Solar City Master Plan - Executive Summary

Meeting the growing energy demand is one of the biggest challenges that the world is facing today. Rising population and depleting fossil fuel resources are compelling the world to develop renewable sources of energy. Global warming too has assumed enormous significance today. Under the scenario, the role of alternate and renewable energy resources has become very crucial. Urbanization has been a critical phenomenon in the Indian context especially in the last two decades. After the independence, the urban population of India has grown almost five times while the total population has grown by about three times. According to the census data of 2001 census, 285.35 million i.e. about 30% of the Indian population resides in urban area which is expected to increase in a very rapid manner.

To address the rising issue of combating climate change challenges, MNRE has come up with the proposal of developing solar cities in the country. The objective of the programme is to assist the Urban Local Bodies in assessing their present energy consumption and future demand and preparation of a master plan for increasing energy efficiency and renewable energy supply in the city. The programme 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.

Vijayawada Municipal Corporation (VMC) has taken the responsibility of bringing out Vijayawada as Solar City, in terms of MNRE guidelines and SR Corporate Consultant (P) Ltd. has been assigned the task of preparing the master plan thereof.

The present report is divided into 10 main chapters. First chapter deals with the background of the project; objectives and scope of the plan.

Second chapter describes the profile of Vijayawada city and VMC. In this chapter, population pattern of the city has been given since 1961. It indicates that the population of VMC has grown from 2.30 lacs in the year 1961 to 10.33 Lacs in 2001 with an average annual growth rate of 3.30%. Besides population, the land use pattern also plays an important role in the growth of a city.

The City Development Plan for the year 2021 envisages that the Residential sector is expected to grow at much faster rate. As against 28.09% in 1996 it is estimated that area under residential sector will be 53.82% by 2021. Since it is proposed to develop Industrial areas outside the Municipal area hence only 2.44% area has been proposed for industrial sector. Besides this, the economic base of Vijayawada has also been covered in this chapter.

Chapter three details the methodology adopted for preparation of the master plan. In the light of the objectives set up by the MNRE for development of Solar Cities, the proposed Master Plan drafts a road map through an in-depth analysis of allied indicators of energy consumption, supply, emission and conservation in the city. This is in harmony with a pre-set goal of minimum 10% reduction in projected total demand of conventional energy at the end of five years. SR adopted the methodology in line with the Guidelines issued by the MNRE in this regard.

Next chapter deals with the energy baseline of Vijayawada city based on the consumption data of previous five years prior to the base year 2010. For determining the energy baseline, we have considered secondary data collected from various sources and primary data on the basis of research carried out by our survey teams. Relevant data of the primary research has been used at appropriate place in the report. Electricity and petroleum products are two major forms of energy consumed in VMC area.

Electricity has emerged as the prime source of energy in Residential; Commercial & institutional; Industrial and Municipal Sectors. Other sources of energy had been identified as Petroleum products viz. petrol, diesel, kerosene, LPG, PNG and CNG whose consumption had been observed in Residential, Commercial and Municipal sectors.

Based on our research the Baseline sectoral energy consumption scenario in VMC area as identified is reflected in the following table:

Table-1: Baseline Energy Consumption Scenario in VMC Area

Description of Energy Resources/Sector	Unit	Residential	C&I	Industrial	Municipal	Total
Electricity	MWh	499738	158182	44831	26385	729136
Petrol	KL	56701	135	-	-	56836
Diesel/FO	KL	-	54209	-	4	54214
Kerosene	KL	3618	-	-	-	3618
LPG	MT	40965	1750	-	-	42715
PNG	MT	-	-	-	-	-
CNG	MT	-	26614	-	-	26614
Energy in terms of TJ	TJ	6369	4301	161	95	15814
% share		58.29%	39.36%	1.48%	0.87%	100.00%

The analysis reveals that the Residential Sector contributes about 58.29% of the overall energy consumption followed by Commercial & Institutional Sector with 39.36%.

We have calculated the quantum of energy consumption in respective units of the energy form. For the purpose of arriving at the baseline GHG emission Scenario, all energy resources consumption have then been converted into a uniform unit i.e. TJ. Based on this, the quantum of GHG emissions have been calculated sector wise. This has been estimated using the default Carbon Emission Factor data in accordance with 2006 IPCC Guidelines for National Greenhouse Gas Inventories except for Electricity. Carbon Emission Factor for Electricity is considered as the CM for Sothern Grid for the year 2009-10 according to the CO_2 Baseline Database for Indian Power Sector Version 6 prepared by CEA, New Delhi.

