic Waste from kitchen and other services per day		kg
Biogas plant recommended		CuM

Investment		Lakh
MNRE subsidy @50%		Lakh
User's share		Lakh
LPG saved per year		kg
Energy in terms of MU savings per year		MU
Cost savings per year		Lakh
Payback period		Years
Emission Reduction per year		Tonnes

(ii) Summary of RE strategy for Restaurants

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

Table 46: Summary of RE strategy for Restaurants

Restaurants	Numbers	RE System Proposed			Energy Savings (MU)	Total Emission reduction Tonnes/ year
		SWH/SC system LPD/ Nos.	PV system kWp	Biogas/ Biomass system (cum)		
Large Restaurants						
Medium Restaurants/ Dhabas						
Small Restaurants						
Food Cart						
Aggregate						
Target 25% for 5 years						
Total investment (Lakh INR)						
MNRE subsidy (Lakh INR)						

Beneficiary's contribution (Lakh IN						

* Replacing kerosene by using 2 lanterns in one cart

4.1.8 Renewable Energy Systems for Hospitals

The Gandhinagar city has ___ health care facilities – EXPLAIN IN DETAIL. Apart from that the city has other health care facilities like dispensaries, dental clinic, microsurgery, day care centre and pathological laboratories. To portray the energy consumption scenario in these facilities a 100 and 250 bed Hospitals have been chosen in Gandhinagar city. Detailed energy consumption data have been collected and specific recommendations for renewable energy systems have been made. An average occupancy of 75% has been considered for making all calculations.

(i) Renewable Energy Systems for 100 bedded Hospital

NAME ____Hospital has been chosen as the case study site for a 100 bed hospital in Gandhinagar. The general details and the energy consumption pattern of the hospital are mentioned in the tables below.

Table 47: Case Study of 100 bed hospital

Location of the Hospital	Gandhinagar	
No of beds	100	Nos.
Roof Area available		sqm
Number of staff		
Connected Load		KVA
Average Load Shedding		Hours/day
Average electricity bills per month		Lakh
Average occupancy		
Standby Power Supply:		
Diesel Generator 1 (off peak load)		KVA
Diesel Generator 2 (peak load)		KVA
Diesel Generator 2 (peak load)		KVA
Average consumption of diesel per day		Liters/ day

Electrical Energy Demand:							
Electrical Appliances	Nos.	Operating Hours	Watt/ unit	Load (kW)	Energy consumption /day at 75% occupancy (kWh)	Utilization /year	Energy Consumption per year
Ceiling Fans							
Air conditioner							
Air Conditioner							
Electric Geyser							
Fluorescent (Tube)							
Water pump							
Computers							
Printer							
Auto clave							

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

Recommended Renewable Energy Systems		
Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1400.00 per sqm of collector area		Lakh
Electricity savings per year		kWh
Annual cost savings from saving electricity		Lakh
Payback period		Year
Emission reduction		tonnes
Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm

Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.75 per Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		litres
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		Lakh
Payback period		Years
Emission reduction		tonnes

(ii) Renewable Energy Systems for 250 bedded Hospital

NAME _____hospital and Research Centre has been chosen as the case study site for a 250 bedded hospital in Gandhinagar. It is one of the primary medical facilities in Gandhinagar. The energy baseline scenario of the Hospital reveals huge energy consumption on daily basis, supplemented by a high capacity diesel generator back-up of 75KVA. An average occupancy of 75% has been taken to provide the calculations given below. The calorific value of LPG is taken to be 12500 kcal/kg for the below mentioned calculations.

Table 48: Case Study for 250 bed hospital

Location of the Hospital	Gandhinagar	
No of beds		Nos.
Roof Area available		sqm
Premise area		sqm
Connected Load		kW
Average Load Shedding		Hours/day
Average electricity bills per annum		Lakh
Average occupancy		
Standby Power Supply:		
Diesel Generator 1		KVA

Diesel Generator 2		KVA
Diesel Generator 2		KVA
Average consumption of diesel per day		Liters/ day

Electrical Appliances	Nos.	Operating Hours	Watt/ unit	Load (kW)	Energy consumption /day at 75% occupancy (kWh)	Utilization /year	Energy Consumption per year
Table Fans							
Ceiling Fans							
Air Conditioner							
Television							
Refrigerator							
Autoclaves for steam generation							
Room Heaters							
Water Pump							
Inverters							
Incandescent 60 watt							
Incandescent 100 watt							
Compact Fluorescent							
Fluorescent Tube, Long							
Computers							
Printers							

Recommended Renewable Energy Systems

The energy consumption baseline assessment of eth 250 bedded hospital in Gandhinagar, lead to the recommendation of Solar water heater to address the daily hot water requirement and PV systems for diesel abatement.

Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1400.00 per sqm of collector area		Lakh
Electricity savings per year		kWh
Annual cost savings from saving electricity		Lakh
Payback period		Year
Emission reduction		tonnes
Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.75 per Wp		Lakh
Approximate annual energy generation		MU
Fraction of DG power replaced		
Amount of diesel saved per year		litres
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		Lakh
Payback period		Years
Emission reduction		tonnes

(iii) Summary of RE strategy for Hospitals

The analysis of the above two case studies of a 100 bedded hospital and a 250 bedded hospital in Gandhinagar has revealed the huge energy consumption patterns in sector. Hospitals are a growing

infrastructure need of any developing city. Hence the source to future energy consumptions lies in the proper streamlining of energy consumption patterns in these building sectors. Policy mandates and programmes for facilitating the adoption/installment of renewable energy technology in these building types will be a milestone for future energy savings. Adoption of Re systems in ___% of the hospitals will save ____MU energy per year reducing GHG emission by ____ tonnes per year. The payback period for solar water heater system for hospitals is about one year only due maximum use of hot water in health care facility.

Table 49: Summary of RE systems for Hospitals

Hospitals	Nos.	RE System Proposed			Energy Savings (MU)	Total Emissio reduction Tonnes/ year
		SWH/SC system LPD/ Nos.	PV system kWp	Biogas/ Biomass system (cum)		
Small hospitals and nursing homes with l 50 beds						
Hospitals with 50-100 beds						
Large hospitals with more than 100 beds						
Medical college hospital with about 1000						
Dispensaries/ day care centers/ micro su dental						
Microbiology/Pathology/Diagnostic Lab						
Aggregate						
Targeting 25% implementation						
Investment (Lakh INR)						
MNRE subsidy @Rs.1400.00 per sqm						
Beneficiary/state/ANN contribution						

4.1.9 Renewable Energy Systems for Educational Institutes

Educational institutes are major establishments in the commercial sector of a city. Although they are not major source of energy consumption in the city yet they account for a substantial degree of energy utilization. The official website of Gandhinagar gives the following figures of educational institutes in Gandhinagar. The city has _____ primary/ nursery schools, ____intermediate and high

schools, two universities, one medical college, four engineering colleges, six degree colleges, two management institutes, two computer institutes, two polytechnics and two industrial training institutes. The government primary schools provide free mid-day meal to its students. Community solar cookers can be used to cook mid-day meal in these schools. The institutes having hostels can use solar water heater to supply hot water to the bath rooms and the kitchen thereby providing bathing comfort to the students and hot water for cooking. A case study has been made with an institute having hostel accommodation.

(i) RE systems for Technical Institute with resident student in Hostels

NAME _____, Gandhinagar has been chosen as the case study site for a technical institute with Hostel facilities for NO. _____ students. The general and the energy consumption portfolio of the educational institute are given below.

Name of the Institute	NAME _____, Gandhinagar	
Residential student		Nos.
Premise area		sqm
Built-up area		sqm
Roof area in the hostel		sqm
Roof area in the institute		sqm
Open space available		sqm
Connected Load		kW
Average Load Shedding		Hours/day
Monthly LPG consumption for cooking		kg
Standby Power Supply:		
Diesel Generator		KVA
Average consumption of diesel per year		liters/ day

Electrical Energy Demand

Electrical Appliances	Nos.	Operating Hours	Watt/ unit	Load (kW)	Energy consumption /day (kWh)	Utilization /year	Energy Consumption per year
Institute							
Table Fans							
Ceiling Fans (old)							
Desert coolers							
Water pump							
Incandescent bulb							
CFL							
Fluorescent tubes							
Computers							
Printer							
Hostels							
Ceiling fans							
Incandescent							
Compact Fluorescent							
Fluorescent Tube, Long							

Recommended Renewable Energy System

The energy baseline scenario in NAME_____ in Gandhinagar led to the recommendation of the following renewable energy systems in the educational institute. Solar water heater and solar PV systems for diesel abatement would have the maximum potential for reducing energy consumption in this building.

Solar Water Heating system		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1750.00 per m2		Lakh
Electricity savings per year		kWh
LPG savings		kg
Annual cost savings from saving electricity		Lakh
Annual cost savings from saving LPG		Lakh
Payback period		Years
Emission reduction		tonnes
Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.100 per Wp		INR
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		litres
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		Lakh
Payback period		Years
Emission reduction		tonnes

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

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

Table 50: Target for Introducing Solar Cookers in Primary Schools

Community Solar cookers for mid-day meal cooking		Unit
Total number of Primary Schools		Nos.
Schools providing Mid-day meal	_____%	
Target for introducing of solar cooker in 5 years	_____%	
Number of Solar Cooker to be installed in 5 years plan		Nos.
Average savings of LPG domestic cylinder per year (14kg)		Nos.
Total LPG saved per year		kg
Total energy saved per year		MU
Indicative cost of installation		Lakh
MNRE subsidy for solar cooker @30%		Lakh
Beneficiary/ State/ ANN share		Lakh
Cost of energy savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

(iii) Summary of RE strategy for Educational Institutes

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

Table 51: Summary of RE strategy for educational institutes

Educational Institutes	Nos.	RE System Proposed			Energy Savings	Total Emission reduction
		SWH/SC system	PV system	Biogas/ Biomass system		
		LPD/ Nos.	kWp	(Cum)	(MU)	Tonnes/ year
Primary Schools/ Nursery						
Intermediate & High schools						
Universities						
Medical College						
Engineering Colleges						
Degree Colleges						
Management Institutes						
Computer Institutes						
Polytechnics						
Industrial Training Institute						
Aggregate						
Target 25% in 5 years						
Investment (Lakh INR)						
MNRE subsidy @Rs.1750.00 per sqm						
Beneficiary/state/ANN contribution						

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

The target of RE strategy for commercial and institutional sector is to achieve about ___% of total energy savings requirement. The strategy, once implemented fully will save _____ MU of energy per year and reduce GH of _____ tonnes per year. The primary focus should be given to introduction of solar water heaters for hotels, restaurants, hospitals and other residential institutes, which will save _____MU per year. Solar PV power plant should be introduced for diesel abatement in the

establishment which are using diesel sets as standby power supply source. The restaurants and hotels which has considerable amount of food and organic waste, should introduce biogas system. Use of solar cooker for preparing mid-day meal in primary schools will be an attractive option to save LPG for cooking and creation of awareness and demonstration about use of renewable energy devices among school children.

Table 52: RE Strategy for Commercial and Institutional Sector

RE Strategy for Commercial ar Institutional sector	Units of Target	Target Capacity	Total Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ ANN/ User's share	Energy Saved (MU)	Emissions Reductions (Tonnes per year)
Solar Cooker for mid-day meal in schools	Nos.						
Solar Water Heaters for Hotels Restaurants, Hospitals and Institutes	LPD						
Solar PV Power Plant for Hotel Restaurants, Hospitals and Institutes	kWp						
Biogas for Hotels and Restaurants	CuM						
Total							

4.1.10 RE Strategy for Industrial Sector

The industry sector in Gandhinagar consumes ____% of total electricity and considerable amount of coal, diesel and LPG for its different manufacturing and process industries. Gandhinagar City has about _____ odd small and medium scale industries which includes food processing industries, the shoe making industries, foundry, garments, handicraft and cottage industries and last but not the least tourism industry which brings in flux of floating population that has influenced the economic development of the city. There are also a large number of ancillary industries, supporting footwear industries in Gandhinagar.

(i) Renewable Energy system for GIDC Electronics estate

EXPLAIN THROUGH CASE STUDY

Type of the Industry	NAME - Electronics	
Production Capacity per day		Pairs
Roof area of the manufacturing facility/ Buildings		sqm
Connected Load		kW
Average Load Shedding		hours/day
Diesel Generator 1		KVA
Diesel Generator 2		KVA
Average consumption of diesel per day		liters/ day

Electrical Energy Demand						
Electrical Appliances	Nos.	Operating Hours	Watt/ unit	Load (kW)	Use per year (months)	Energy Demand (kWh/year)
Compressor						
Fitter Machines						
Polish Machines						
Ceiling Fans						
Incandescent bulb						
AC						

Recommended RE system

Rooftop PV system for diesel abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE Subsidy @Rs.1.00 lakh per Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		litres
Cost savings from diesel per year		Lakh
Annual O&M Cost of DG sets		INR
Payback period		years
Emission reduction		tonnes

(ii) Renewable Energy System for food processing Industry

EXPLAIN IN DETAIL WITH 1 CASE STUDY

Table 53: Case study for Petha Industry in Gandhinagar

Name of the Industry	Panchi Petha Store	
Production Capacity per year		Quintal
Roof area of the manufacturing facility/ Buildings		sqm
Open space		sqm
Connected Load		kW
Average Load Shedding		hours/day
Average electricity bills per month		INR
Amount of coal required per year		kgs
Organic waste generated (biodegradable) per day		kg
Suggested RE Technologies		
Biogas Plant		CuM

Area Required		Sqm
Waste Available		kg/day
Indicative cost of Biogas unit		Lakh
Savings per day		kWh
Savings of coal per day		kg
Percentage of coal savings		
Cost of savings against coal per year		Lakh
MNRE subsidy		
Beneficiaries share		Lakh
Payback period		Years
Savings in terms of emissions (coal)		tonnes
Savings in terms of methane emissions that would have otherwise gone to the landfill site		tonnes
Solar Water Heating system to replace preheating of water making petha		LPD
Approximate area required for installation		sqm
Indicative cost of the system		Lakh
MNRE subsidy @1400.00 per m2		Lakh
Energy savings per day average		kWh
Savings of coal per day		kg
Annual cost savings from saving coal		Lakh
Payback period		years
Emission reduction		tonnes

(iii) Summary of RE Strategy for Industrial sector

Target should be made to introduce solar water heaters, PV power plants and biogas system in the industries in Gandhinagar as shown in the table below. The system capacity assumed is average capacity and will vary based on the size of the industry and energy requirement. Introducing

proposed systems in ___% of the industries will save _____MU of energy per year reducing _____ tonnes of GHG emission.

Table 54: Summary of RE Strategy in Industrial sector in Gandhinagar

		RE System Proposed				
Gandhinagar Industries	Numbers	SWH system	PV system	Biogas/ Biomass system (cum)	Energy Savings (MU)	Total Emission reduction
		LPD/ Nos.	kWp			Tonnes/ year
Petha Industry						
Other Food processing Industry						
Beverages, Toba and Toba Products						
Hosiery & garments						
Wood Products						
Paper products & Printing						
Leather Products						
Rubber & Plastic						
Chemical & Chemical Products						
Non-metallic mineral products						
Metal products						
Machinery & Part Except Electrical						
Electrical Machinery & Apparatus						
Foundry						
Miscellaneous Mfg.						
Repairing & Service Industry						
Aggregate						
Targeting 25% implementation						
Investment (Lakh INR)						
MNRE subsidy @Rs.1400.00 per sqm						

Beneficiary/state/ANN contribution						

RE Strategy for Industrial sec	Unit	Target Capacity	Total Investment (INR)	MNRE subsidy	Sate/ ANN/ Beneficiary's contribution	Amount of Energy Saved (MU)	Emissions Reductions per year (Tonnes)
Solar Water Heaters for Industries	LPD						
Solar PV Power Plant, Inverte	kWp						
Biogas system from organic v	Cu M						

4.1.11 RE Strategy for Municipal Sector

The municipal sector of Gandhinagar city consumes ____% of total electrical energy in the city. The primary consumers in this sector are street lights, outdoor lights in parks and monuments, markets, office buildings of the Municipal Corporation, water supply, sewerage treatment plant etc. Renewable energy devices are suggested to all categories of consumers depending upon the energy demand. The sector has ample opportunity to save energy through introducing renewable energy and energy conservation measures and could show case these initiatives to encourage people to adopt further.

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

The main building of the municipal corporation consumes about _____MU of electricity per year. The loads consume most of the energy are air conditioners, fans and lighting loads.

Name of the Building	Main Building, Municipal Corporation	
Total premise area		sqm
Built up area		sqm
Average Load Shedding		hours/day

	Total Nos.	Load (W)	Total Load (kW)	Hours of Operation	Annual Consumption (kWh)
Ceiling Fans					
Ceiling Fans					
Air Conditioner					
Desert Cooler					
Television					
Refrigerator					
Room Heater					
Room Heater					
Electric Water Pump					
Incandescent					
CFLs					
Fluorescent Long					
36 watt CFLs					
Other Flood Lights					
TOTAL					

Recommended Renewable Energy System:

Rooftop PV system for diesel Abatement		kWp
Approximate area required		sqm
Indicative cost of the system with 1 day battery backup		Lakh
MNRE subsidy for diesel Abatement @75.00/Wp		Lakh
Approximate annual energy generation		kWh
Fraction of DG power replaced		
Amount of diesel saved per year		Ltrs.

