



Gandhinagar: A Solar City

Gujarat Energy Development Agency, Gandhinagar.

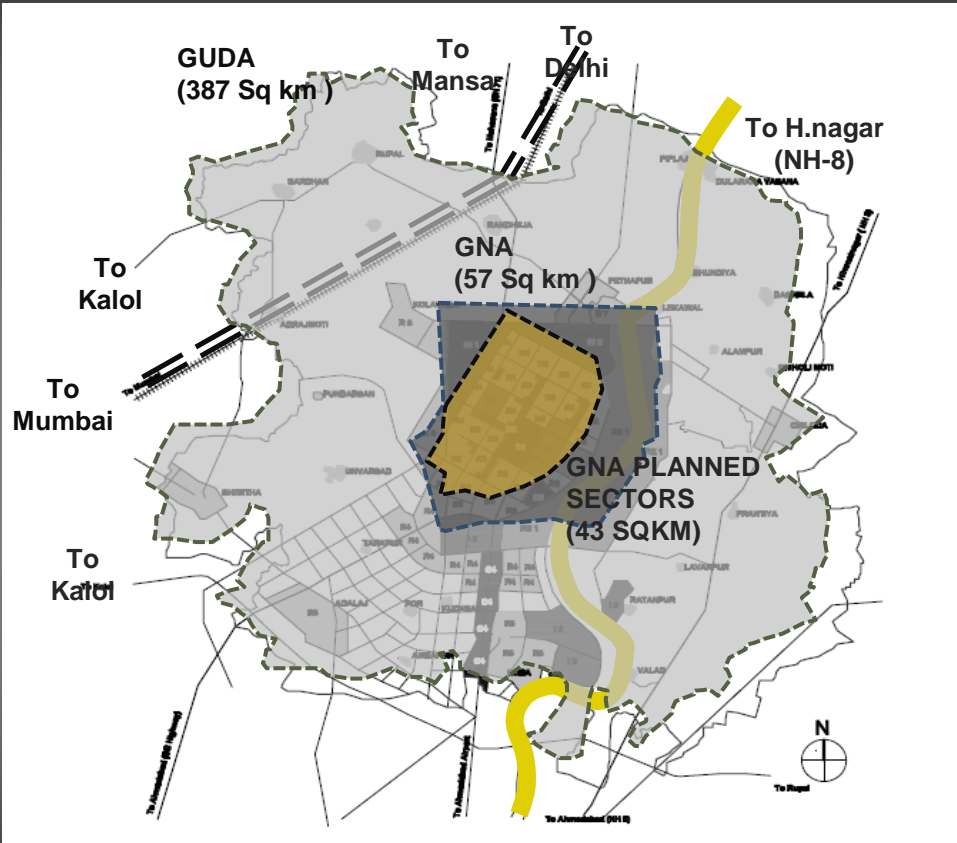
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Gandhinagar City Profile

Gandhinagar is the Capital City of Gujarat.

- Situated along bank of Sabarmati River at 23.22°N & 72.68 ° E
- Primarily an Administrative City
- Capital functions shifted from Ahmadabad to Gandhinagar in 1960's
- Climate of Gandhi Nagar: Summer: 43 °C - 25 °C
Winter: 27 °C - 12' C



	GUDA	387 Sq km
	GNA	57 Sq km
	GNA Planned Sectors	47 Sq km

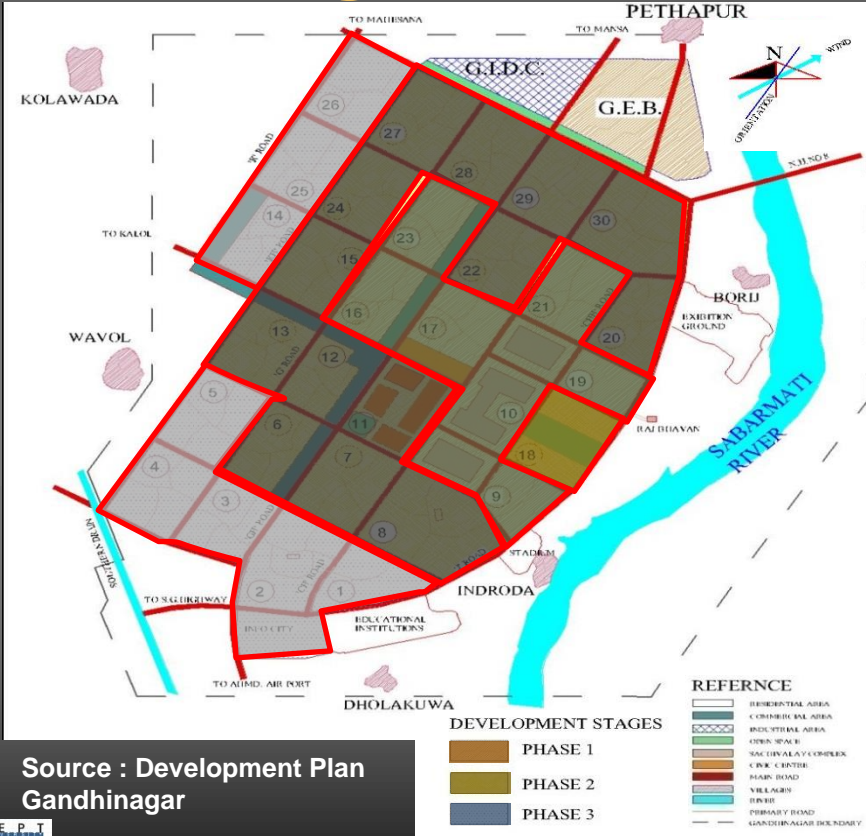
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Densification of Residential Sectors of Gandhinagar