The baseline GHG Emissions during the year 2010 are estimated at 1180254 tCO_2e. The major contributor to the GHG emission is electricity followed by petroleum products. On Sectoral basis, residential sector contribute to 61.99% of the overall GHG emissions whereas C&I sector contributed 32.88% and a small share of 3.23% from industry and 1.90% from Municipal Sector.

Based on the energy pattern of Vijayawada city for last five years ending March 2010 and baseline data for the year 2009-10, future energy demand under Business As Usual (BAU) scenario have been forecasted for next ten years in chapter 5. The forecasting has been carried out on the basis of growth pattern, future plans and analysis of past time series data. While projecting the demand for energy in Vijayawada city we have gone through different growth plans of various Government Departments, if any, viz. City Development Plan, JNNURM Master Plan, electricity infrastructure/ utility plans, industry and business forecasts by local chamber of commerce and industry and other planning documents.

In chapter six, renewable energy resource assessment of Hubli Dharwad city has been done. Our analysis of secondary data obtained from various sources and the information collected by our research team during primary survey reveals that following renewable energy resources are available in Vijayawada city.

i. Solar power for electricity generation;
ii. Municipal Solid waste
iii. Bio-methanization

There is no scope for Small Hydro power or wind power that can be used as energy source in the municipal area. Techno-economic feasibility of various RE systems reflects in chapter seven. TE feasibility of a 1 MW SPV power system, a 4kWp rooftop system (off-grid application); a biomass based gasifier and a solar water heating system, Replacing GLS by CFLs, Replacing Tube lights by T-5, Street Lighting Segment, Solar Lanterns and Solar Cookers, Centralized Solar Cooking System, Solar Generators for telecom towers replacing DG sets, Energy Saving in transport Sector have been provided in this chapter.

Master plan for implementation of the projected GHG emissions during next five years (year wise) is given in chapter eight. We have earlier projected the GHG emission scenario of VMC in terms of tCO_2e under Business As Usual (BAU) situation. According to our calculations, estimated GHG emissions under all the four sectors, during the year 2015 will be 1933122 tCO_2e.

It is targeted to reduce 10% GHG emissions by the year 2015. Accordingly, we have to reduce 193312 tCO_2e by the year 2015.Out of this, 50% target (i.e. 96656 units) is to be achieved through generation of renewable energy and an equivalent amount of remaining 50% through energy efficiency measures. Year wise break-up of GHG emission reduction is shown in following table.

Table: 2 – Projected GHZ Emission Scenario of VMC in terms of tCO_2e under BAU Situation

S No	Description	Base Year	1st Year	2nd Year	3rd Year	4th Year	5th Year
1	Residential Sector	731606	847074	939386	1039611	1145629	1258117
2	Commercial Sector	388104	423380	450860	478262	505585	532831
3	Industrial Sector	38113	57198	65514	74193	83249	92694
4	Municipal Sector	22432	30772	35189	39776	44538	49481
	Estimated GHG Emission under BAU Situation	**1180254**	**1358423**	**1490949**	**1631843**	**1779002**	**1933122**
	Target to reduce from BAU Situation		1%	3%	5%	8%	10%
	Estimated GHG Emission under Solar City Situation		**1344839**	**1446221**	**1550250**	**1645577**	**1739810**
	Target Emission Reductions in tCO_2e		**13584**	**44728**	**81592**	**133425**	**193312**
	Targeted Emission Reduction through RE generation		**6792**	**22364**	**40796**	**66713**	**96656**
	Targeted Emission Reduction through EE Measures		**6792**	**22364**	**40796**	**66713**	**96656**

To achieve the desired GHG emissions, we have proposed following actions in the master plan:

Table: 3 - Year wise Physical Plan for achieving the projected targets

A.	Renewable Energy Generation						
S. No.	**Description**		**1st Year**	**2nd Year**	**3rd Year**	**4th Year**	**5th Year**
1	Solar Energy -On grid	MW	1.000	2.500	5.000	7.500	10.000
2	Soar SPV	MW	0.500	1.000	1.500	5.000	5.000
2	Waste to Energy	MW	1.000	3.000	6.000	10.000	10.000
3	Recycling of Biodegradable Waste	MW	0.250	1.000	1.500	1.500	2.000
	Energy Generation/Saving Potential						
	Solar Energy	MWh	1576.8	3942	7884	11826	15768