Cost savings from diesel per year		Lakh
Annual O&M Cost of Turbine Generator sets		Lakh
Payback period		Years
Emission reduction per year		tonnes

(ii) Renewable Energy System for Markets

EXPLAIN REGARDING MARKET AREA IN GANDHINAGAR AND NUMBER OF SHOPS

Table 55: RE Systems for General Markets

		Unit
Capacity of solar PV system for Shops		Wp
Indicative cost of incorporating Solar PV to Shop's inverter		Lakh
Total no of shops in eight markets		Nos.
Shops uses Inverter during load shedding		
Target to introduce solar charger for inverter in 5 years		
Number of solar inverter to be installed in 5 years plan		Nos.
Total PV capacity installed		kWp
Energy generated by PV arrays per year		MU
Cost of energy saved		Lakh
Indicative cost of installation		Lakh
MNRE subsidy @50%		Lakh
User's share		Lakh
Payback period		years
Emission reduction per year		Tonnes

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

The city has about _____ outdoor lights, which have been fixed for illumination streets, wards, monuments etc. The objective is to introduce one solar PV outdoor light in every three conventional

lights so that minimum illumination level is maintained. The tables below indicate targets, investment thereon and energy savings potential etc.

Table 56: RE Systems for Outdoor lights, Road safety

Street Light Details	Existing SL (Nos.)	Solar SL (Nos.)	Units
250/70 watt sodium points			Nos.
40 watt tube light point			Nos.
Simple Bulb Point			Nos.
80 watt CFL fitting			Nos.
High Mast			Nos.
Mini mast			Nos.
400 watt flood light point			Nos.
Total			Nos.
Targeting 50% in 5 years			Nos.
PV module capacity			Wp
Total PV Module capacity			kWp
Total Investment			Lakh
MNRE subsidy @50%			Lakh
ANN/ State/ Beneficiary share			Lakh
Energy Generated			MU
Emission reduction			Tonnes
Payback period			Years

Table 57: Summary of RE Strategy for outdoor light and road safety

RE Strategy for Gandhinagar City Street and Road Safety	Total Potential (Nos.)	Target (Nos.)	Investment (Lakh)
LED based Street Light in every 3 alternative existing stre light to maintain minimum level of illumination during load shedding			
Solar PV Traffic Lights (2x74Wp) @			
Solar Blinkers (37Wp) @			
Road Stud @ 1 stud in 2m for 50% of 91km main road			
Total Investment required (Lakh INR)			
MNRE subsidy @50% (Lakh INR)			
ANN/State (Lakh INR)			
Energy saved (MU per year)			
Emission reduction (Tonnes per year)			

(iv) Renewable Energy System for Advertisement hoardings

Solar hoarding is economically attractive options for advertisement in comparison to conventional hoardings. Target should be made to replace the conventional hoardings in to solar hoardings. Financial implication and energy savings potential is indicated for replacement of _____ hoardings during 5 years of solar city implementation period.

Table 58: Renewable Energy System for Hoardings

	Target	Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ ANN/ User's Share (Lakh)	Energy Saved (MU per year)	Emissions Reductions per year (Tonnes)
Large Hoardings						
Medium Hoardings						

(v) Renewable Energy Systems for Parks

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

Table 59: Renewable Energy Systems for Parks

	No. of units	Unit load (W)	Total Load (kW)	Hours of operation	Energy Demand per day (kWh)
Flood light					
CFL outdoor light					
Water Pump					
Total					
RE Options:					
Options	Nos.	Capacity	Unit	Investment (Lakh)	
Converting 50% of conventional outdoc light into solar light to provide basic minimum illumination during load shedding			Wp		
Providing solar pump for sprinklers			kWp		

Table 60: Summary of RE Strategy for Gandhinagar Nagar Nigam Parks

Total Number of Parks in Gandhinagar		Nos.
Targeting 50% in 5 years		Nos.
Total PV system capacity per park		kWp
Total investment		Lakh
MNRE Subsidy @50%		Lakh
ANN/ state/ Park Operator		Lakh
Energy saved per year		MU
Emission reduction per year		Tonnes

Cost of electricity saved per year		Lakh
Payback period		Years

(vi) Summary of RE Strategy for Municipal Sector

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

Table 61: Summary of RE Strategy for Municipal Sector in Gandhinagar

RE Strategy for Municipal Secto	Units of Target	Target Capacity	Total Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ ANN/ User's Share (Lakh)	Energy Saved per year (MU)	Emissions Reductions per year (Tonnes)
50kWp PV Power Plant for Municipal and other Office Buildings	Nos.						
LED based Solar Street Light	Nos.						
Solar PV Traffic Lights	Nos.						
Solar Blinkers (37Wp)	Nos.						
Road Stud @ 1 stud in 2m for 50% of 91km main road	Nos.						
Outdoor lights for Parks	Nos.						
Solar Pumps for Parks	Nos.						
Replacing Neon Board with Sola Hoarding	Nos.						
Replacing other hoardings with Solar Hoarding	Nos.						
PV system for Inverters in the market shops	Nos.						

4.1.12 Waste to Energy Potential in Gandhinagar

EXPLAIN WASTE GENERATION IN GANDHINAGAR

Table 62: Municipal Solid Waste Characterization

Waste Composition	Percentage Waste	Quantity (MT/Day)
Bio-degradable		
Recyclable		
Non-biodegradable (Inert)		
Total Waste		
Per capita waste (Kg/capita/day)	_____ gms/day/person	

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

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

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

Table 63: Waste to Energy through thermo-chemical conversion

		Unit
Total solid waste generated		Tonnes
Net Calorific Value (conservative estimate)		kcal/kg
Energy recovery potential (NCV x W x 1000/860)		kWh
Power generation potential		kW
Conversion efficiency		
Net Power generation potential		MWe
Plant Load Factor		

Net electrical energy savings potential @70% PLF		MU
Emission reduction per year		Tonnes
Total Investment		Lakh
MNRE subsidy @ 50% subject to maximum of Rs.300.00 per MW		Lakh
State/City/Private Power Producer		Lakh
Cost savings		Lakh
Payback period		Years

(ii) Waste to Energy Potential through bio-methanation

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

Table 64: Waste to Energy through bio-methanation

		Unit
Total solid waste generated		Tonnes
Total biodegradable volatile solid (VS)		
Typical digester efficiency		
Typical bio-gas yield (m3 / kg. of VS destroyed)		CuM/kg
Biogas yield		CuM
Calorific Value of bio-gas		kcal/CuM
Energy recovery potential		kWh
Power generation potential		kW
Conversion efficiency		
Net Power generation potential		MWe
Plant Load Factor		
Net electrical energy savings potential		MU
Emission reduction per year		Tonnes
Total Investment		Lakh

MNRE subsidy @ Rs.200.00 lakh per MW		Lakh
State/City/Private Power Producer		Lakh
Cost savings		Lakh
Payback period		Years

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

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

Table 65: Waste to Energy from Sewage Treatment Plant

		Unit
Total waste water generated		MLD
Total biodegradable organic/ Volatile Solid available for Biomethanation		Tonnes/day
Typical Digestion Efficiency	____%	
Typical Biogas yield		cum / kg
Biogas yield		cum
Electricity (kWh)		kWh
Capacity of the plant		KW
Conversion Efficiency		
Total Electricity Generated		MWe
Plant Load Factor		
Net electrical energy savings potential		MU
Emission reduction per year		Tonnes

Total Investment		Lakh
MNRE subsidy @40% subject to maximum of Rs.200.00 lakh per MW		Lakh
State/City/Private Power Producer		Lakh
Cost savings		Lakh
Payback period		Years

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

Total solid waste generated in Gandhinagar is ____MT/day and capacity of three waste treatment plants is ____MLD. A very preliminary assessment for energy recovery from MSW and STPs has been done based on the widely used assumptions and presented in the table below.

Table 66: Summary of waste to energy potential in Gandhinagar City

Waste to Energy Potential in G city	Units of Target	Target Capacity	Total Investment (Lakh)	MNRE subsidy (Lakh)	Sate/ ANN/ User's Share (Lakh)	Amount of Energy Saved (MU)	Emissions Reductions per year (Tonnes)
Waste to Energy Potential for t chemical conversion	MWe						
Waste to Energy Potential for b methanation	MWe						
Liquid Waste to Energy Potenti Sewage Treatment Plant (STP)	MWe						

CHAPTER 5

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

5 Energy Efficiency Strategies for Gandhinagar

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

Residential Sector: (detailed Description of below mention measures with the details calculation)

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

Commercial and institutional building Sector:

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

Industrial Sector:

- Replace Incandescent Lamps with Fluorescent
- T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic BallasEfficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs
- Energy efficiency in motors, furnaces, boilers, etc.

Municipal Sector:

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

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

EE Strategy for Residential sector

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

5.1.1 (i) Replace Incandescent Lamps with Fluorescent

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

Table 67 Replacement of incandescent lighting with CFL

		Unit
Total Residential household		Nos.
Household using incandescent bulb		
Target to replace incandescent bulb with CFL		
Number of incandescent bulb to be replaced per household		Nos.
Total number of incandescent bulb to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing 60W bulb with 15W CFL		MU
Cost of electricity savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

5.1.2 T5 tube light + Electronic Ballast to replace T12/T8 tube light+ Magnetic Ballast

A conventional tube light (with magnetic ballast consuming 15W) consumes around 55 watts. It can bereplaced with T5 tube (28W) with electronic ballast (4W) which will require around 32W. The calculationshave been done for a period of 5 years assuming 80 % replacement of T 12 /T8 tube lights can be possible in88% of the households using T12/T8 tube lights.

Table 68 T5 tube light + Electronic Ballast to repalce T12/T8 tube light + Magnetic Ballast

		Unit
Total Residential household		Nos.
Household using T8/T12 tube lights		
Target to replace T8/T12 by T5 tube lights		
Number of incandescent bulb to be replaced per household		Nos.
Total number of T8/T12 tube lights to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (w electronic ballast)		MU
Cost of electricity savings		Lakh

Payback period		Years
Emission reduction per year		Tonnes

5.1.3 Efficient ceiling fans to replace conventional ceiling fans

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

		Unit
Total Residential household		Nos.
Household using Conventional Fans		
Target to replace CF by EE Fans		
Number of Conventional fan to be replaced per household		Nos.
Total number of Conventional Fans to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional Fans by EE Fans		MU
Cost of electricity savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

5.1.4 Replacement of conventional air-conditioners with EE star rated ACs

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

Table 69 Replacement of conventional air conditioners with EE star rated ACs

		Unit
Total Residential household		Nos.
Household using Conventional ACs		
Target to replace Conventional ACs by EE star rated Acs		
Number of Conventional ACs to be replaced per household		Nos.
Total number of Conventional ACs to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional ACs by EE Star Rated A		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.5 Replacement of conventional refrigerators with EE star rated refrigerators

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

Table 70 Replacement of conventional Refrigerators with EE star rated Refrigerators

		Unit
Total Residential household		Nos.
Household using Conventional Refrigerators		
Target to replace Conventional Refrigerators by EE Star Rated Refrigerators		
Number of Conventional Refrigerators to be replaced per household		Nos.
Total number of Conventional Refrigerators to be replaced		Nos.

Indicative cost of installation		Lakh
Energy saved by replacing Conventional Refrigerators by EE Star Rated Refrig		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.6 Replacement of conventional water pumps with EE star rated water pumps

Give the details of existing water pumps used in Gandhinagar . calculate the energy saving by replacing 10% conventional pumps by energy efficient pumps have been targeted for energy savings.

Table 71 Replacement of conventional water pumps with EE Star rated water pumps

		Unit
Total Residential household	217975	Nos.
Household using Water Pumps	80%	
Target to replace Conventional Water Pump by EE Pump	10%	
Number of Conventional Pumps to be replaced per household	1	Nos.
Total number of Conventional Pumps to be replaced	24413	Nos.
Indicative cost of installation	244.13	Lakh
Energy saved by replacing Conventional Water Pumps by EE Water Pumps	2.67	MU
Cost of electricity savings	93.56	Lakh
Payback period	2.61	Years
Emission reduction per year	2165	Tonnes

5.1.7 Summary of EE Strategy in Residential Sector

Summarized all the energy saving in Residential sector through energy efficiency measure

EE Measures in residential sector	Unit	Target Capacity	Investment (Lacs INR)	Amount of Energy Saved (MU)	Emissions Reductions (Tonnes)
Indicative cost of replacing 100 watt incandescer with 15 watt CFL	Nos.				
Indicative cost of replacing T12/T8 with T5 FTL	Nos.				
Indicative cost of replacing conventional Fans wi EE star rated fans	Nos.				
Indicative cost of replacing conventional AC with star rated AC	Nos.				
Indicative cost of replacing conventional refrigera with EE star rated refrigerator	Nos.				
Indicative cost of installing a EE water pump	Nos.				

EE Strategy for Commercial Sector

The commercial sector comprises primarily of offices, shopping malls, markets, hotels and restaurants and comprises of a mix of air conditioned and non air-conditioned buildings. The prime load centres in the sector are air-conditioning, lighting and pumps/equipment. The major share of electricity consumption is attributed to by air-conditioning in a full conditioned building followed by lighting, whereas the prime energy consumption in a non-air conditioned building is lighting followed by space conditioning (coolers, fans, etc.).

The energy conservation and efficiency measures targeted for commercial sector thus should be aimed at enhancing efficiency levels and deploying conservation options for lighting and air

conditioning. Thus efficiency and conservation have to be addressed in existing and new buildings to affect overall demand and consumption reduction.

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

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

5.1.8 Replace Incandescent Lamps with Fluorescent

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

Table 72 Replacement of incandescent lamps with fluorescent

		Unit
Total Commercial Consumers	56700	Nos.
Consumers using incandescent bulb	64%	
Target to replace incandescent bulb with CFL	80%	
Number of incandescent bulb to be replaced per consumer	3	Nos.
Total number of incandescent bulb to be replaced	86887	Nos.
Indicative cost of installation	130.33	Lakh
Energy saved by replacing 60W bulb with 15W CFL	7.03	MU
Cost of electricity savings	351.89	Lakh
Payback period	0.37	Years
Emission reduction per year	5701	Tonnes

5.1.9 Replacement of T12/T8 Tube light T5 Tube light

Table 73 Replace T12/T8 tube light by T5 tube light

		Unit
Total Commercial Consumers	56700	Nos.
Consumers using T8/T12 tube lights	90%	
Target to replace T8/T12 by T5 tube lights	80%	
Number of incandescent bulb to be replaced per consumer	2	Nos.
Total number of T8/T12 tube lights to be replaced	81648	Nos.
Indicative cost of installation	408.24	Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electronic b	2.25	MU
Cost of electricity savings	112.67	Lakh
Payback period	3.62	Years
Emission reduction per year	1825	Tonnes

5.1.10 Replacement of inefficient fans

Describe the existing scenario and calculate the energy saving by replacing with more enrgy efficient fans .

Table 74 Replacement of conventional fans

Total Commercial Consumers	56700	Nos.
Consumers using Conventional Fans	100%	
Target to replace CF by EE Fans	25%	
Number of Conventional fan to be replaced per consumer	3	Nos.
Total number of Conventional Fans to be replaced	38081	Nos.
Indicative cost of installation	380.81	Lakh
Energy saved by replacing Conventional Fans by EE Fans	0.53	MU
Cost of electricity savings	26.65	Lakh
Payback period	14	Years
Emission reduction per year	3276	Tonnes

5.1.11 Replacement of conventional air-conditioners with EE star rated ACs

Table 75 Repalcement of conventional Air conditioners with EE Star Rated ACs

		Unit
Total Commercial Consumers		Nos.
Consumers using Conventional ACs		
Target to replace Conventional ACs by EE star rated ACs		
Number of Conventional ACs to be replaced per household		Nos.
Total number of Conventional ACs to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional ACs by EE Star Rated A		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.12 Replacement of conventional refrigerators with EE star rated refrigerators

Describe general Trend used by the consumer and calculate the energy saving potential of replacing conventional refrigerators.

Table 76 Replacement of conventional Refrigerators with EE Star Rated Refrigerators.