Source : Development Plan Gandhinagar

1967-1980

1st phase - northern sectors sector 9,11,12,15,16,17,19,20,21,22, 23,28,29 & 30.- residential 17-part of Civic Center, 16-city level commercial are, 12-civil Hospital and sector 11-the City Bus Terminus and Pathika Ashram.

1981-1990

2nd phase, Gujarat Housing Board and need for allotment of land to MLA"s/MP"s. sectors 6,7,8,13,24 and 27. Development of industries both services as well as electronics also took place.

1991-2004

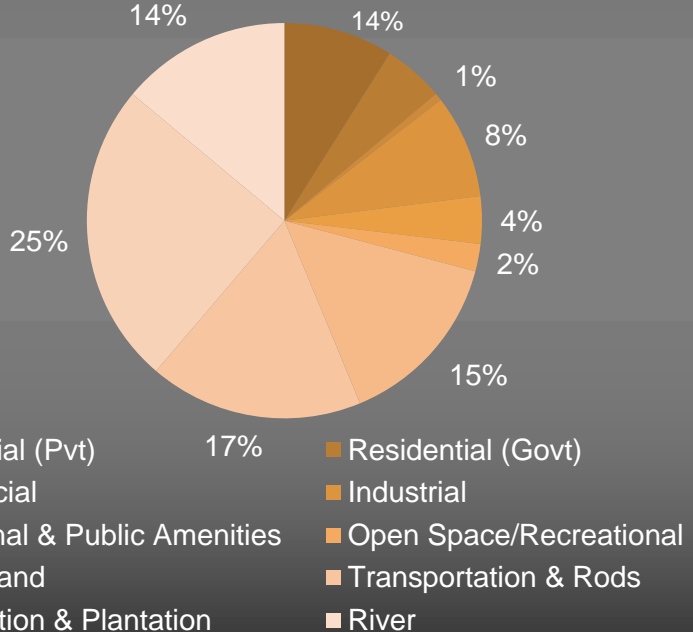
3rd phase- sectors 25 & 26
 During this phase, all the area towards Ahmedabad i.e. southern sectors were developed, sectors 1,2,3,3A, 4,5,14,25 & 26



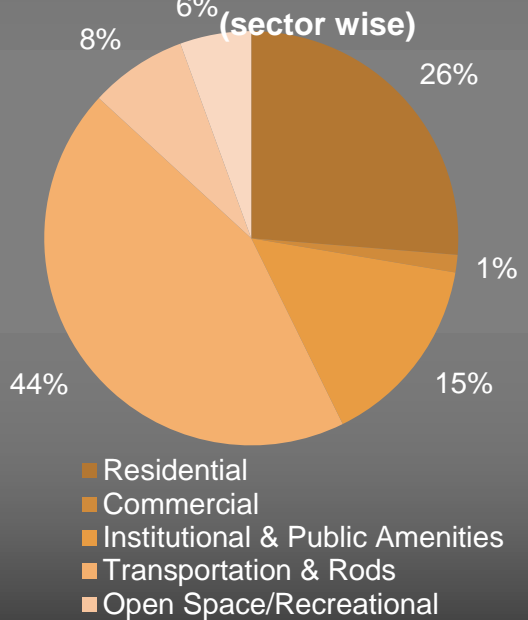
Density & Land Use – Gandhinagar

INDICATOR	GNA	PLANNED AREA
Population (2001 Census)	1,96,000	1,70,000
Area	5738 HA	2150 HA
Gross Population Density (PPH)	34	80
Net Residential Density (PPH)	245	310

Land Use - GNA



Land Use - Planned Area



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Developing Gandhinagar as Solar City

GoI Definition: reduction in conventional energy consumption by **5 years by min.10%** through use of renewable energy resources and implantation of energy conservation measures in equal proportion .

MNRE's financial support to Gujarat Energy Development Agency for preparing a Master Plan for developing Gandhinagar

A Solar City Cell at Gujarat Energy Development Agency.