	Solar SPV	MWh	788.4	1576.8	2365.2	7884	7884
	Waste to Energy	MWh	6336	19008	38016	63360	63360
	Methane capturing	MWh	841.5	3366	5049	5049	6732
	CO_2 Saving Potential						
	Solar Energy	tCO2e	1340	3351	6701	10052	13403
	Solar SPV	tCO2e	670	1340	2010	6701	6701
	Waste to Energy	tCO2e	5386	16157	32314	53856	53856
	Methane capturing	tCO2e	715	2861	4292	4292	5722
	Gross CO_2 Saving Potential from Energy generation	tCO2e	**8111**	**23709**	**45317**	**74901**	**79682**
B.	**Energy Efficiency Measures**						
1	Solar Water Heating System	Lacs LPD	2.000	3.000	6.000	7.000	8.500
2	Reduction in Connected Load in Municipal Area	MW	0.250	1.000	1.300	1.600	2.500
3	Awareness Generation, Capacity Building & Knowledge Sharing	MW	1.000	2.500	4.000	7.500	15.000
	Energy Generation/Saving Potential						
	Solar Water Heating System	MWh	3000	4500	9000	10500	12750
	Energy Saving in Municipal Area	MWh	1584	6336	8236.8	10137.6	15840
	Awareness Generation, Capacity Building & Knowledge Sharing	MWh	7008	17520	28032	52560	105120
	CO_2 Saving Potential						
	Solar Energy	tCO2e	2550	3825	7650	8925	10838
	Waste to Energy	tCO2e	1346	5386	7001	8617	13464
	Awareness Generation, Capacity Building & Knowledge Sharing	tCO2e	5957	14892	23827	44676	89352
	Gross CO_2 Saving Potential from EE Measures	tCO2e	**9853**	**24103**	**38478**	**62218**	**113654**
	Gross CO_2 Saving Potential from EE Measures	tCO2e	**17964**	**47811**	**83796**	**137119**	**193336**

While renewable energy technologies would provide clean energy, energy efficiency and demand side management measures would help in reducing the energy demand. An indicative list of these measures for different sectors is given in chapter nine of the report. By applying these measures, we shall be able to save or generate the requisite quantity of energy as well as GHG emission savings.

In chapter 10, we have shown other activities. This includes, establishment of solar city cell, formation of a solar city stakeholders' committee, year wise details of training programmes awareness generation and capacity building initiatives, and some regulatory measures to be formed by the VMC. To implement the master plan, an action plan and its financial implications

and the funding pattern have been prepared for next five years. These are reflected in separate booklets. The action plan and financial plan are integral parts of the master plan.

Table: 4 - Year wise financial plan for achieving the projected targets

S. No.	Description	1st Year	2nd Year	3rd Year	4th Year	5th Year
A.	**Renewable Energy Generation**					
1	Solar Energy -On grid	8.00	20.00	40.00	60.00	80.00
2	Solar SPV	4.00	8.00	12.00	40.00	40.00
2	Waste to Energy	10.00	30.00	60.00	100.00	100.00
3	Bio-methanization	1.88	7.50	11.25	11.25	15.00
B.	**Energy Efficiency Measures**					
1	Solar Water Heating System	4.00	6.00	12.00	14.00	17.00
2	Reduction in Connected Load in Municipal Area	0.25	1.00	1.30	1.60	2.50
3	Awareness Generation, Capacity Building & Knowledge Sharing & Incentives	0.10	0.50	1.00	1.50	2.00
	Total Financial Outlay	**28.23**	**73.00**	**137.55**	**228.35**	**256.50**

Table: 5 - Year wise Projected Means of Finance for achieving the projected targets

S. No.	Description	1st Year	2nd Year	3rd Year	4th Year	5th Year
i	CFA	8.98	24.10	45.15	75.10	78.90
ii	SFA	0.93	2.30	3.85	7.80	9.50
iii	Beneficiary Share/ Private Sector Investment	18.33	46.60	88.55	145.45	168.35
	Total Finance	**28.23**	**73.00**	**137.55**	**228.35**	**256.75**

The formats of primary survey and glossary of terms have been given as annexure to the report.