		Unit
Total Commercial Consumers		Nos.
Consumers using Conventional Refrigerators		
Target to replace Conventional Refrigerators by EE Star Rated Refrige		
Number of Conventional Refrigerators to be replaced per consumer		Nos.
Total number of Conventional Refrigerators to be replaced		Nos.
Indicative cost of installation		Lakh

Energy saved per year		MU
Cost of electricity savings		Lakh
Payback period		Years
Emission reduction per year		Tonnes

5.1.13 Replacement of conventional water pumps with EE star rated pumps

Table 77 Replacement of conventional pumps with EE star Rated Pumps

		Unit
Total Residential household		Nos.
Household using Water Pumps		
Target to replace Conventional Water Pump by EE Pump		
Number of Conventional Pumps to be replaced per household		Nos.
Total number of Conventional Pumps to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional Water Pumps by EE Water Pumps		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.14 Summary of EE Strategy in Commercial & Institutional Sector

Summarized all the EE Strategy in Commercial & Institutional sector through energy efficiency measure

Table 78 Summary of EE Strategy in commercial & Industrial Sector

EE Measures	Units	Targets	Investment (lakhs)	Electricity Saved (MU)	Emissions Saved (Tonnes)
Indicative cost of replacing 60W incandescent with 15W	Nos.				
Indicative cost of replacing T8/T12 tube lights with T5 F	Nos.				
Indicative cost of replacing conventional fans with EE fa	Nos.				
Indicative cost of replacing conventional AC with EE sta rated AC	Nos.				
Indicative cost of replacing conventional refrigerators wit EE star rated refrigerators	Nos.				
Indicative cost of installing EE water pumps	Nos.				

EE Strategy for Industrial Sector

5.1.15 Replacement of incandescent with CFLs

Table 79 Repalcement of incandescent with CFLS in Industrial Sector

		Unit
Total Industrial Consumers		Nos.
Consumers using T8/T12 tube lights		
Target to replace T8/T12 by T5 tube lights		
Number of incandescent bulb to be replaced per consumer		Nos.
Total number of T8/T12 tube lights to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electr ballast)		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.16 Replacement of T8/T12 by T5 tube lights

Table 80 Replacement of T8/ T12 Tube lights

		Unit
Total Industrial Consumers		Nos.
Consumers using T8/T12 tube lights		
Target to replace T8/T12 by T5 tube lights		
Number of incandescent bulb to be replaced per consumer		Nos.
Total number of T8/T12 tube lights to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing T8/T12(with magnetic ballast) with T5 (with electr ballast)		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.17 Replacement of Conventional Fans by EE Star Rated Fans

Table 81 Replacement of conventional Fans by EE Star rated fans

		Unit
Total Commercial Consumers		Nos.
Consumers using Conventional Fans		
Target to replace CF by EE Fans		
Number of Conventional fan to be replaced per consumer		Nos.
Total number of Conventional Fans to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional Fans by EE Fans		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.18 Replacement of Conventional ACs with EE Star Rated ACs

Table 82 Replacement of Conventional ACs with EE star Rated ACs

		Unit
Total Industrial Consumers		Nos.
Consumers using Conventional ACs		
Target to replace Conventional ACs by EE star rated ACs		
Number of Conventional ACs to be replaced per household		Nos.
Total number of Conventional ACs to be replaced		Nos.
Indicative cost of installation		Lakh
Energy saved by replacing Conventional ACs by EE Star Rated A		MU
Cost of electricity savings		Lakh
Payback period		years
Emission reduction per year		Tonnes

5.1.19 Summary of EE Strategy in Industrial Sector

Table 83 Summary of EE Strategy in Industrial Sector

EE Measures	Units	Target	Investmer (INR)	Electricity Saved (MU)	Emission s Saved (Tonnes)
Indicative cost of replacing 100 watt incandescent with					
watt CFL	Nos.				
Indicative cost of replacing T12/T8 tube lights with T5 t					
lights	Nos.				
Indicative cost of replacing conventional fans with EE s					
rated fans	Nos.				
Indicative cost of replacing conventional AC with EE st					
rated AC	Nos.				
	Nos.				

EE Strategy for Municipal Sector

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

5.1.20 EE measures in Street Lighting

Describe the existing light sources used in the municipal area.

i. Replacement of 150 watt HPSV with LEDs

Table 84 Replacement of 150 watt HPSV with LED

		Unit
Total number of 250 watt HPSV	8027	Nos.
Target to replace incandescent bulb with CFL	100%	
Total number of 112 watt LEDs needed	8027	Nos.
Indicative cost of installation	4414.85	Lakh
Energy saved by replacing 250 watt HPSV with 112 watt LED	4.85	MU
Cost of electricity savings	242.59	Lakh
Payback period	18.20	Years
Emission reduction per year	3930	Tonnes

ii. Replacement of 40 watt T8/T12 tube lights with T5 tube lights

Table 85 Repalcement of 40 watt T8/T12 tube lights with T5 tube lights

		Unit
Total number of 40 watt Tube lights		**Nos.**
Target to replace incandescent bulb with CFL		
Total number of 112 watt LEDs needed		**Nos.**
Indicative cost of installation		**Lakh**
Energy saved by replacing 250 watt HPSV with 112 watt LED		**MU**
Cost of electricity savings		**Lakh**
Payback period		**Years**
Emission reduction per year		**Tonnes**

iii. Sensors for automatic on/off of street lights

Automatic street lights ensure that energy is not wasted by lights turned on during day time. Many street lights in India face this predicament due to faulty manually controlled street lights. Manual control involves labor costs, energy wastes and poor efficiency, hence Municipal street lights should hasten the process of installing automatic sensors. Solar sensors are the new and upcoming products in the market today and should be applied by municipalities for higher efficiency in the operation and maintenance of municipal street lights.

iv. Energy Efficiency Measures in Water Pumping

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

v. Proper pump-system design (efficient Pump, pumps heads with system heads

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

Table 86 Proper Pump system Design

Standard/Recommended Condition	**Value**	**Units**
Annual Energy Consumption		**MU**
Annual Energy Cost		**Lakh**
Saving %		
Total Annual Saving		**MU**
Annual Saving		**Lakh**
Emission Reduction		**Tonnes**

vi. Installation of variable speed drivers

Dimension and adjustment losses are two of the major energy loss sources in pumping processes. Adjusting pump speed or using Variable Speed Driver to adjust speed is one way to decreasing both the fore mentioned losses in pumping processes.

	Value	Units
Annual Energy Consumption		MU
Annual Energy Cost		Lakh
Saving %		
Total Annual Saving		MU
Annual Saving		Lakh
Emission Reduction		Tonnes

vii. Power saver installation in pump house

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

Table 87 Power saver Installation in pump house

Standard/Recommended Condition	Value	Units
Annual Energy Consumption		MU
Annual Energy Cost		Lakh
Saving		
Total Annual Saving		MU
Annual Saving		Lakh
Emission Reduction		Tonnes

viii. Energy Efficiency Measures in STP

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

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

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

Table 88 Proper Pump system Design

	Value	Units
Annual Energy Consumption		MU
Annual Energy Cost		Lakh
Saving		
Total Annual Saving		MU

Annual Saving	111.65	Lakh
Emission Reduction	2583.9	Tonnes

x. Installation of variable speed drivers

Installation of variable speed drivers for municipal pumps could save at least 5% energy resulting total savings of 0.8MU per year reducing 648 tonnes of GHG emission.

Table 89 Variable speed Drivers

Standard/Recommended Condition	Value	Units
Annual Energy Consumption	15.95	MU
Annual Energy Cost	558.25	Lakh
Saving	5%	
Total Annual Saving	0.80	MU
Annual Saving	28	Lakh
Emission Reduction	648	Tonnes

xi. Power saver installation in pump house

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

Table 90 Power saver Installation in pump house

Standard/Recommended Condition	**Value**	**Units**
Annual Energy Consumption in MU		**MU**
Annual Energy Cost in Rs. (lacs)		**Lakh**
Saving %		
Total Annual Saving in MU		**MU**
Annual Saving in Rs. (lacs)		**Lakh**
eCO2 (Tonne) Reduction		**Tonnes**

xii. Summary of EE Strategy for Municipal Sector

The energy savings potential through energy efficiency measures in municipal sector is 22.60 MU per year which is about 9% of total target to achieve.

Table 91 Summary of EE strategy for Municipal Sector

Areas	EE Measures	Target	Investment (Lakh)	Electricity Saved (MU)	Emissions Saved (Tonnes)
Outdoor Lighting	**Indicative cost of replacing T8/T12 tube lights witl tube lights**				
	Indicative cost of replacing 250 watt HPSV with 1 LED				
	100% timer based operation and installation of po saver				
Water Supply	**Proper pump-system design (efficient Pump, pum**				
	heads with system heads				
	Installation of variable speed drivers	81		0.73	591.3
	Standard/Recommended Condition	81		2.19	1773.9
STP	Proper pump-system design (efficient Pump, pumps heads with system heads	15		3.19	2583.9
	Installation of variable speed drivers	15		0.80	648
	Standard/Recommended Condition	15		2.39	1935.9
			4620	22.60	18305

CHAPTER 6

6 ACTION PLAN AND BUDGET

Year-wise Goals of Energy Savings

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

Table 92: Energy savings goal over 5 years solar city implementation period

RE and EE Strategy for Gandhinag	Energy Savings target over 5 years period of implementation (MU per year)					% of savings target to achieve	Emission reduction/ year
	1st Year	2nd year Cumulative	3rd year Cumulative	4th year Cumulative	5th year Cumulative		
RE for Residential Sector							
RE for Commercial & Inst. Sector							
RE for Industrial Sector							
RE for Municipal Sector							
Total for RE strategy							
EE for Residential Sector							
EE for Commercial Sector							
EE for Industrial Sector							
EE for Municipal Sector							
Total for EE Strategy							
RE and EE Combined Strategy							
	___%	___%	___%	___%	___%		

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----------GRAPH----------

Table 93: Year wise Goal of Energy Savings

Physical Target and Action Plan

The Master Plan for developing Gandhinagar as Solar City sets a target of installing ____ MLPD capacity Solar water heater with a collector capacity of _____million sqm, ____MWp cumulative solar PV systems, _____ CuM Biogas systems, _____MWe waste to energy projects and _____ nos. solar cookers. A list of renewable energy equipments and energy efficient devices has been presented in the table below.

Table 94: Physical target of RE systems and EE devices

Cumulative Capacity of RE systems		
Solar Water Heating Systems		LDP
Solar PV Systems		kWp
Biogas Systems		CuM
Waste to Energy Systems		MWe
Solar Cookers		Nos.
Renewable Energy Devices proposed		
x 100 LPD Domestic Solar Water Heating System		Nos.
x 1000LPD solar water heating system		Nos.
Solar cookers (Box and dish type)		Nos.
Community Solar Cooker		Nos.

Solar lanterns		Nos.
Solar Home Systems (SHS)		Nos.
250 -500Wp Solar PV system for inverters		Nos.
x 10kWp PV Power Plant for diesel abatement		Nos.
x 10CuM Biogas system from organic/food waste		Nos.
Solar Street Light		Nos.
Solar PV Traffic Lights		Nos.
Solar Blinkers (37Wp)		Nos.
Road Stud		Nos.
Solar PV Pumps		Nos.
Solar Hoarding		Nos.
Waste to Energy Power Plant		Nos.
Energy Efficient Devices proposed		
CFLs		Nos.
T5 tube light + Electronic Ballast to replace		Nos.
Star rated ceiling fans		Nos.
Star rated ACs		Nos.
Star rated refrigerators		Nos.
Star rated water pumps		Nos.
112 watt LED		Nos.
Power saver		Nos.

Table 95: Physical Target and Action Plan

Implementation Strategy

6.1.1 Establishment of the Solar City Cell

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

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

6.1.2 Awareness and Publicity

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

(i) Publicity through electronic media

- Production and telecast of documentary films, short duration films, TV spots/advertisements etc through local TV network.
- Production and broadcast of Radio sponsored programmes, Radio Spots/jingles and Radio Talks etc. through local FM channels.
- Creating an interactive E-Commerce website exclusively for "Gandhinagar Solar City" for awareness
  campaigns, information sharing and support to the users for submission of online application for incentives etc.

(ii) Print Media/Publication

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

(iii) Exhibitions, Outdoor Publicity, Campaign

- Use of Exhibitions and Outdoor Publicity activities like hoardings, kiosks, bus panels, bus-stop shelters, wall paintings, computerized animation display systems, etc. in the city.
- Display and demonstration of RE and EE equipments in the Solar City Cell.
- Organizing runs, debates, seminars, quiz, drawing, model making, poster, essay and slogan writing competitions among others for school children and others;
- Promotion and publicity of RE and EE by displaying models and posters etc in different public places, institutions/organizations, hospitals, bus stand etc.
- Encourage maximum participation by residents and business owners in the City's energy efficiency programs through marketing and education.

- Educate government purchasing agents in each City department regarding the benefits of Energy Star rated equipment, including the cost savings to the city.

- Encourage community input on strategies for improving energy efficiency in building.

(iv) Workshops and Seminars

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

6.1.3 Implementation of RE Strategy

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

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

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

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

- Providing technical assistance to project developers in site assessment, feasibility and detailed project report preparation.
- Providing assistance in conducting energy audit
- Involvement of financial institution/ IREDA for providing soft loan for large scale promotion of RE projects.
- Setting up of a high level committee including city administration, state nodal agency, developers, MNRE, RE/ EE experts, Finance institution stakeholders from different sectors to oversee and review implementation of the Master Plan
- Provide additional subsidy/ incentives for those systems which have payback period more that 3 years
- Amend building bye-laws for making the use of solar water heating systems mandatory
- Provide rebate in property tax through Municipal Corporations/ Municipalities & in electricity tariff though Utilities/ Electricity Boards to the users of solar water heaters especially in domestic sector.
- Comply MSW Rules 2000 notified by the MoEF and set up projects of suitable capacity for generating energy from the waste collected from the city/town.
- Conduct energy auditing of Govt./Public sector buildings, water pumping and street lightings in the city at regular interval and take necessary steps towards conservation of energy for the same.
- Issue G.O as regards to construction of energy efficient solar buildings at least in Govt. /Public sectors in accordance with ECBC : 2006 and follow up its implementation rigorously.
- Generate necessary funds from State Govt. and other funding organizations for achieving the objective of making the city as "Solar City". Benefits of the schemes of Govt. of India will also be taken in meeting the objectives.
- Promote National Rating System for construction of energy efficient Green Buildings in particular to commercial and institutional buildings
- Avail financial benefit from Carbon Market

6.1.4 Renewable Energy Pilot Projects

MNREs will provide financial assistance for implementation of pilot projects in all the sectors. Five categories of projects in different RE technologies are proposed in each sector. It is proposed that MNRE will provide financial assistance to meet ___% of the project cost, ANN/ State will support ___% and users will contribute 10% project cost. The total investment for implementation of all proposed pilot projects is estimated as Rs.____Lakh out of which MNRE will contribute Rs.____Lakh, City/ Sate will contribute Rs._____Lakh and the users will contribute Rs._____Lakh. All the pilot projects shall be executed in the first year of implementation.

Table 96: Pilot Projects in Residential Sector

Sl. No.	Proposed Pilot Projects	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Solar lanterns for roadside markets/ hawkers to replace kerosene lamps								
2	PV system for Home inverter								
3	PV system to replace Home Genera								
4	Solar Water Heating System for residential Apartment Complex								
5	PV Power Plant for residential apartment Complex								
	Total								

Table 97: Pilot Projects in Commercial and Institutional Sector

Sl. No.	Project	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Community Solar Cooker for mid da meal in schools								
2	Solar Water heatres for Hospitals								
3	Biogas system for Restaurants								
4	Solar Water Heater for Restuarnats								
5	PV system for educational institutes								
	Total								

Table 98: Pilot Projects in Industrial Sector

Sl. No.	Project	Capacity	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Biogas system for (FOOD) Industry								
2	PV System for Leather Industries								
3	Solar Water Heaters for Food processing								
4	Solar PV system for Garment Indus								
5	Solar steam generator process heatings								
	Total								

Table 99: Pilot Projects in Municipal Sector

Sl. No.	Project	Capaci	Unit	Nos.	Cost per system (Lakh)	Total cost (Lakh)	MNRE Share (Lakh)	City/ State Share (Lakh)	Users share (Lakh)
1	Solar PV power plant for Municipal building/ bus stand								
2	Solar Streetlights/ trafic lights/ blinkers								
3	Solar PV system for markets								
4	Outdoor PV systems for Municipal Parks								
5	Solar Hoardings								
	Total								

Table 100: Summary of Pilot Projects and indicative project cost implication

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

Financial outlays and sharing of fund

The total indicative budget for development of Gandhinagar as Solar City is estimated at Rs._____ crore which will be invested over the 5 years of implementation period of solar city development programme. The total budget will be shared by the state government/ City authority (___%), MNRE (___%) and the private users (___%). The budget for implementation of RE strategy and EE strategy

is estimated at Rs._____ crore and is Rs._____ crore respectively. Budget for establishment of the Solar City Cell and awareness and publicity is estimated at Rs.____ Lakhs which could be enhanced depending upon the requirement. While budget for RE strategy will be shared among MNRE, state/city and private users, private investors will primarily drive EE activities. A substantial amount of investment could be recovered or the entire project could be partially financed through carbon finance mechanism. A suitable methodology will be adopted to avail benefit from carbon market selling the CER generated from the project.