In Principal approval from MNRE to Develop Gandhinagar as Solar City

Developing Gandhinagar as Solar City

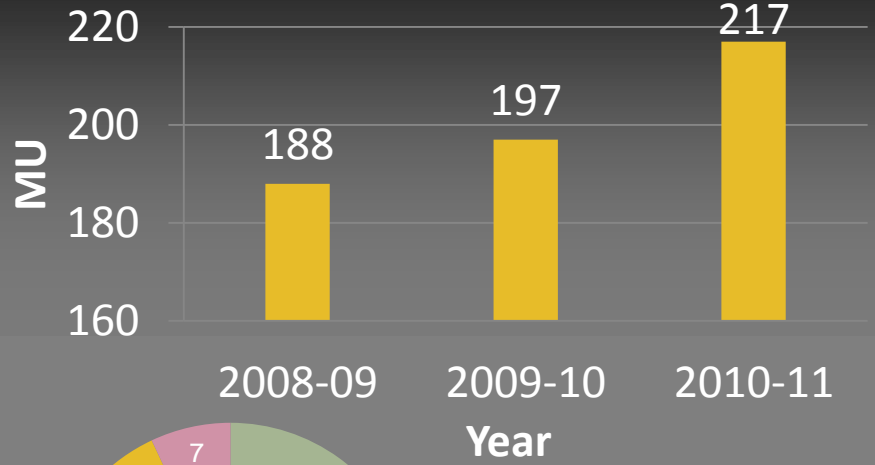
Preparation of Master Plan Solar city

Master Plan preparation process is divided in five steps :

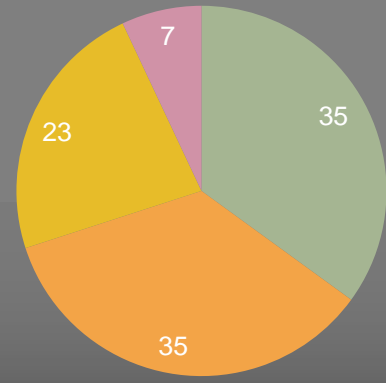
- Preparing Energy Base line
- Demand Forecasting for 2013-2018
- Sector wise Strategies
- Action Plan
- Financial Outlay and sharing of fund

Energy baseline status of Gandhinagar

	Electricity Consumption (MU)			
Year	2007-08	2008-09	2009-10	2010-11
Residential	40.94	43.24	45.31	49.91
Commercial	12.46	13.61	13.79	15.19
Industrial	62.3	65.8	68.95	75.95
Government	62.3	65.8	68.95	75.95
Total	178	188	197	217



Government & Industrial sector dominates (67%) – Target DSM



Sector wise Break up of Electricity Consumption

- Industrial (35%)
- Government (35%)
- Residential (23%)
- Commercial (7%)



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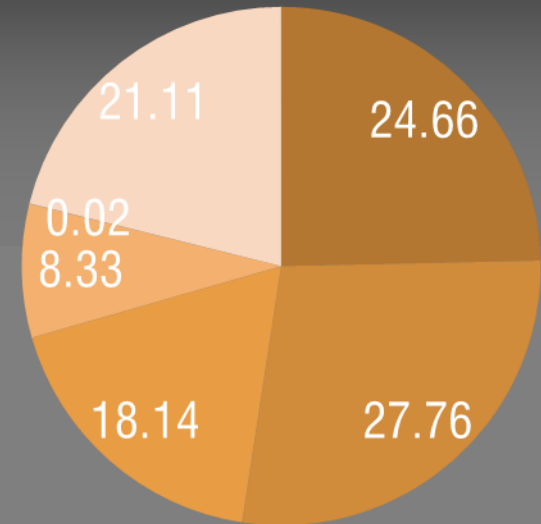
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Supply side energy balance

Source	Consumption (2009-2010)	Consumption (2010-2011)	Unit	Consumption (MU)
Electricity	197	217	MU	217
LPG	15534789	16800318	Kgs	244.26
Petrol	16272	17292	KL	159.60
Diesel	16763	20124	KL	185.74
Kerosene	7537.37	7937.32	KL	73.26
CNG	9526	9720	Kgs	0.14
			Total	880

Electricity and LPG are the major sources of energy consumed in the city and needs attention for effective and optimal use through energy efficiency measures, DSM and application of renewable energy resources.