Table 101: Sharing of budget for development of Gandhinagar Solar City

	Year 1 (Crore)	Year 2 (Crore)	Year 3 (Crore)	Year 4 (Crore)	Year 5 (Crore)	Total (Crore)
State / City Share						
MNRE Share						
Private Share						
Total Budget						

----------PIE CHARTS AND GRAPHS----------

Table 102: Sector wise total budget and annual expenses

	Unit	Total		Year 1	Year 2	Year 3	Year 4	Year 5
MNRE contribution for RE strategy								
Establishment of Solar city ce	Lakh							
Publicity and awareness	Lakh							
RE for residential sector	Lakh							
RE for Commercial & Inst. sector	Lakh							
RE for Industrial sector	Lakh							

RE for Municipal sector	Lakh							
W2E Project form MSW & STPs	Lakh							
MNRE								
State/city contribution								
Establishment of solar city ce								
RE for Institutional sector	Lakh							
RE for Municipal sector	Lakh							
EE measures for Inst. sector								
EE measures for Municipal sector								
State / City								
Private/ Users contribution								
RE for residential sector	Lakh							
RE for Commercial & Inst. sector	Lakh							
RE for Industrial sector	Lakh							
RE for Municipal sector	Lakh							
EE for Residential sector	Lakh							
EE for Commercial & Inst. sector	Lakh							
EE measures for Industrial sector	Lakh							
Private Investor for W2E projects	Lakh							
Private/ Users								
Total	Lakh							

Table 103: Total Budget and Sharing of cost

Potential Carbon Market Benefit

The RE and EE activities under solar city programme will considerable amount of green house emission per year. The CER generated under this project can be sold to carbon market under suitable mechanism. It is estimated that a total of _____ CER could be sold from the project which will give a revenue of Rs. _____ crore per year. If project life is considered 10 years, the income from carbon market will recover about 35% of the project cost.

Table 104: Potential Carbon Market Benefit

Assumption: Value of CER = 12 Euro; 1Euro= 60 INR	Energy Saved (MU)	CER (Tonnes)	Value (Lakh/ year)
CER from RE strategy			
CER fro EE strategy			
CER from entire solar city project			

Annexure 1

Assumed solar street Light

GNA (Gandhinagar notified area)

SDL: Standard double lane clear carriage way of width 7m to 10.5m – 102 km

SML: Standard multilane clear carriage way of width 10.5 m and above – 82 km

Radius of SDL streetlight i.e. secondary lane is considered as 4m.

Radius of SML streetlight i.e. primary lane is considered as 8m.

Number of street light:

SDL = (L) 102000 / 4 =25500.

SML = (L) 82000/8 = 10250.

Type of street light: (source – suryakirantech)

SDL – consumption = 11 Watt CFL

SPV - generation = 74 Watt peak

SML – consumption =33 Watt CFL

SPV – generation = 150 Watt peak

Electricity consumed: (For one street light)

11 Watt = 11 X 12 (hours) = 132 Wh

33 Watt = 33 X 12 (hours) = 396 Wh

Total consumption:

10250 X 396 = 4059000 W = 4059 kW (Primary road)

25500 X 132 = 3366000 W = 3366 kW (Secondary road)

Total consumption = 7425 kW

SPV generation:

Primary roads:

SPV = 150 Watt peak = 150 X 2.5 = 375 Wh

Secondary road:

SPV = 74 Watt peak = 74 X 2.5 = 185 Wh

Total generation:

10250 X 375 = 3843750 W = 3843.75 kW (Primary road)

25500 X 185 = 4717500 W = 4717.50 kW (Secondary road)

Total generation = 8561.25 kW

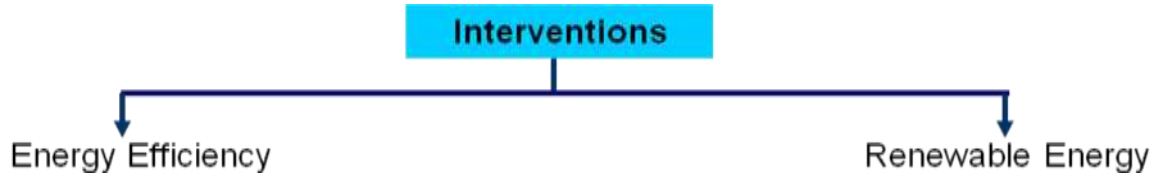
Annexure 2

Solar City : Gandhinagar

What is "Solar City" ?

"Solar city is a city that aims at reducing the level of green house gas emission through a holistic strategy for introduction of renewable energy sources/systems and rational use of energy by implementing measures on energy conservation"

Government of India defines solar city as a city which aims at reducing the conventional energy consumption at the end of 5 years by min. 10% through use of renewable energy resources and implementation of energy conservation measures in equal proportion.



Global Practice and Benchmarks

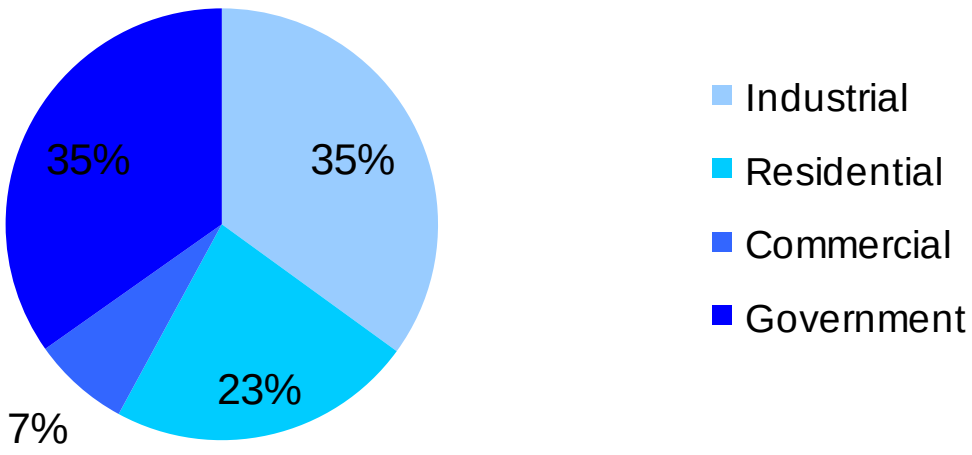
RE Goals	Target or goals set for future share from renewable energy
CO2 Goals	Future CO2 emissions targets set, usually on a city wide or per capit often referenced to the emissions of a base year like 1990 or 2000
Solar Water Heaters (SWH)	Policies and or incentives for solar water heaters
Solar PV	Policies and or incentives for solar power enacted
Transport	Policies and or urban planning approaches for sustainable transport being used
Buildings	Energy-efficient building codes, standards and or incentives enacted
Planning	Overall urban planning approaches with consideration for future ener consumption and sources
Demos	Specific projects , subsidized by public funds or otherwise financed demonstrations or limited-scale investment in any of the above

Global Practice and Benchmark

City	Country	RE Goals	CO_2 G	SWH	Solar PV	Transport	Buil-dings	Planning	Demos
Adelaide	Australia	15% by 2020	x	10% Homes by 2020 b				x	x
Barcelona	Spain			x				x	x
Cape Town	South Africa	x	x					x	
Daegu	Korea	5% energy I	x		x			x	
Freiburg	Germany	10% by	x		x			x	x
Gelsenkircher	Germany							x	x
Gothenburg	Sweden							x	x
Gwanglu	Korea	2% ener	x					x	
The Hague	Netherlands		x				x		
Linz	Australia								
Minneapolis	US	10%							x
Oxford	UK	x	x	x	x		x	x	
Portland	USA	100% by	x	x	x	x	x	x	
Quindog	China								
Santa Monica	USA	100%				x	x	x	x
Sapporo	Japan		x					x	x

Existing Situation :Gandhinagar

Population	**1,96,000 (2001 Census)**
No. of House holds	**42,471**
Average Electricity use	**2.68 kWh / day / House hold**
Peak Load	**39 MW**
Annual Consumption	**192 Million Units**
► **Industrial**	**67.2 Million Units (35%)**
► **Government**	**66.8 Million Units (35%)**
► **Residential**	**44 Million Units (23%)**
► **Commercial**	**14 Million Units (6998 Consumers) (7%)**
Kerosene Usage	**25,000 KL p.a.**
Water requirement	**45 MLD**



Intervention in GIDC Industries: Gandhinagar

- Gandhinagar GIDC - 22 HT industries and 17 major LT industries
- Contract demand - Over 11.5 MW / annual consumption of approx. 32 MU
- ECON (Energy Conservation Measures) can be implemented in these industries
- Adopting best practices/ House keeping reduces 5% consumption (1.5 MU)
- 10-15% saving feasible through ECON measures (4.5 MU) with investments
- To be implemented in PPP by GIDC/Association/GEDA

Intervention In Industries: Gandhinagar

Intervention	Cost	Energy Savings (%)
Use of energy efficient motors and pumps	1.3 times than regular mo	5-10%
Use of variable speed drives and frequency driv	25-50% of the motor cost	20%
Use of automatic power factor controllers	Pay back period less than	2%
Utilisation of waste heat recovery system	Pay back period 2-3 years	10%
Use of vapour absorption system in place of vapour compression system	3 times costlier than the v compression system	40%
Energy efficient lighting and Lighting controls(Occupancy sensors)	Negligible Cost	25%
Use of solar water heaters for boiler feed water	Rs. 100 per litre	20%
Better house keeping	Adopting best practices	5-10%

Intervention in Government

- MNRE vide sanction letter no. 3/5/2007/UICA (SE) dated 05/11/2008, the "in principal" approval is accorded to develop Gandhinagar and Rajkot cities as Solar Cities.

- Constitution of a ”Solar City Stakeholders Committee” under the chairmanship of PS (EPD) for overseeing the implementation of project - “ Solar City Gandhinagar”
- Creation of a exclusive “Solar City Cell” at GEDA for implementation of the Solar City Gandhinagar - coordination with various department etc. O/O dated 25/02/2011
- MNRE vide sanction letter no. 40/2/2008/UICA(SE) dated 11/08/2010, the “in principal” approval is accorded to develop Surat City as Solar City.
- MNRE vide letter no. 5/372010-11/ST dated 28/03/2011, the “in principal” approval is accorded to develop Gandhinagar City as Model Solar City.

Intervention in Government: Gandhinagar

Intervention	Cost	Energy Savings (%)
Replacement of mercury and sodium va with LEDs and metal halides	Pay back period 2 year	25-30%
Replacement of incandescent lamp with CFLs	Pay back period 6 mon	25-30%
Replacement of fluorescent tube lights with T-5	Pay back period 1.5 ye	25-30%
Replacement of inefficient pumps with energy efficient pump at water pumping stations	Pay back period 2 year	22-50%
Use of vapor absorption refrigeration sy	3 times costlier than the compression system	75%
Use of solar water heaters in Government buildings (Circuit house, h hospitals and residential bungalows)	Rs. 100 per litre	800 units/100 lpd p.a.
Use of solar photovoltaic roof top systems for reducing the conventional energy use	Rs. 3 Lakh per KW	1200 units/KW p.a
Use of community solar cookers under mid day meal scheme	13 lakhs per 250 perso	50 LPG cylinders p.a.

Intervention in Residential/Commercial: Gandhinagar

Intervention	Cost	Energy Savings
Replacement of 40,000 incandescent lamp with CFLs	40 Lakhs	12.50 Lakh KWH p.a.
Replacement of 25,000 fluorescent tube lights with T-5	175 Lakhs	17.60 Lakh KWH p.a.
Use of solar water heaters in houses and commercial buildings (20,000 litres/day)	25 Lakhs	1.60 Lakh KWH p.a
Use of solar photovoltaic roof top systems for reducing the conventional energy use (700 KW)	19.60 Crores	8.40 Lakh KWH p.a
Replacement of old fans by BEE labeled fans (10,000)	1.50 Crores	2.40 Lakh KWH p.a

Initiatives taken for Energy Conservation

- Replacement of 10,000 nos. of 40 W conventional tube lights to 28 W, T-5.
- Savings: 7.20 lac kWh p.a.
- Replacement of 48 Halogen Lamps (1000 W) by energy efficient lamps of 330 W.
- Savings: 1 lac kWh p.a.
- Replacement of 200 nos. of 350 W Street lights by 150 W metal halides.
- Savings: 1.20 lac kWh p.a.
- Staggering of lift operation
- Replacement of Conventional Cooling tower by FRP Cooling Tower
- Optimizing operation of central AC Plant

The above measures at an investment of Rs. 128 lacs have resulted into energy savings of 16. 83 lac kWh p.a.

Awareness programme in schools in Gandhinagar

- Mount Carmel High School, Sector-21
- St. Xavier School, Secor-8
- Swaminarayan Gurukul, Sector-22
- J.M.Chaudhari Sarvajanik Kanya Vidyalay,Sector-7
- Mahatma Gandhi Vidyalay, Sector-16
- Government Primary School, Vavol
- Sharda Vidyalay, Sector-25
- Gandhinagar District Science Fair-66 Schools

A continuous awareness program through exhibitions, seminars, workshops, rallies, demonstrations on renewable energy and energy conservations for various target groups under the aegis of various NGOs like CEPT, CEE, Community Science Center etc.

Actions Taken So Far

S.No	Activity	Year	Cost (Rs. In Crore)	Savings in lac kWh/pa
A	**Government**			
1	170 kW (17 x 10 kW) Grid connected SPV systems 4.87 kW (65 x 75 W) SPV Street lights in gardens 15000 lpd SWHS in four Govt. buildings	2008-09	5.00	3.26
2	Replacement of 30 nos. HPSV 250 W with LEDs of 75 W in Ministers Enclave Replacement of 700 lights on CHH and J Roads, with energy efficient lights. Replacement of 3785 nos. of bulbs with CFLs at Ministers/MLA bungalows	2008-09	Funding by BEE, R & B	3.00

	Replacement of Old pumps at Chharedi Water works			
B	**Government**			
1	Installation of 125 nos. 1 kW Solar PV Rooftop System on Government Bungalows.	2009-10	3.225	0.9375
2	Installation of 210 nos. Solar Water Heating Systems on Government Bungalows of 250 LPD each.	2009-10	1.155	5.25
3	Installation of 6 nos. 5kW Wind-Solar Hybrid Power plant at Circuit house, Civil Hospital, Nirman Bhavan ,PDPU , Antim Dham (Crematoria) , Town Hall.	2009-10	0.56	0.225

S.No	**Activity**	**Year**	**Cost (Rs. In Crore)**	**Savings in lac kWh/pa**
C	**Government**			
1	Installation of 2 nos. 10 kW Solar PV Rooftop System on Hon' Chief Minister's Bungalow.	2010-11	0.35	0.24
2	Installation of 1 MW Solar PV Power Plant at Pandit Deendayal Petroleum University, Gandhinagar.	2010-11	18	12
	Total		**28.29**	**24.9125**

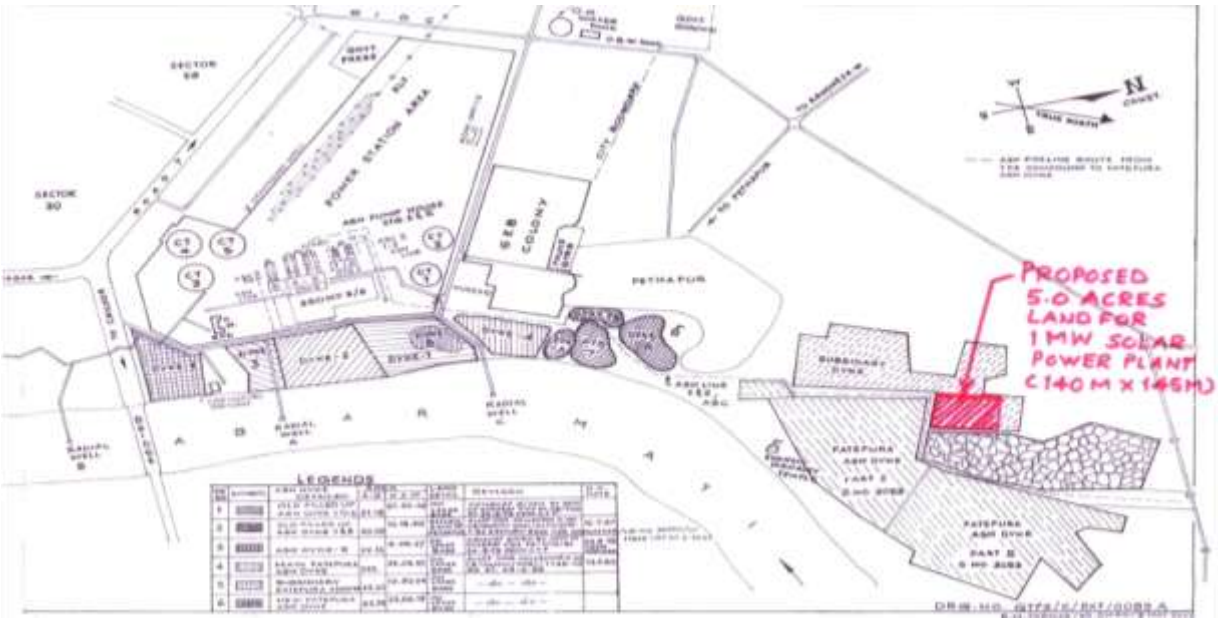
10 kW SPV system at Secretariat Gandhinagar –roof top