Energy Consumption



- Electricity
- LPG
- Petrol
- Kerosene

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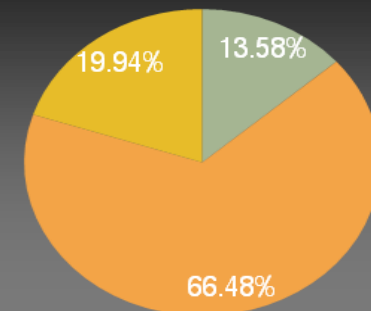
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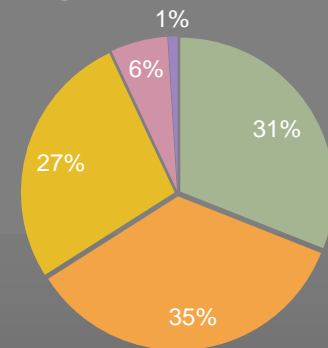
Residential sector

Primary sources energy consumption



Source	Energy Consumption	
	2009 – 2010	2010-2011
Electricity (MU)	45.31	49.91
LPG (Kgs)	15534789	16800318
Kerosene (KL)	7321.14	7937.32

Electricity LPG kerosene



Apartment / flat Independent house Row house

GSPC GAS provides Piped Natural Gas (PNG)

Presently, GSPC GAS supplies PNG to following major areas of Gandhinagar State:

6,75,000 cu.m. per month during 2011-12. present coverage 45,000 households

Sample Survey of Residential Sector :Housing Universe at Gandhinagar

Type	Universe	Coverage	Sample House for Survey .No. of households	Coverage
Government	16405	38.6%	447	2.72%
Private	21957	51.7%	388	1.77%
GHB	4109	9.6%	106	2.58%
Total	42471	100%	941	2.22%

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Based on the preliminary finding , residential sector

Categories	No. of house	Area Allotted	Energy Consumed per year (kWh)
Higher Economic category (HEC)	15701	130 SQ. Mtr or more	1,33,13,869 (1.33 L)
Middle Economic Category (MEC)	16144	61 TO 129 Sq.Mtr	1,88,51,504 (1.88L)
Low Economic Category (LEC)	15701	60 Sq. Mtr or below	1,42,47,987 (1.42 L)

***Total energy consumption in residential sector:
49.91 MU***

Source : Teri : project report – integration of action plan to make Gandhinagar a solar city , 2007.

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Use of Energy Devices

The common devices use in all this categories
NORMALISED OVER YEAR

Tube lights	7.6 hrs /day
Bulb	5.9. Hrs /day
Fan	13.2 hrs /day
TV	7 hrs /day
Fridge	365 x 24
Room cooler	9.1 hours/day.
Window AC	5.1 month /year i.e. @ 6.8 hrs/day.
Electric iron	1hrs/day
Washing machine	5 days /week i.e. 2.7 hours /week

Their differences across economy categories are as follow:

- HEC and LEC use operate tube lights for 7.8 hrs /day each, while MEC does it for 6.9 hrs /day.

- MEC and LEC bulb for 5.3. Hrs /day each, HEC uses it for 6.9 hours /day.

- The differenced in fan use /day are not very significant. It varies from 13.2 hrs/day for HEC to 12.1 hrs/day for LEC.

Commercial sector

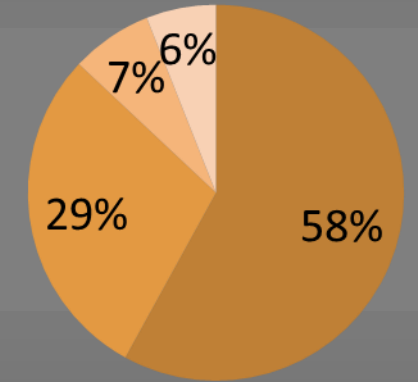
The number of electricity connections to commercial customers is 6998 which includes commercial complex, market and small establishments and offices

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

Shopping Complex – case study

In office building the maximum load is contributed by :

- Space cooling (ceiling fan , pedestal fan , window air conditioner and split units) which accounts for 58%
- Lighting (florescent lamps , CFL etc .) for 29%
- Office equipments (computer , photocopy etc) 7% a
- Remaining 6% is contributed by other (toilet exhausts , water coolers)



- Space Cooling 58%
- Lighting 29%

Total energy consumption in Commercial sector is 15.19 MU (2010-11)

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Municipal sector

Municipal service includes government building and the services such as street lighting , water pumping plants and Waste water treatment plant .

Old Sachivalay complex

- The old Sachivalay building has both HT and LT supplies..
- The total annual electricity consumption is estimated to be approximately **2540000 kWh** based on the electricity bills.
- HT supply accounts for 70 % and LT for remaining 30% of the total annual consumption.

Overall Municipal Sector Energy Consumption

(MU)	2008-09	2009-10	2010-11
Municipal Buildings	65.8	68.95	75.95
Pumping Station	---	----	3.54
Street lights	---	----	1.47

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.

Electronics and Textiles have been the main sectors of investment and employment in Gandhinagar district .

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

Total energy consumption in Commercial sector: 75.95 MU

City Wide Green House Gas Inventory

Sectors	GHG's (tCO ₂ e)	Sources of emission
Residential	83772.01	64% from electricity and 22.5% from cooking gas
Commercial	34644.74	52.7% from electricity and 43% from CNG
Industrial	5288145.16	99% from coal (GTPS)
Government	18187.21	

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Waste to Energy: Resources

Solid Waste management in Gandhinagar is a pressing issue and has deficiencies.

Solid waste collection is done for government owned and privately owned areas.

The agency responsible : Gandhinagar Notified Area Committee

Liquid Waste generation in Gandhinagar City	50 to 60 MLD
Solid waste generation in Gandhinagar City	60 tonnes per day.
Solid waste generation in Gandhinagar Notified area	12 tonnes per day

- It is planned to harness the above for energy generation.

Energy Demand Forecast for Gandhinagar

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

Population projection of GNA

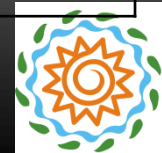
Year	2009	2016	2021	2031
Population	309684	407523	495814	733925

The table given below illustrates the projected values for the period between 2013 and 2018 – with linear growth projection. The projection has been done based on the past data.

					Projected Data	
Year	2007-08	2008-09	2009-10	2010-11	2013	2018
Electricity (MU)	178	188	197	217	275.5	373
LPG (kg)	15696	15910	16128	16800	17472	17632
Petrol (kL)	14232	15252	16272	17292	18312	19332
Diesel (kL)	10041	13402	16763	20124	23485	26846
CNG (kG)	9138	9332	9526	9720	9914	10108
Kerosene (kL)	7228.32	7628.32	7878.32	7993.32	8143.32	8258.32

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Renewable Energy Strategies for Gandhinagar

- To identify the potential of renewable energy sources for Gandhinagar city.
- Identifying most techno economically viable renewable energy options .
- Target to meet at least 5% energy consumption form renewable energy.

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.

Solar Street Lighting/ Power Plants:

▪ Power generated from solar photovoltaic system can be utilized for supplying power to CFL in street lighting as well as homes, traffic signals and also be fed into the grid.

Wind Energy :

▪ 10 KW Wind-Solar Hybrid system installed at Udyog Bhavan roof-top since 2009. The total installed capacity could be 43 MW.

Biomass resources

Specification	Values	Units
Total No. of Trees	1,23,59,487	Nos .
25% of the total trees (potential)	3089872	Nos.
Biomass	308987	Tons/ Year
Equivalent Electricity	181757 (1.8L)	MWh/year
Average operation per day	10	H/day
Potential for power generation	50	MW

Wind Energy: Gujarat

The State of Gujarat with its longest coast line in the country and inland windy sites has a potential of over 10,000 MW of Wind Power.

Last more than 25 years more than 65 sites have been monitored for the wind speed and wind power density, and over 50 sites have been found feasible for harnessing of the Wind Power.

Year	During the Year, MW
Upto March 1998	89
2002-03	6
2003-04	19
2004-05	52
2005-06	85
2006-07	284
2007-08	616
2008-09	314
2009-10	297
2010-11	313
2011-12	790
2012-13	208
2013-14	280
TOTAL	3352

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



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5MW Rooftop programme

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

- 4 MW: Government Buildings (80%)
- 1 MW: Private Buildings/Homes (20%)

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.