10 KW Wind-Solar Hybrid system installed at Udyog Bhavan roof-top

Actions To Be Taken

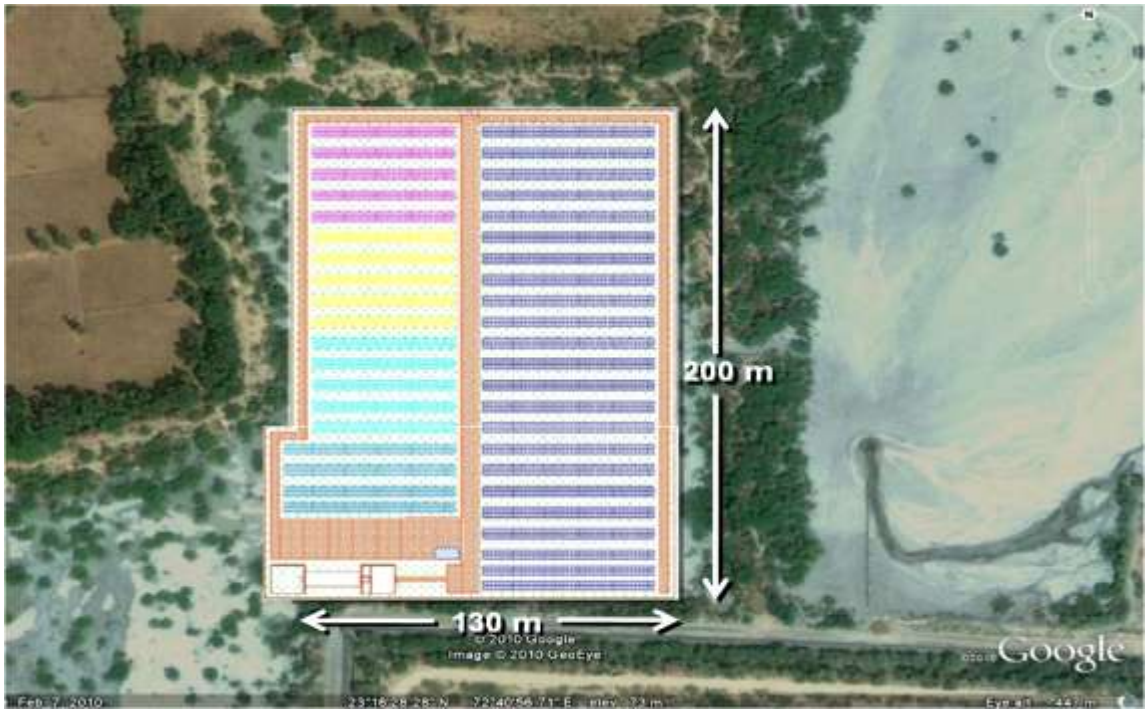
S.No	Activity	Year	Cost (Rs. In Crore)	Savings in lac kWh/pa
C	**Government**			
1	Installation of 1 MW Solar PV Power plant at Ash Dyke of Gandhinagar Thermal Power Station, Gandhinagar.	2011-12	15	12
2	Installation of 5 MW Solar PV Rooftop Systems under Public Private Partnership in Gandhinagar	2011-12	15	60
3	Redevelopment of Pick-up Bus stand near Secretariat, with Solar PV rooftop systems (Solar Trees) with approx. 380 kW SPV capacity which will provide shade to the passengers and power generation shall be utilized in Secretariat.	2011-12	10	4.56
	Total		**40**	**76.56**

Sketch of Site Location of 1 MW SPV power plant at Ash Dyke of Thermal Power station , Gandhinagar.

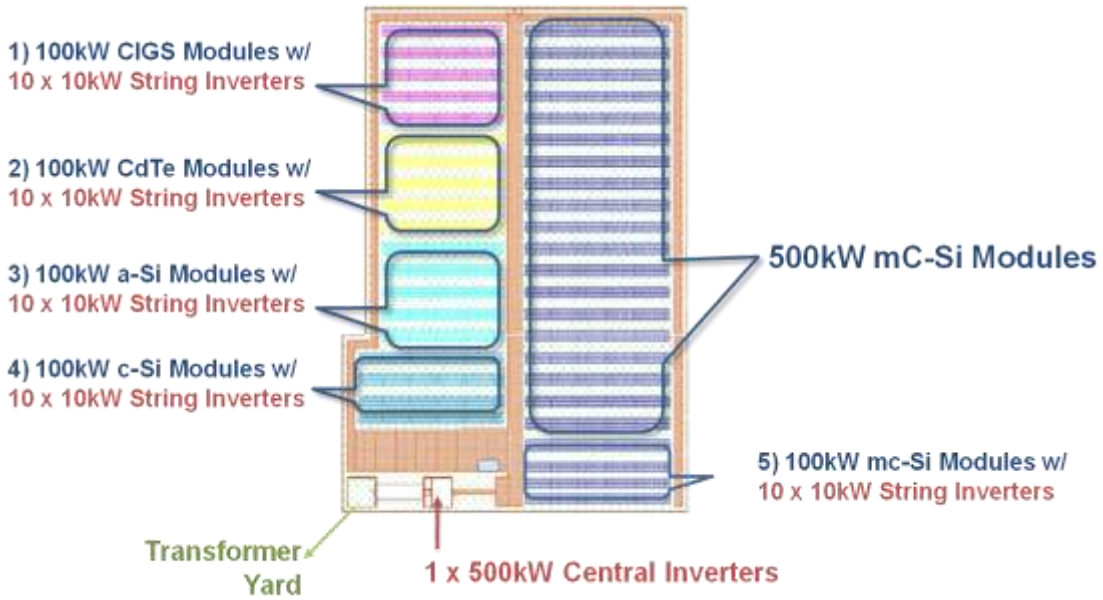


Satellite Image of the Site of 1 MW SPV power plant at Ash Dyke of Thermal Power station , Gandhinagar

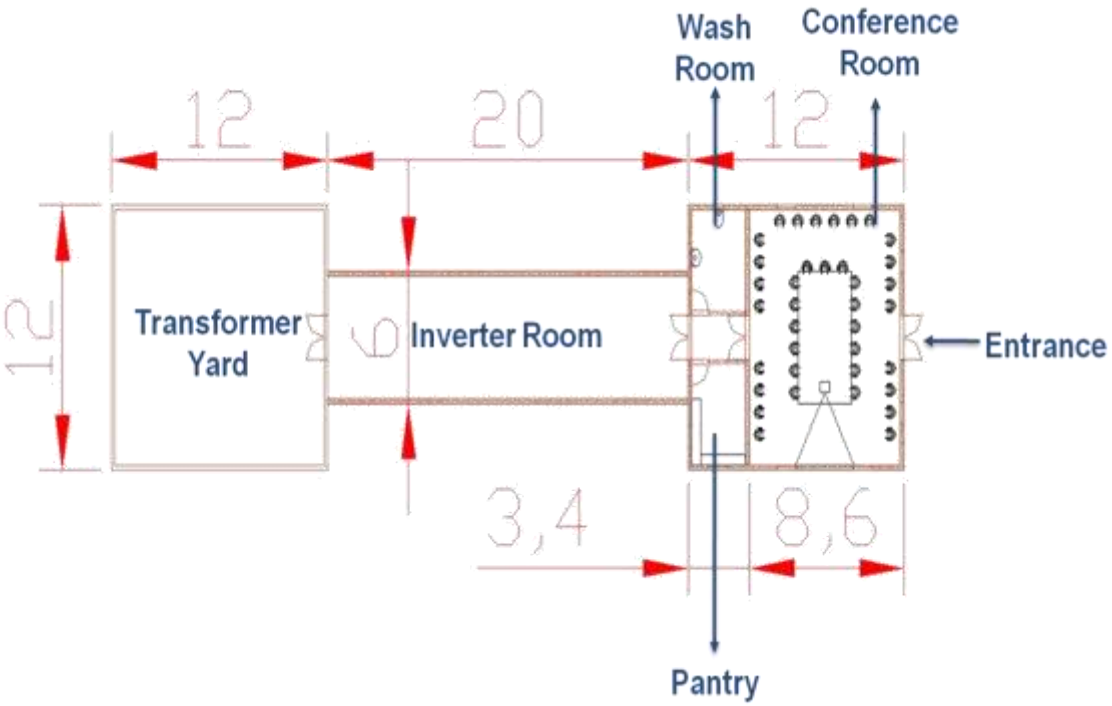
Indicative Layout of Photovoltaic Power Plant of 1 MW SPV power plant at Ash Dyke of Thermal Power station , Gandhinagar.



Indicative Configuration of Photovoltaic Power Plant



Indicative Layout of Inverter/ Control Room and Conference Room of 1 MW Solar Photovoltaic Power Plant



Annexure 3

Achievements Solar City-Gandhinagar

A Budgetary provision of Rs.5 crores was made by the State Government during the year **2008-09.**

S. No	Area/ attribute	Action Point	Remarks
A	Renewable Energy		
1	Solar PV	Installation of 2 nos. 10 kW Solar PV power plant/ Wind-Solar H plant at Ugyog Bhavan.	Completed.
2	Solar PV	Installation of 13 nos. 10 kW Solar PV power plant on various bl Sachivalaya Block No. 1 – One System Block No. 2 – Two Systems Block No. 4 – One System Block No. 5 – One System Block No. 7 – One System Block No. 9 – Two Systems Block No. 11 – One System Block No. 12 – Two Systems Block No. 14 – Two Systems	Completed (System provi units per day, powers 150 T 8 hrs. daily)
3	Solar PV	Installation of 3 nos. 10 kW Solar PV power plant on other build Collector's Office – One System DDO's Office – One System Chief Electrical Inspector's Office – One System	- do-
4	Solar PV	Installation of 65 nos. Solar PV street Lights in nine Gardens Sector 7 Public Garden, opp. Suvidha Enquiry 7 nos. Sector 3 Public Garden, opp. Shopping5 nos. Sector 8 Public Garden, opp. Temple 12 nos. Sector 29 Public Garden, opp. Jalaram Dham 6 nos.	Completed (Operates fror dawn – whole

		Sarita Udhyan, opp. Sector 9 10 nos. Sector 6 Public Garden, opp. Shopping Centre 5 nos. Sector 16 Public Garden, opp. Shopping Centre 5 nos. Sector 12 Public Garden, opp. Suvidha Dairy 5 nos. Police Garden, Sector 2710 nos.	
5	Solar Thermal	Installation of Solar Water Heating Systems in Government buil Water Heating System of 1,000 liters per day has been installed on Civil Hospital, Gandhinagar, 5,000 liter per day on Staff Training College, 6,000 liters per day on Circuit House and 3,000 liters per day on Vishram Gruh . (SWHS Total capacity 15,000 LPD)	Completed
6	Energy Conserv	Replacement of HPSV 250 Watts lights with LED based lights of 75 Watts in Minister's Enclave.	Completed th B.
		Re-lamping with PS-MH200Wats lamps and suitable ballast.	Completed
		Replacement of 959 nos. bulbs by 11 W CFL in Government offices. Replacement/ installation of 2826 nos. CFL in Government bungalows.	Completed
		Installation of 17 nos. of Energy Savers for street light on main roads. Replacement of 1144 nos. of T-5 tube lights in Gujarat State Text Book Board. Replacement of 8000 nos. of T-5 tube lights in Old Secretariat.	Completed
C	Awareness		
7	Demonstration	Mobile Van demonstrations in Mount Carmel High School, Sector-21 St. Xavier School, Secor-8	Completed.

		Swaminarayan Gurukul, Sector-22 J.M.Chaudhari Sarvajanik Kanya Vidyalay, Sector-7 Mahatma Gandhi Vidyalay, Sector-16 Government Primary School, Vavol Sharda Vidyalay, Sector-25 Gandhinagar District Science Fair-66 Schools	

Achievement for the year 2009-10.

Expenditure Rs. 4.96 crores.

S. N	Area/ attribute	Action Point	Remarks
A	Renewable Energy		
1	Solar PV	Installation of 125 nos. 1 kW Solar PV Rooftop System or Government Bungalows.	Completed.
2	Solar Thermal	Installation of 205 nos. Solar Water Heating Systems on Government Bungalows of 250 LPD each.	Completed
3	Wind	Installation of 6 nos. 5 kW Wind-Solar Hybrid power plant House, Civil Hospital, Nirman Bhavan, PDPU, Antim Dha (Crematoria), Town Hall.	Completed.

Achievement for the year 2010-11.

Expenditure Rs. 15.34 crores.

S. N	Area/ attribute	Action Point	Remarks
A	Renewable Energy		
1	Solar PV	Installation of 2 nos. 10 kW Solar PV Rooftop System on Minister's Bungalow.	Completed.
		Installation of 1 MW Solar PV Power Plant at Pandit Deen Petroleum University, Gandhinagar.	Completed

Achievement for the year 2011-12.

Estimated expenditure Rs. 40.0 crores.

S. N	Area/ attribute	Action Point	Remarks
1	Solar PV	Installation of 1 MW Solar PV Power Plant at Ash Dyke o Gandhinagar Thermal Power Station, Gandhinagar.	Work under progress
		Installation of 5 MW Solar PV Rooftop Systems under Public Private Partnership in Gandhinagar.	Work under progress
		Redevelopment of Pick-up Bus Stands, near Secretariat, with Solar PV rooftop systems (Solar Trees) with approx. 380 kW SPV capacity which will provide shade to the passengers and power generation shall be utilized in Secretariat.	Work under progress

Annexure 4

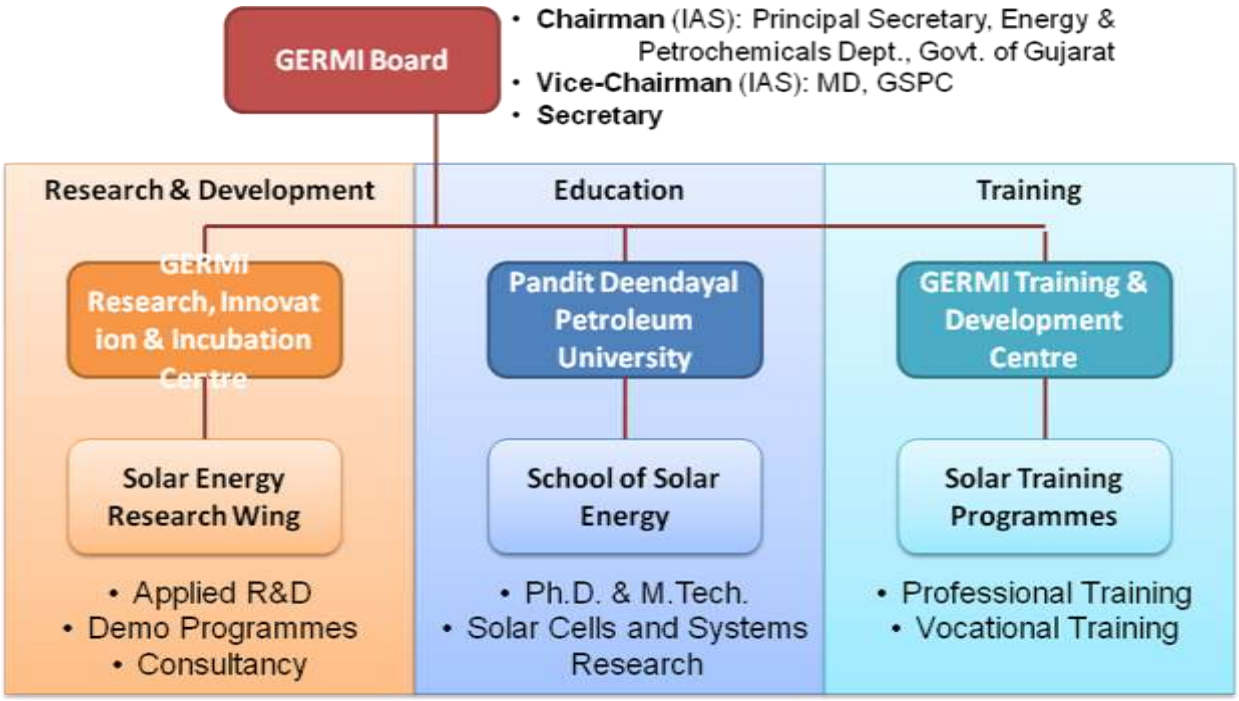
INVESTOR CONFERENCE PRESENTATION by GERMI

GANDHINAGAR PHOTOVOLTAIC ROOFTOP PROGRAMME – 5MW

About GERMI

- The Gujarat Energy Research & Management Institute (GERMI) is a centre of excellence in industry learning, and has been set up to develop human resource assets to cater to:
- The renewable as well as petroleum energy sectors duly recognizing the cross-cutting environmental dimensions,
- Improve knowledge base through empirical state-of-the-art assessments,
- Assist development and implementation of suitably adapted policies, plans, programs and projects, and
- Provide a competitive edge to present & future leaders including policy makers and technologists , for excellence at the national, regional and global levels.
- GERMI is:
- Registered as society under the Societies Registration Act, 1860, and
- Trust under the Bombay Public Trust Act, 1950.
- Promoted by the Gujarat State Petroleum Corporation Ltd. (GSPC), a Govt. of Gujarat Undertaking.