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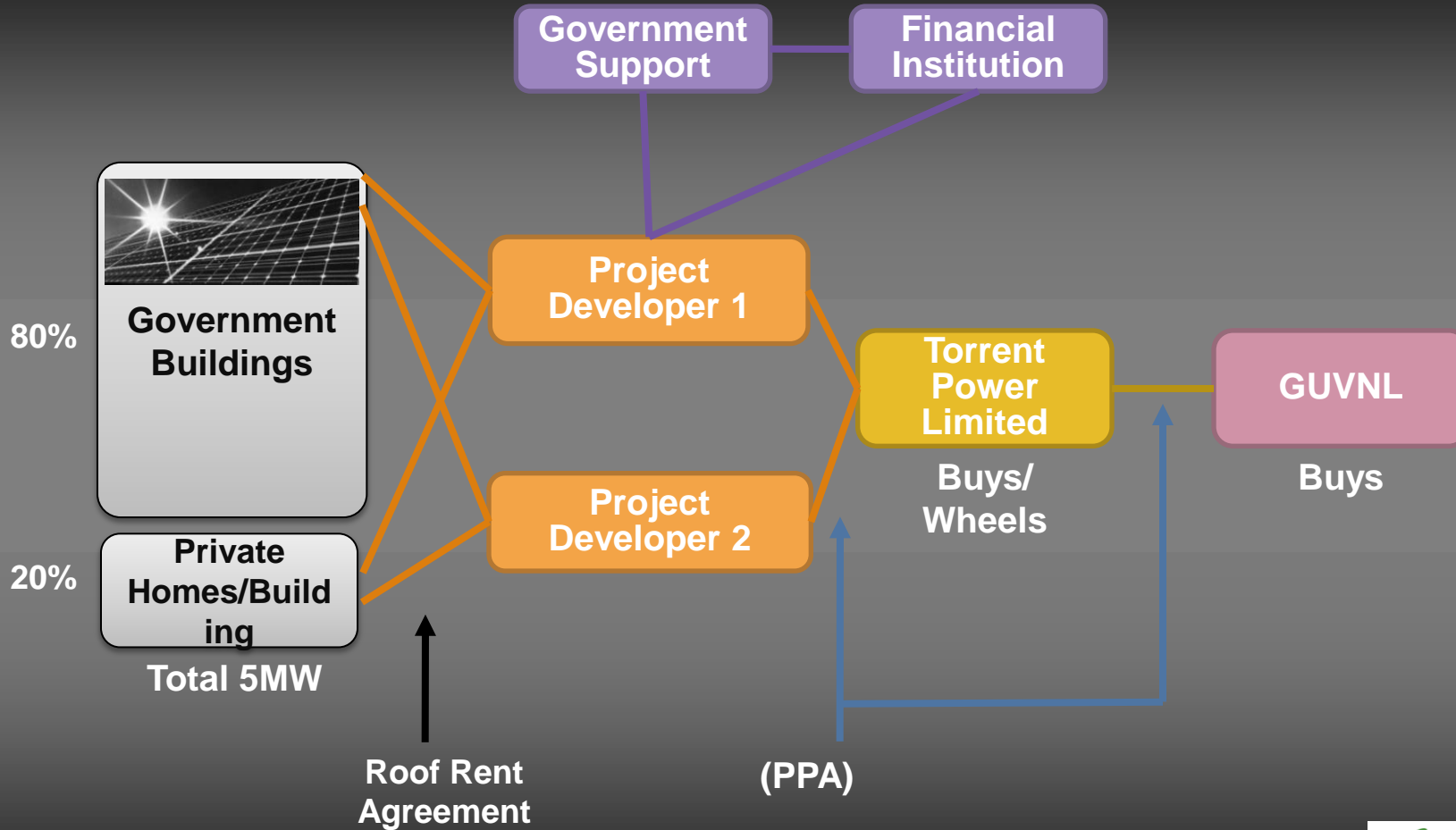
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Sector	Household Rooftop (m ²)	Commercial/ Public/ Government (m ²)
1	49,043	
2	67,818	
3	33,112	
4	26,377	
5	20,572	
6	31,121	
7	52,042	
8	56,811	16,867
9	11,814	11,467
10		69,263
11	1,023	23,444
12	15,502	13,252
13	36,118	13,755
14	10,124	9,642
15		34,678
16	8,100	11,889
17	2,331	9,968
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	

Available "fraction" of net "shadow-free" area.

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	

Programme Architecture



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Actions Taken So Far- Implementing Renewable Strategies

Sr.No	Activity	Year	Cost (Rs. In Crore)	Savings in lac kWhp
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 Replacement of Old pumps at Chharedi Water works	2008-09	Funding by BEE, R & B	3.00

Actions Taken So Far- Implementing Renewable Strategies

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

Actions Taken So Far- Implementing Renewable Strategies

Sr.No	Activity	Year	Cost (Rs. In Crore)	
2010-11: MNRE accorded "in-principle" approval to develop Gandhinagar city as a Model Solar City				
1	<ul style="list-style-type: none"> ➤ 1 MW Solar Power Plant at Ash Dyke of Gandhinagar Thermal Power Station. ➤ 1,310 kW – 19 nos. Grid connected SPV systems installed on various Government buildings, which includes EQDC, Police Bhavan, GSCS, GSLDC, Rajbhavan, GPCB, Govt. Press etc. 	2011-12	42.71	
2	➤ 5 MW Gandhinagar Rooftop Programme	2012-13	Developer	
3	➤ 555 kW – 6 nos. Grid connected SPV systems installed on various Government buildings, which includes Govt. Library, ISR, SSA, GFS University, BISAG, GWRDC	2013-14	4.97	

Savings through RE strategies

Savings in residential sector per year	SHW – savings in electricity	Payback period	Cost of energy savings in lakhs	Emission reduction per year (tonnes)	Roof top PV-savings in electricity	Payback period	Emission reduction per year (tonnes)
For 28% residential houses	3770000 kWh	1.93	188.44	3770	4050000 kWh	7.6	4050

Savings in commercial sector per year	SHW – savings in electricity	Payback period	Cost of energy savings in lakhs	Emission reduction per year (tonnes)	Roof top PV-savings in electricity	Payback period	Emission reduction per year (tonnes)
For 1 Hotel	3150 kWh	13	24538	5	7500 kWh	10	7
For 1 Restaurant	878.76 kg (LPG)	3.07	35150		7500 kWh	22.85	7.5
For 1 Hospital	47250 kWh	1	330750	47	15000 kWh	2.5	15

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Savings through RE strategies