GERMI Solar Mandates



Selected Solar Activities

Projects:

- Gandhinagar Photovoltaic Rooftop Programme (5MW)
- Net-Zero Energy Demonstration
- Feasibility Study of Solar Crematorium

Consultancy:

- Development of 1MW Multi-Technology Solar PV Plant at ash dyke of Thermal Power Station, Gandhinagar
- Development of 5MW Solar PV Plant for Gujarat Power Corporation Ltd. at Solar Park, Charanka (Patan)

Training

Other associations:

- Solar Park, Patan
- Gandhinagar Solar City Initiative
- Scope of Solar Energy Generation/Utilization for the Kalpasar Project

Programme Overview

The Gandhinagar Photovoltaic Rooftop Programme envisions installation of distributed 5 MW rooftop solar photovoltaic systems in Gandhinagar.

- 3-4 MW: Government Buildings
- 1-2 MW: Private Buildings/Homes

Salient Features:

- Exploit a large potential for solar energy distributed generation.
- Establish a sustainable legal, regulatory and technical framework.
- Serve as a benchmark for replication in other cities in Gujarat & India.
- Facilitate sustainable private sector participation in rooftop solar.

Organizational Roles

Promoted by:

- Energy & Petrochemicals Dept., GoG and
- Gujarat Energy Development Agency

Administered & Implemented by GERMI

Lead Transaction Advisor: IFC

- Technical & Regulatory consultants: Deloitte Touche Tomatsu
- Legal consultants: CMS Cameroon Mckenna & Hemant Sahai Associates

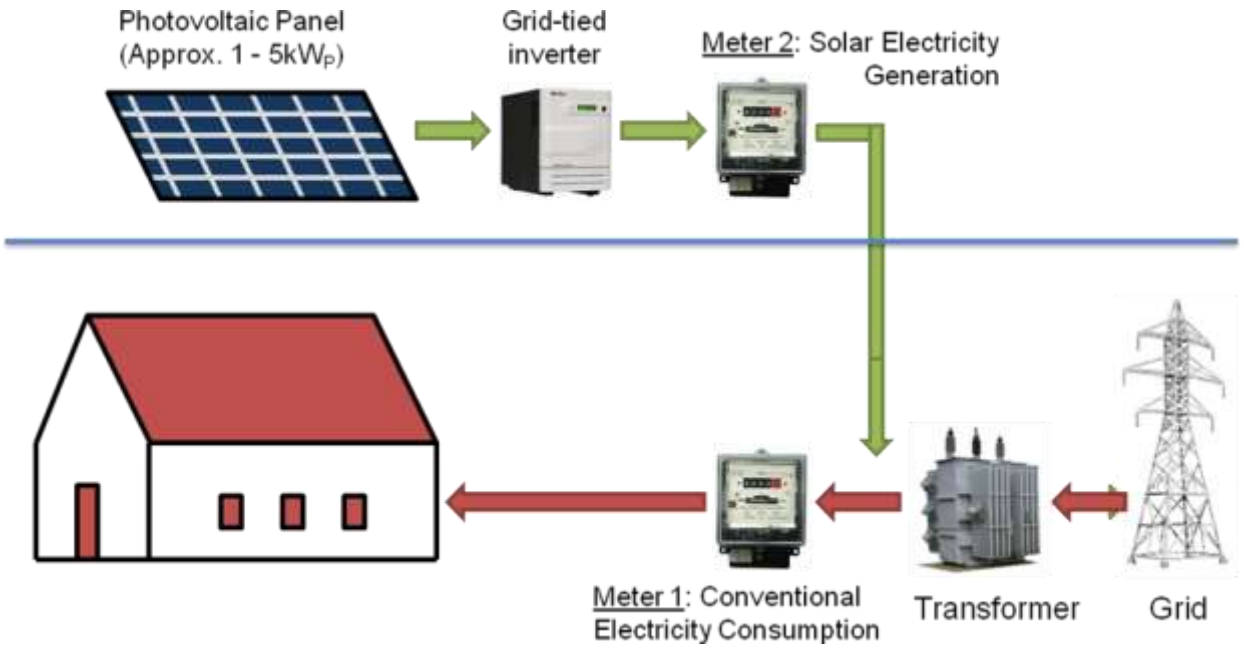
Gandhinagar PV Rooftop Potential

Sector	Household Rooftop (m^2)	Commercial/ Public/ Government (m^2)
1	49,043	
2	67,818	
3	33,112	
4	26,377	
5	20,572	
6	31,121	
7	52,042	
8	56,811	16,867
9	11,814	11,467
10		69,263
11	1,023	23,444
12	15,502	13,252
13	36,118	13,755
14	10,124	9,642
15		34,678
16	8,100	11,889

17	2,331	9,968
18		
19	32,383	
20	27,795	21,722
21	29,294	20,123
22	67,390	7,141
23	33,034	26,151
24	30,672	2,144
25	26,999	
26	22,597	
27	42,269	3,914
28	50,127	
29	55,547	
30	24,723	

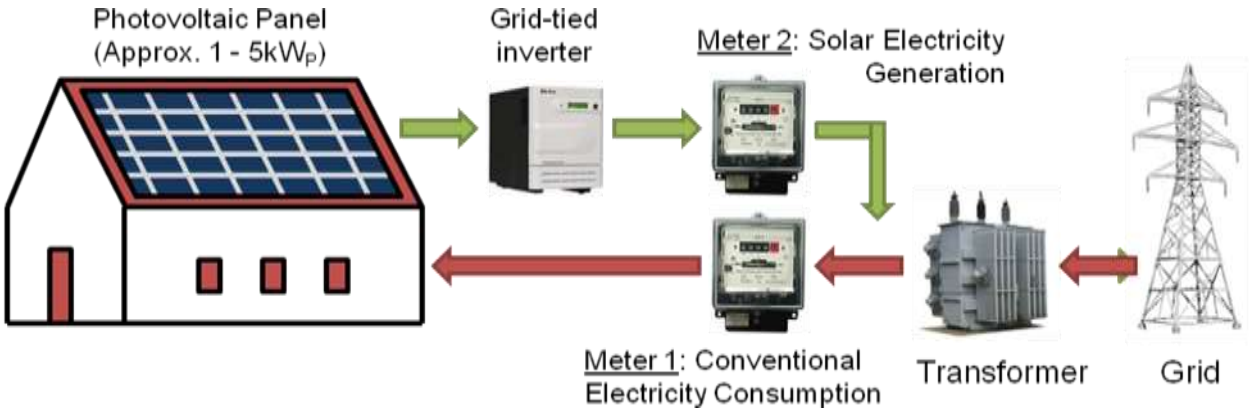
Sector	**Household Rooftop (m^2)**	**Commercial/ Public/ Government (m^2)**
Sub-Total (m^2):	864,736	295,420
Equivalent MW:	86.47	29.54
Acceptance Rate:	5%	33%
Net Capacity (MW):	**4.32**	**9.75**
TOTAL (MW):	**14.07**	

Typical PV System Architecture

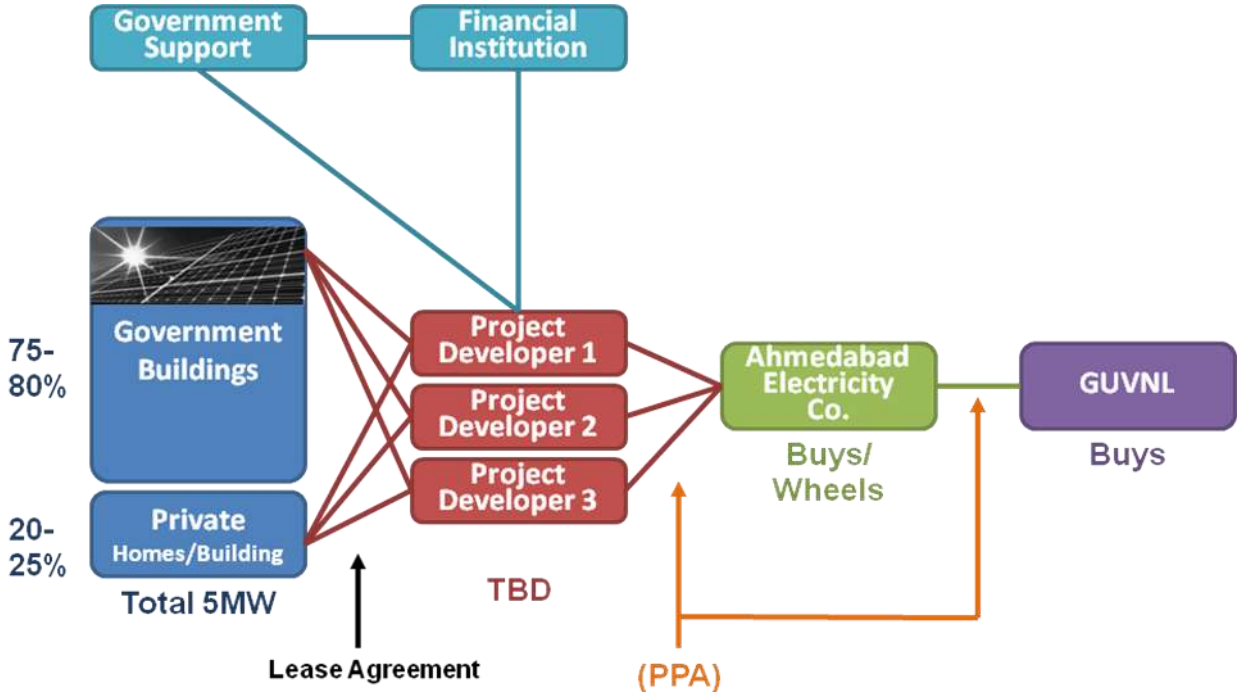


Advantages of PV System Architecture

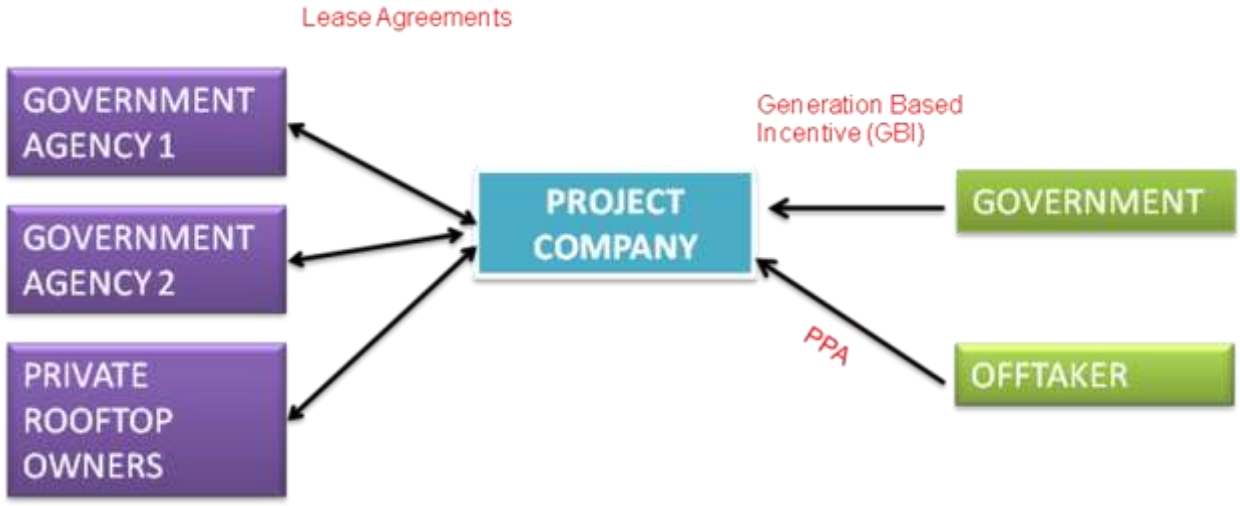
- Relatively simple to install, operate and maintain.
- Most popular and globally accepted configuration.
- Disadvantage: No availability when grid is down



Programme Architecture



Proposed Contractual Arrangements



Expected Project Timelines

Event	Tentative Timelines	
Issuance of Draft Bid Docs	Zero date	Mar 2011
Pre Bid Conference	Zero date+ 15 days	Mar 2011
Issuance of Revised Bid Dc	Zero date + 60 days	Apr 2011
Submission of Bid	Zero date + 75 days	May 2011
Evaluation of Proposal	Zero date+ 90 days	May 2011
Issue of letter of intent	Within 15 days from evaluation of proposals	Jun 2011
PPA Signing	Within 15 days from the date of issue of letter of intent (LOI date +15 days)	Jun 2011
Commissioning of the Proje	12 months from the date of signing of PPA	Jun 2012

Dataroom

Will be available shortly

Will comprise:

- Legal & Regulatory Information (Acts, policies)
- Preliminary assessment of usable roof-area available in Gandhinagar (non-binding)
- List & details of available public buildings
- Maps

Areas for Discussion

Optimal size of each cluster?

- Ranging from 1 cluster of 5MW to 5 clusters of 1 MW each

Factors for designing clusters?

- Geographic division
- Potential roof area of available buildings
- Any other

Possible incentive mechanisms for attracting private building owners?

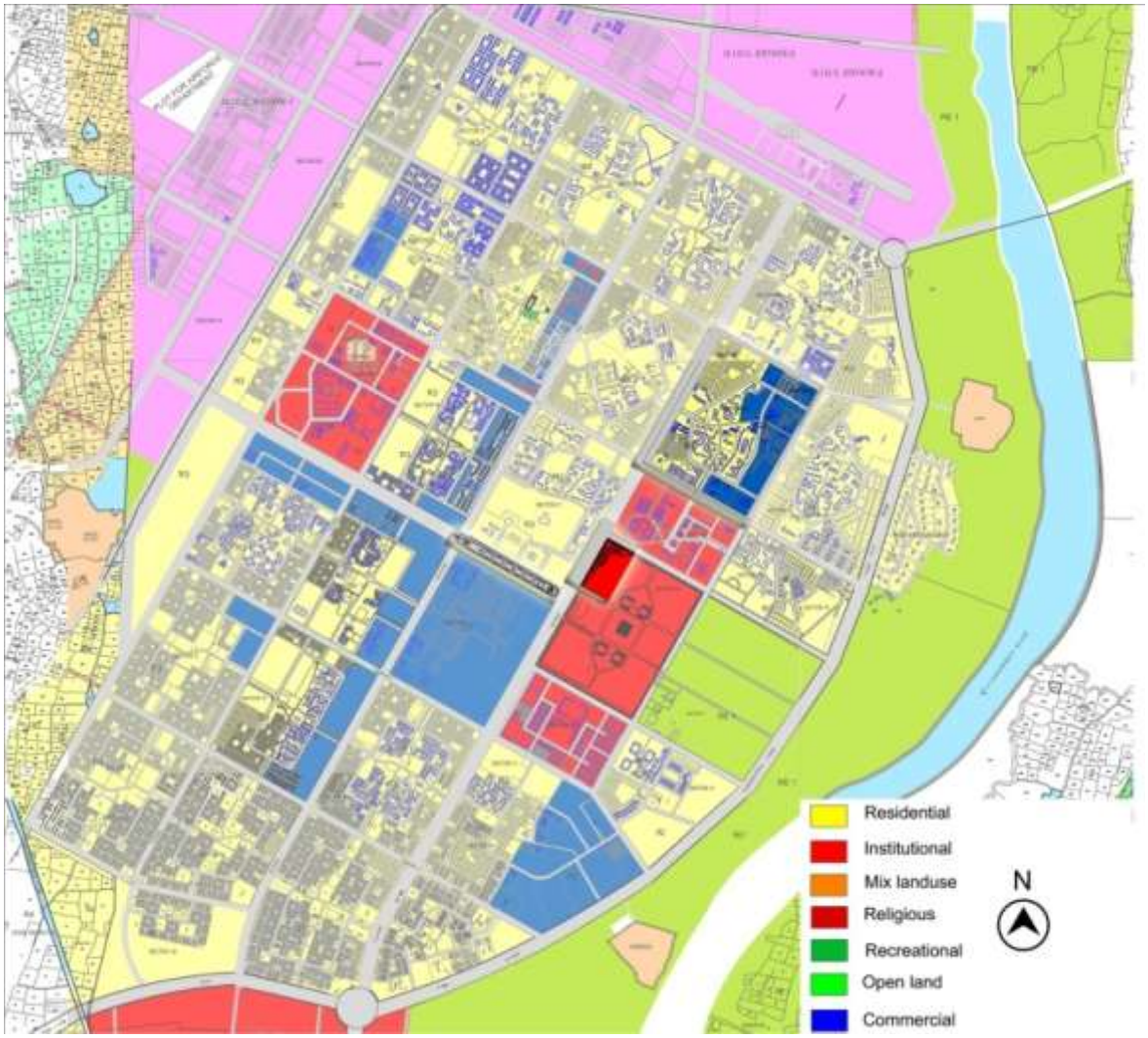
Time requirements?

- Bidder due diligence & preparation of bid
- Identification of private roof top owners interested in the project
- Project implementation/ commissioning timeline

- Any other discouraging factor?
- Environmental & social considerations?
- Technical Issues?

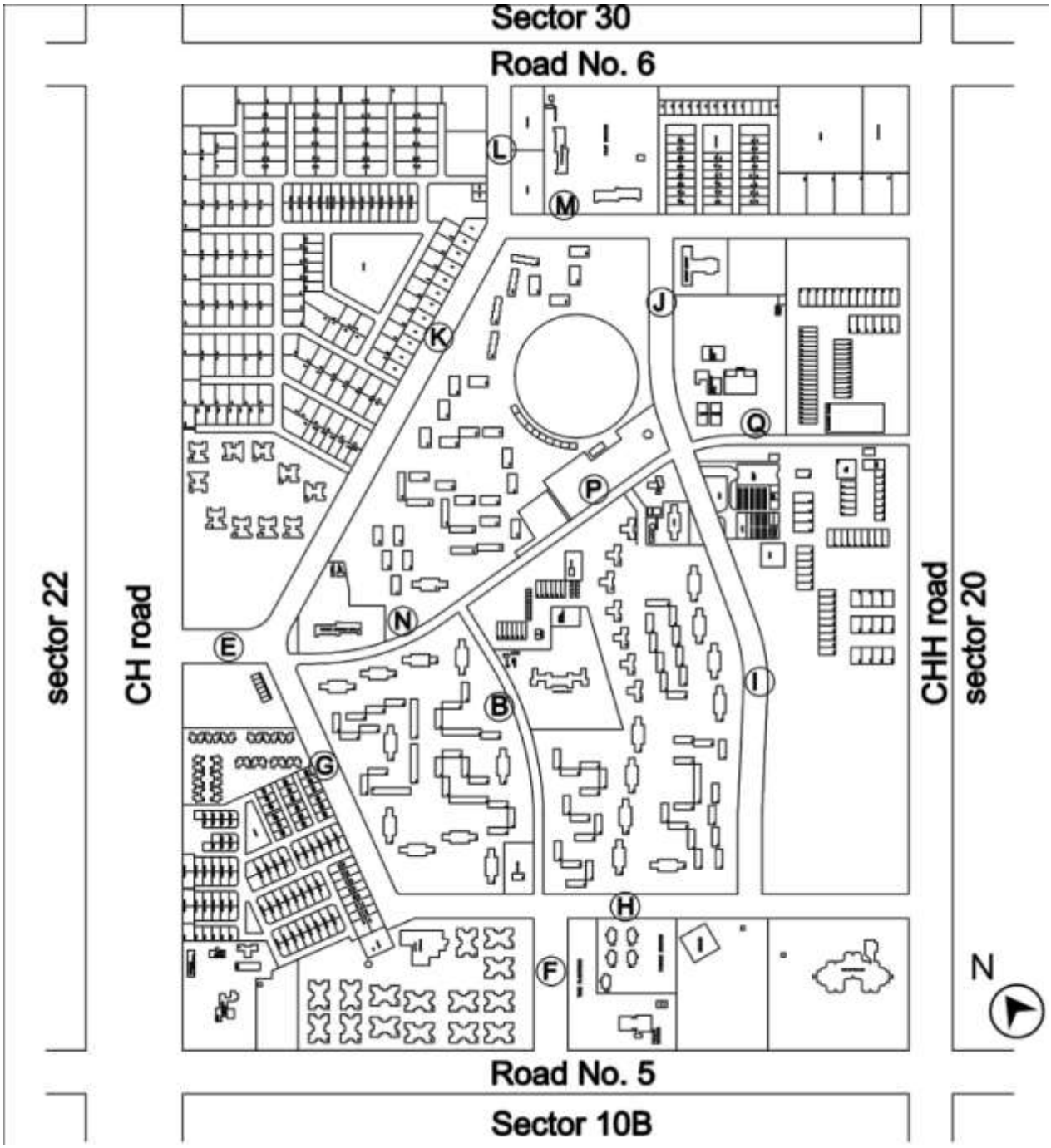
Annexure 5

1. Gandhinagar city plan

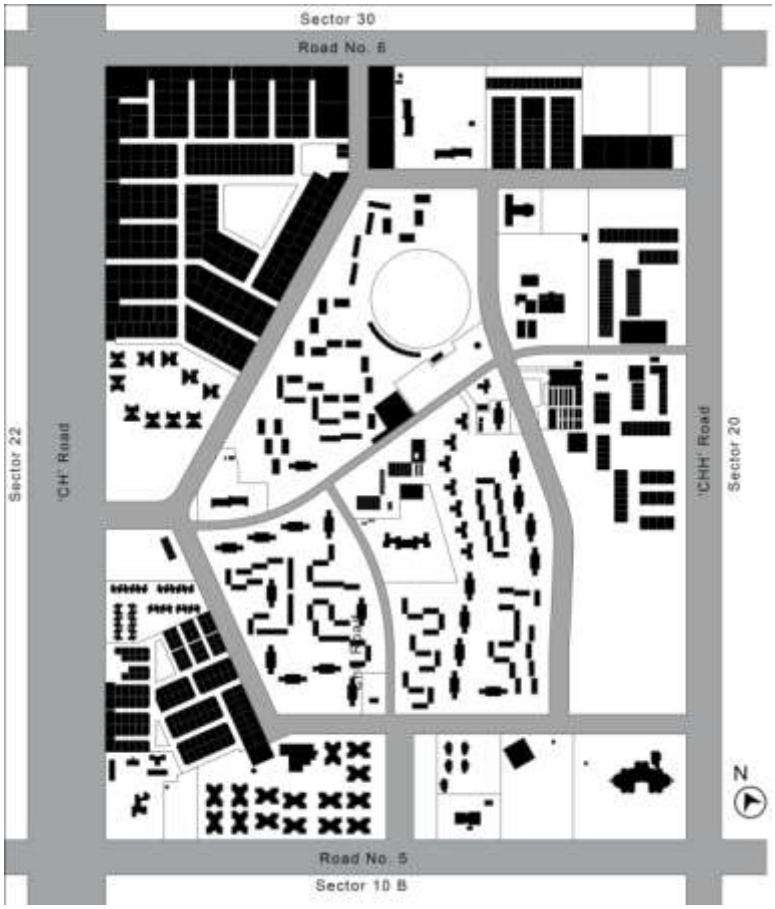


City plan

2. Detailed analysis of sector 21



3. Sector 21 plan showing built v/s open



Existing Site : Sector 21

Existing Site : Sector 21

Existing Site : Sector 21

Area of the sector - 75.70 hectare

Ground coverage - 13.08 hectare (16.65% of the total sector area)

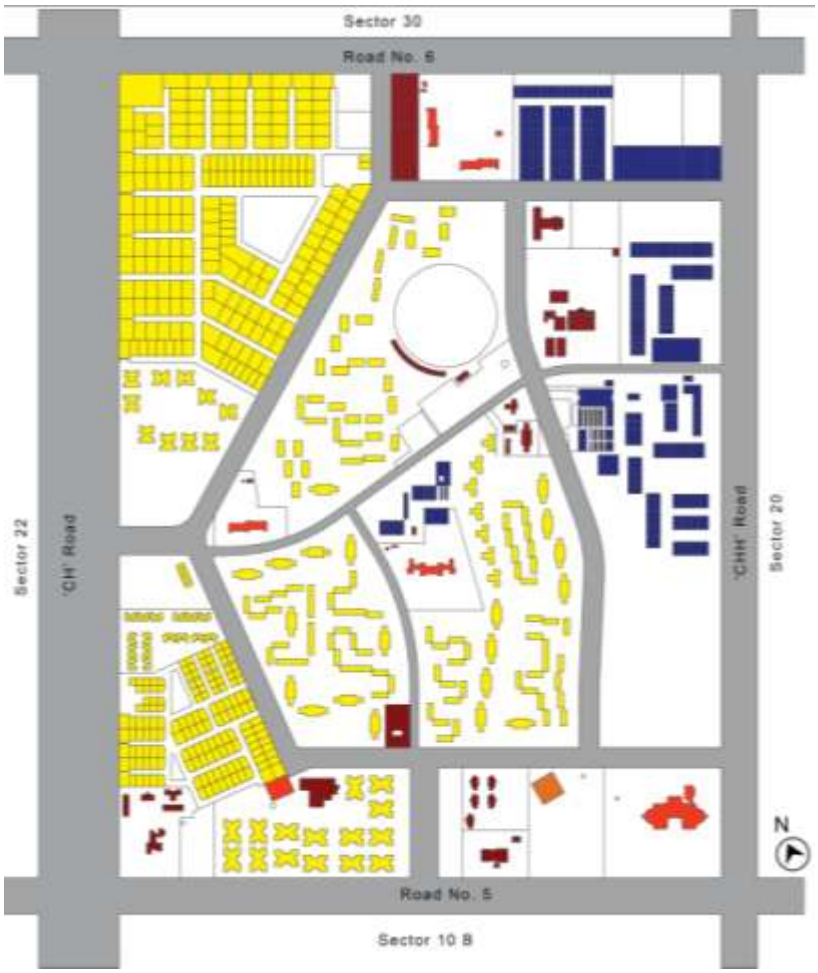
Open area - 59.28 hectare (78.30% of the total sector area)

Roads:

Primary Area - 9.82 hectare (excluded from sector area)

Secondary Area - 3.12 hectare (4.12% of the total sector area)

4. Sector 21:Land use plan



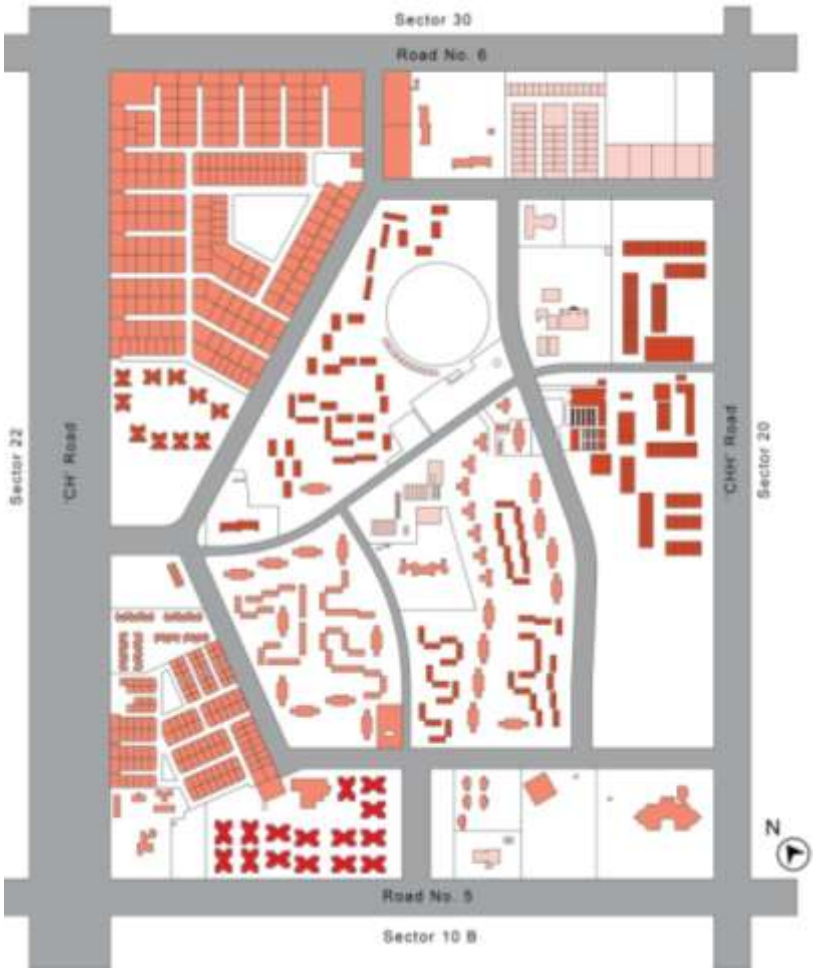

Existing Site : Sector 21


Existing Site : Sector 21


Existing Site : Sector 21

Residential	8.35 Hectare (11.03%)	
Commercial	2.86 Hectare (3.77%	
Amenties	0.70 Hectare (0.92%)	
Religious	0.44 Hectare (0.27%)	
Institutional	0.73 Hectare (0.66%)	

5. Sector 21: Building height plan



Existing Site : Sector 21

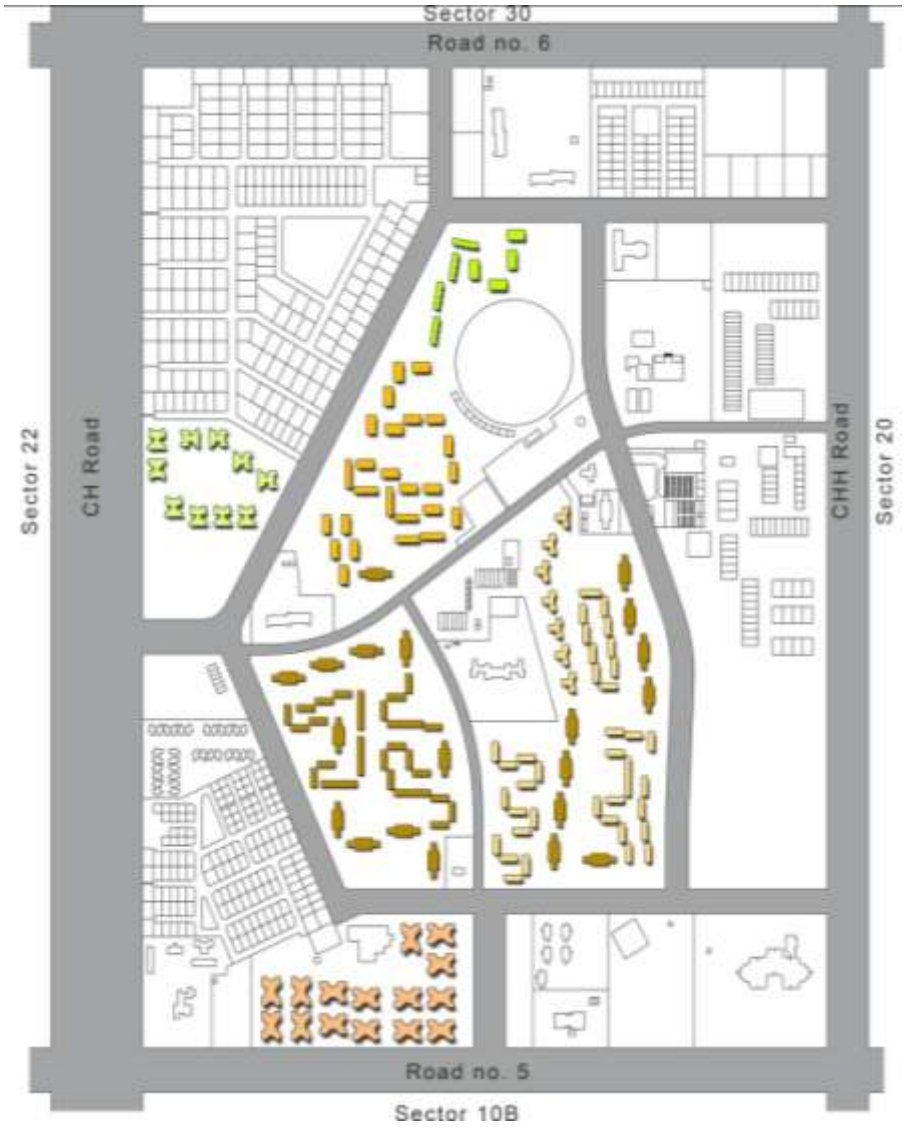
Existing Site : Sector 21

Existing Site : Sector 21

G Floor	1.56 X 1 = 1.56 ha	
G+ 1Floor	6.48 X 2 = 12.96 ha	
G + 2 Floor	4.17 X 3 = 12.51 ha	
G+ 3 Floor	0.51 X 4 = 2.04 ha	