Energy generation in municipal sector per year	SHW – savings in MU	Payback period	Cost of energy savings in lakhs	Emission reduction per year (tonnes)	Roof top PV for electricity generation	Payback period	Emission reduction per year (tonnes)
	-	-	-	-	6240000 kWh	3.15	6240

Energy generation in industrial sector per year	SHW – savings in MU	Payback period	Cost of energy savings in lakhs	Emission reduction per year (tonnes)	Roof top PV for electricity generation	Payback period	Emission reduction per year (tonnes)
	-	-	-	-	33880000 kWh	3.15	32

Savings through EE strategies

Implementation of ECBC – GDCR update in GUDA Area

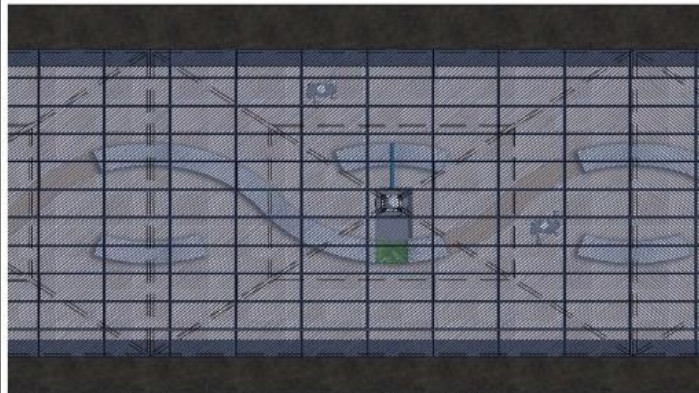
Energy Conservation	Replacement of HPSV 250 Watts lights with LED based lights of 75 Watts in Minister's Enclave.	Completed through R & B.
	Re-lamping with PS-MH200Wats lamps and suitable ballast.	Completed
	Replacement of 959 nos. bulbs by 11 W CFL in Government offices. Replacement/ installation of 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

- Replacement of 40 watt T8/T12 tube lights with T5 tube lights + Electronic Ballast
- Efficient ceiling fans to replace conventional ceiling fans
- Replacement of conventional air-conditioners with EE star rated ACs.
- Sensors for automatic on/off of street lights
- Power saver installation in pump house
- Proper pump-system design (efficient Pump, pumps heads with system heads.

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



View



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

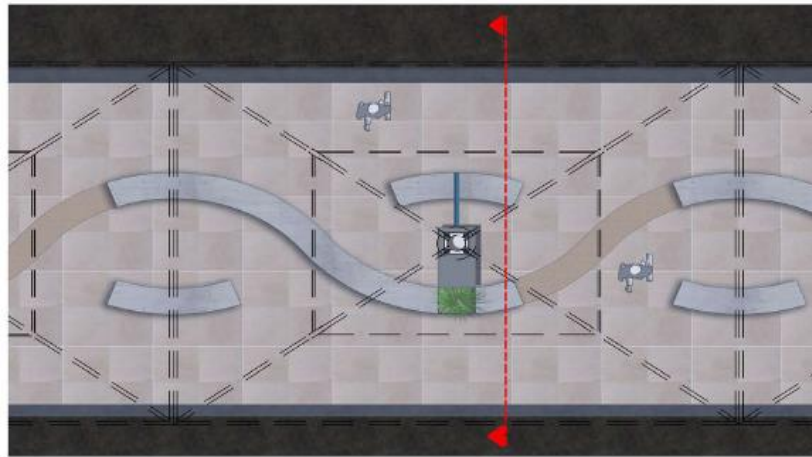


Existing View at Gandhinagar





TYPICAL CROSS SECTION OF PICK UP BUS STOP NEAR SACHIVALAYA



TYPICAL PLAN OF PICK UP BUS STOP NEAR SACHIVALAYA AT-1200 LVL



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Residential Sector

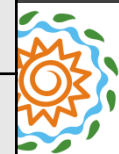
- In Residential Sector approximately 6MU of energy saving was recommended.
- To Conserve 6.01 MU energy in residential sector at the end of 5th year 42.62% residential households needs to be retrofitted.
- The retrofiting of 18102 households were recommended to achieved energy saving of 6.01 MU at the end of the 5th year.

Saving in existing households

This has been achieved via the following measures.

- Replacing all the tubular fluorescent lamps (CFL) of 48 watt/36 watt lamps
- electromagnetic ballast (copper chokes) to energy saving
- T-8 or T-5 TFL of 28 watt / 33watt and electronic ballasts .

Categories	No. of house	Energy Consumed per year without energy efficient options (MU)	Energy Consumed per year with energy efficient options (MU)	Savings (MU)
Higher economic category (HEC)	15701	13.31	9.3	4.01
Middle Economic Category (MEC)	16144	18.85	13.2	5.65
Low Economic Category (LEC)	16350	14.24	9.9	4.34



Commercial Sector & Industrial sector

The prime load centres in the sector are air-conditioning and lighting.

- Replace existing 40 W-TL & 36 W-TL with energy efficient T-5 lamps.
- Replace existing ceiling fans with energy efficient 50 W ceiling fans.
- Replace existing AC's with BEE labelled

The total load estimated for sample survey complex was 46.132 kWh .
The energy saving in this commercial complex after replacing fans and lighting there was energy saving of 5.42 kWh.

The total energy sufficed using Energy Efficiency devices in commercial Sector is 0.64 MU.

The same changes were applied assumed for the Industrial sector and the total energy sufficed using Energy Efficiency devices in Industrial sector is 3 MU

Street Lighting

Lighting pole details

Sr .no	Type of lamp	Wattage	Total no.	Total wattage kW	Load (% share)
1	CFL	11	537	5.9	0.4
2	HPSV	70	1729	121.0	.2
3	GLS	100	3818	381.0	26.0
4	HPSV	125	305	38.1	2.6
5	HPSV	150	1636	245.4	16.7
6	HPSV	250	1339	334.8	22.8
7	HPM V	250	587	146.8	10.0
8	HPM V	400	301	120.4	8.2
9	Tube Light (T-5)	14	5422	75.9	5.2
		TOTAL	15674	1470.7	100

At present the total estimated peak load of existing street lighting system is approximately 1470.7 kW

- Installation of load controller and dusk to dawn timers at the feeders

- Replace 400 W HPMV lamps with 250 W HPSV lamps

- Replace 250 W HPMV lamps with 150 W HPSV lamps

Retrofitting using above options there is possibility to reduce connected load by **142.85 kW**. Hence there exists a potential to reduce street lighting system's peak load by **9.7% in street lighting**.

Alternate Fuels for Surface Transportation

- Under the Solar City Gandhinagar 5000 BOV2 Wheelers could be promoted under MNRE scheme.
- Support for dissemination of all types of Battery Operated Vehicles (BOVs), Plug Hybrid Vehicles (PHEVs), Hybrid Electric Vehicles (HEVs) and Electric / Exercise Bike Generator Inverter (E2BI) for their usages by users for surface transportation.
- Vehicles, Plug Hybrid Vehicles, Hybrid Electric Vehicles and Electric/Exercise Bike Generator Inverter (E2B1) for field performance evaluation and leading to commercialization.
- Support for projects and activities related to awareness promotion through education and training, organization of business meet and seminars/conferences/symposia in the area of electric vehicles, plug hybrid vehicles and hybrid electric vehicles. etc.

Information, Education & Communication For Mass Awareness

Renewable Energy Technologies and Energy Conservation measures are promoted and popularized through schemes and programmes formulated in the light of the Central and State governments policy.

Commercially oriented schemes

- Demonstration projects and programmes/schemes
- Aid in the form of subsidies for production and dissemination for RE

Technologies

- Entrepreneurial development
- Support R & D Activities
- Information and Education Activities

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Action Plan and Budget

- The goal is to reduce minimum 10 % of the projected total demand of 243.11 MU of conventional energy at the end of five years through RE and EE strategies.
- The master plan sets a goal of total savings of 27.95 MU with 18.17 MU from renewable energy installation and 13.9 MU from energy efficiency measures.

RE and EE Strategy for Gandhinagar City	Energy Savings target over 5 years period of Implementation (MU per year)					% of savings target to achieve	Emission reduction/Yr
	1st Year	2nd year Cumulative	3rd year Cumulative	4th year Cumulative	5th year Cumulative		
RE for Residential Sector	0.06	0.64	2.56	5.70	7.82	28%	7820
RE for Commercial & Inst. Sector	0.007	0.07	0.28	0.62	0.86	3.01%	860
RE for Industrial Sector	0.031	0.31	1.27	2.83	3.88	13.9%	3880
RE for Municipal Sector	0.04	0.46	1.84	4.09	5.61	20.09%	5610
Total for RE strategy	0.138	1.48	5.95	13.24	18.17	65%	
EE for Residential Sector	0.04	0.49	1.97	4.38	6.01	21.53%	6010
EE for Commercial Sector	0.005	0.05	0.2	0.46	0.64	2.31%	640
EE for Industrial Sector	0.02	0.24	0.97	2.17	2.98	10.69%	2980
EE for Municipal Sector	0.03	0.35	1.41	3.14	4.31	15.45%	4310
Total for EE Strategy	0.95	1.13	4.55	10.15	13.9	50%	
RE and EE Combined Strategy	1.088	2.61	10.5	23.29	32.07		
	10%	25%	45%	73%	115%		

State Budget for Model Solar City- Gandhinagar

Years	2012-13	2013-14	2014-15	2015-16	2016-17
Budget (Cr.)	27.99	28.60	28.60	28.60	28.60

The total proposed budget for five years from 2012-2017 is approx. 142 Crores

Thank You

For More information please contact

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