Total built up area of the sector = 29.07 ha

6. Sector 21: Building type and building area



Type of Building

J TYPE	
GH TYPE	
CHH TYPE	
CAT III	
CH TYPE	
MLA FLATS	

7. Sector 21: Dwelling unit area

Details	J Type	GH Type	CHH Type	CAT III	CH Type	MLA Flats	Total
Total No. of D	280	98	377	120	110	180	1165
Area of a sing unit	41 sq.M	51 sq.M	51 sq.M	56 sq.M	71.6 sq.M	180 sq.M	
No. of block	47	8	45	10	26	15	115
No. of floor	2	3	3	3	3	4	
Total area of type	10419.3	1515.22 sq.I	6345.79 sq.M	2779.58 sq.M	4652.82 sq.M	6525.6 sq.M	3.223ha
Terrace area	5209.68	757.61 sq.M	3172.89 sq.M	1389.79 sq.M	2326.41 sq.M	3262.8 sq.M	1.611ha

8. Building electric appliances detail:

J TYPE

APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	3	8	1.2
FAN	0.08	3	8	1.92
BULB	0.06	3	8	1.44
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				9.91 KILOWATT HOUR/DAY

CAT. III TYPE

APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	4	8	1.6
FAN	0.08	3	8	1.92
BULB	0.06	4	8	1.92
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				10.79 KILOWATT HOUR/DAY

GH TYPE

APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	5	8	2
FAN	0.08	4	8	2.56
BULB	0.06	4	8	1.92
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				11.83 KILOWATT HOUR/DAY

CH TYPE

APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	5	8	2
FAN	0.08	4	8	2.56
BULB	0.06	5	8	2.4
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				12.31 KILOWATT HOUR/DAY

CHH TYPE

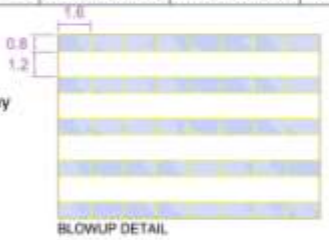
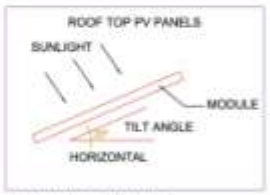
APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	3	8	1.2
FAN	0.08	3	8	1.92
BULB	0.06	3	8	1.44
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				9.91 KILOWATT HOUR/DAY

MLA FLAT

APPLIANCE	KILOWATT	QUANTITY	HOURS	TOTAL
TUBELITE	0.05	5	8	2
FAN	0.08	4	8	2.56
BULB	0.06	6	8	2.88
TV	0.11	1	5	0.55
REFRIGERATOR	0.2	1	24	4.8
TOTAL				12.79 KILOWATT HOUR/DAY

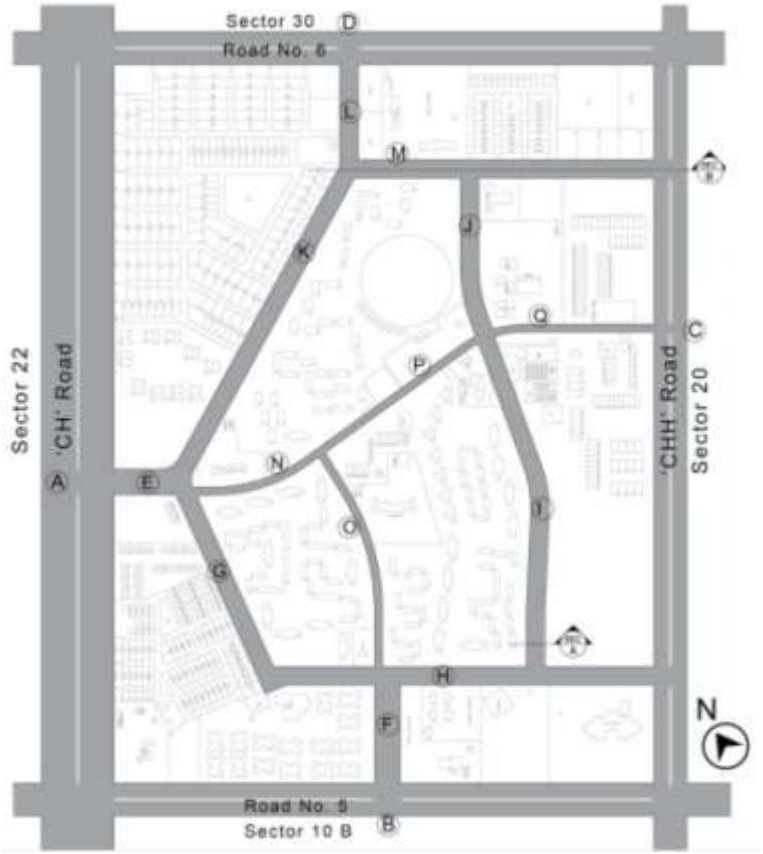
9. Energy consumed and Generated through PV modules

Anticipated Arrey Consumption

Details:-	J Type	GH Type	CHH Type	CAT III	CH Type	MLA FLATS	TOTAL
Energy Consumption of single unit	9.91 kwatt hour/day	11.83 kwatt hour/day	9.91 kwatt hour/day	10.79 kwatt hour/day	12.31 kwatt hour/day	12.79 kwatt hour/day	67.540 kwatt hour/day
Energy Consumption of a blocks type	9.91 x 280 = 2774800 kwatt hour/day	11.830 x 98 = 1159340 kwatt hour/day	9.91 x 377 = 3736070 kwatt hour/day	10.79 x 120 = 1294800 kwatt hour/day	12.31 x 110 = 1354100 kwatt hour/day	12.790 x 180 = 2302200 kwatt hour/day	12621.310 KW hour/day
Taking a PV panel module of 170 watt peak It will produce 2.8 times of energy than its rated watt peak Therefore, energy produced by one module = 170x 2.8 = 476 watt hour/ day Size of PV Module = 1.6 m x 0.8 m Distance between to array = h x 1.5 = 0.8 x 1.5 = 1.2 m Area occupied by single module = 3.21 sq m Tilt angle of 23 degree facing south	 BLOWUP DETAIL					 PV PANEL TILT ANGLE	
No. of Roof Top PV can be installed on a block type	5209.68/3.21 = 1622	757.61/3.21 = 236	3172.89/3.21 = 988	1389.79/3.21 = 432	2326.41/3.21 = 724	3262.8/3.21 = 1016	5018 Total No. of PV Modules
Energy Generation for a block type	1622 x0.476 = 772.072 kwatt hour/day	236 x 0.476 = 112.336 kwatt hour/day	988 x 0.476 = 470.288 kwatt hour/day	432 x 0.476 = 205.632 kwatt hour/day	724 x 0.476 = 344.624 kwatt hour/day	1016 x 0.476 = 483.616 watt hour/day	2388.568 KW hour/day

Energy generated through PV Modules

10. Sector 21 Plan Showing Road Network

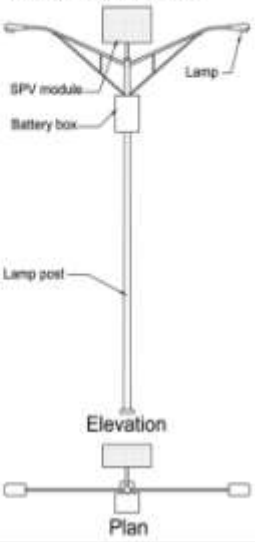
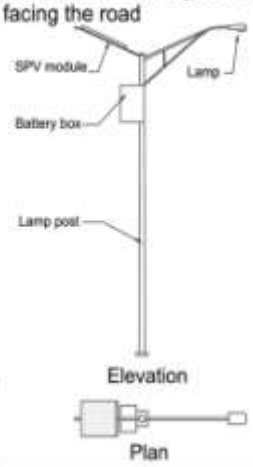


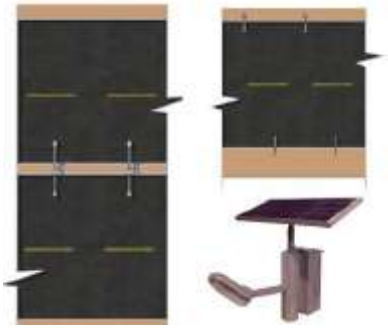
Road section

Section AA

Section BB

Sector 21 Road width and Road length

Details:-	Nomenclature	Width (M)	Length (M)	No. of street lights	Type
PRIMARY ROADS	A	100	1000	120	(1)- Centrally placed, one pole with two light sources, facing either sides of the road 
	B	45	750	88	
	C	45	1000	118	
	D	45	750	88	
SECONDARY ROADS	E	35	86	20	(2)- Placed on the edge of the road, alternately on each side, one pole with one light source, facing the road 
	F	35	137	34	
	G	25	304	76	
	H	25	530	132	
	I	25	470	117	
	J	25	218	54	
	K	25	475	118	
	L	25	133	33	
	M	25	416	104	
	N	10	172	43	
	O	10	312	78	
	P	10	264	66	
	Q	10	224	56	
TOTAL SOLAR STREET LIGHTS-				Type (1)- 414 Type (2)- 931	



11. Solar PV arrays at sector 21

Site Section BB

Site Section AA

Site plan

Schematic View

Schematic View

Sector 21 plan

Area of the Farm - 32523.0 sqm

Area for SPV Array installation - 26146.15 sqmt.

No. of SPV modules - 5760

Power generated by the farm- 0.476 x 5760 = 2741.76 KWH/day

12. Central vista

Site Section

View

View

View

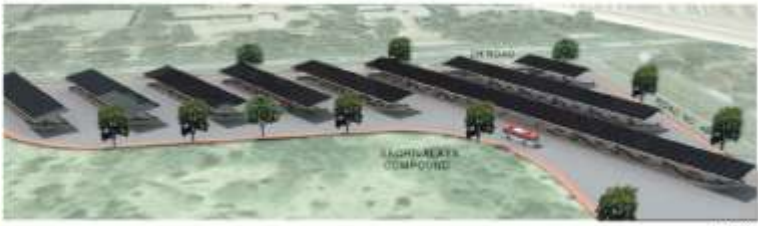
Part Plan : Central vista- Solar installation @ 3500 kV

View

View

View

13. Bus station



View

Site plan of pick up bus stop near Sachivalaya

View

Existing Site

Site section

14. Solar array installation at pickup bus stop

View

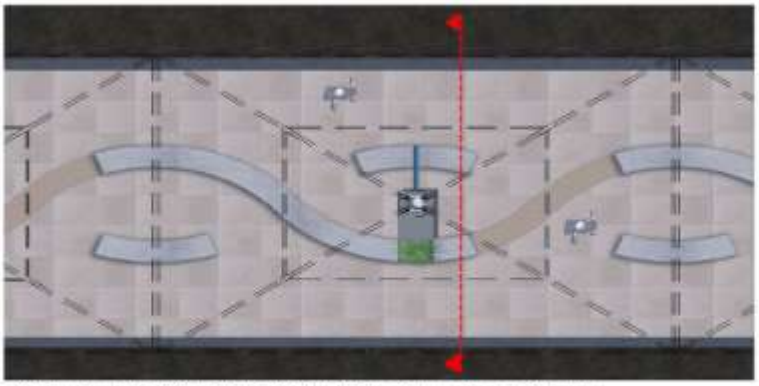
Typical plan of pick up bus stop near Sachivalaya at 3500 lvl

Existing View at Gandhinagar

View

Ariel View Of Bus stop

TYPICAL CROSS SECTION OF PICK UP BUS STOP NEAR SACHIVALAYA



TYPICAL PLANOF PICK UP BUS STOP NEAR SACHIVALAYA AT-1200 LVL

VIEW

Annexure 6

The two water supply schemes namely Charedi water works and Sarita Udyan water works are supplying water to Gandhinagar city.

Charedi water works having capacity of 30 million litres a day (MLD) is major one and the water source for this station is from Narmada canal water. The off take point is at Karai near Koba which is situated at a distance of 15 km from the head works. Water is drawn through 2000 mm diameter MS pipe to the water treatment plant maintained by Gujarat Water Infrastucture Limited (GWIL). The filtered water is sent to 5 number of clear water sump (maintained by Roads and Building Department) each of 8.25 lakh gallon capacity. From clear water sump water is pumped to overhead tanks by centrifugal pumps.

Sarita Udyan water works is the newly commissioned pumping statio, to agument the watrer requirement of growing population. The installed capacity of this plant is 15 MLD. The wwater source for this installation is also from the Narmada canal water, the take off point is located at a distance of 12 km from the head works. Water is drawn through a 750 mm diameter MS pipe to the water treatment plant maintained by GWIL. After filtration water is sent to 3 numbers of clear water sumps each of 8.25 lakh gallons capacity.

City water demand

As stated above the installed capacity is about 45 MLD however metered water supply is found to be 42.81 MLD, which is 95% of the installed capacity.

Pumping details of water supply schemes

Charedi pumping station has six pumps each of 135 kW rating, two pumps of 150 kW and one pump of 450 kW rating and at Sarita Udyan water works three pumps each of 450 kW hp are installed. All the pumps are centrifugal pumps. The water is first pumped to overhead tank and then from the overhead tank it flows down to the city by gravity. Details of pumps are given in Tables 1 and 2 below.

Table 1 Details of the pumps installed at water works in Gandhinagar

Sr. no.	Scheme name	Installed pumps	Running +stand by
1	Charedi water works	9	6 running, 3 stand by

2	Sarita Udyan water works	3	2 running, 1 stand by
	Total	12	8 running, 4 stand by

Table 2 Design specifications of the pumps

	Charedi water works			Sarita Udyan
Description	Pumps # 1,2,3,5 & 6	Pumps # 7 & 8	Pump # 9	Pumps # 1,2 & 3
Type	HSDC	Na	Na	SDB
Size	250HS4AA4-04	10 UP3M	Na	400/500B
Manufacturer name	Jyoti limited	Kirloskar	Na	Beacon Weir
Rated flow, lpm	16680	15600	Na	40200
Rated head, m	38	38	Na	55
Speed, rpm	1470	1450	Na	980
Installed motor, kW	135	150	450	450
Na: not available, pump 4 details are not available				

Operating schedule of pumps

At Charedi pumping station during normal operation five pumps each of 200 hp and one of 600 hp operate parallel for approximately six hours a day. At Sarita Udyan two out of three pumps operate approximately for 3-4 hours a day.

Energy consumption

Monthly electricity bills of the two stations were collected for last one year and bill audit revealed that the average yearly peak demand which is the average of each month registered peak demand stands at 1090 kW as against the maximum peak demand recorded of 1296 kW at Charedi pumping station. However at Sarita Udyan the average peak is found to be 1047 kW as against the maximum recorded peak of 1101 kW. The combined peak of water pumping based on the data available could be estimated as 2400 kW.

The total annual energy consumption of these two pumping stations is approximately 3.53 milion units out of which Charedi water works accounts for 69% and remaining 31% energy is consumed in Sarita Udyan pumping station. Details of monthly energy consumption are given in Tables 3 and 4 below.

Table 3 Energy consumption details at Charedi water works

Month	Contract demand, kW	Billing Demand, Kw	PF	Energy Consumption (kWh)
Oct-05	1200	1223	0.93	236110
Nov-05	1200	1199	0.92	200030
Dec-05	1200	1198	0.9	196580
Jan-06	1200	1209	0.91	191200
Feb-06	1200	1084	0.89	152280
Mar-06	1200	1298	0.9	174200
Apr-06	1200			
May-06	1200	1169	0.91	197630
Jun-06	1200	1235	0.9	178450
Jul-06	1200			
Aug-06	1200	1130	0.9	163570
Sep-06	1200	1172	0.89	160460

The total annual energy consumption, assuming average consumption for the months where data is not available is, 2.22 million units.

Table 4 Energy consumption details at Sarita Udyan water works

Month	Contract demand, kW	Billing Demand, kW	PF	Energy Consumption (kWh)
Oct-05	1000	1015	0.95	111380
Nov-05	1000	1063	0.94	108790
Dec-05	1000	1029	0.93	110560
Jan-06	1000	1101	0.93	111950
Feb-06	1000	1000	0.93	98490
Mar-06	1000	1048	0.93	112350
Apr-06	1000	1012	0.93	105460
May-06	1000	1093	0.93	115040
Jun-06	1000	1038	0.93	107110
Jul-06	1000	1074	0.93	112760
Aug-06	1000	1060	0.93	112210
Sep-06	1000	1038	0.94	117640

The total annual energy consumption is 1.32 million units. Thus the total energy consumption in the Charedi and Sarita Udayan water works is 3.54 million units.

Electricity tariff

The energy tariff structure applicable to both Charedi and Sarita water works is under H.T. category. A brief energy tariff structure of these pumping stations is given below:

Service no. : HT-501 & HT-556

Present Contract Demand: 1200 kW and 1000 kW

Demand charges: Rs.140/kW

Energy charges: Rs 3.32 per kWh

Energy cost

The total annual energy cost for the period October 2005 – September 2006 for the above pumping stations is Rs 164.57 lakhs. Rs 101.13 lakhs and Rs 63.54 lakh have been paid for Cheradi and Sarita pumping stations respectively.