Master Plan

To Develop Gwalior as Solar City

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Report
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Client:
Gwalior Municipal Corporation

Prepared By:
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Bangalore

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List of Acronyms

GHG- Green House Gases

GOI-Government of India

GoMP-Government of Madhya Pradesh

UN-United Nations

GMC-Gwalior Municipal Corporation

CER-Certified Emission ratings

C02-Carbon Di Oxide

BSF-Border Security Force

MNRE- Ministry of New and renewable Energy

IREDA- Indian renewable Energy Development agency Ltd

ESCO- Energy service companies

IRR- Internal rate of return

ULB-Urban Local Body

MT0E-Million tones of Oil Equivalent

Kwh-Kilo watt hour

References

Gwalior City Development Plan

RET screen Manuals

IREDA Financial Norms

Greentech-MNRE report on Solar water heaters

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1. Preface

About 30% (285.35 million people, 2001 census) of the Indian population resides in urban areas. In post-independence era while population of India has grown three times, the urban population has grown five times. Urban areas are heavily dependent on fossil fuels (often imported), for the maintenance of essential public services, for powering homes, transport systems, infrastructure, industry and commerce. The fossil fuels are increasingly becoming more expensive due to scarcity of fuel and increase in demand. In addition to this, the environmental and social impacts of the consumption of fossil fuels are increasingly becoming a concern. These impacts include air pollution, global warming, waste disposal problems, land degradation and the depletion of natural resources.

Urbanization and economic development are leading to a rapid rise in energy demand in urban areas. Urban areas have emerged as one of the biggest sources of Green House Gas (GHG) emissions, with buildings alone contributing to around 40% of the total GHG emissions. As per latest UN report one million people are moving to urban areas each week. It is estimated that around two-thirds of the world population will be living in cities in 2050. This requires a tremendous shift in energy resources in urban areas. In recognition of this, various cities around the world are setting targets and introducing polices for promoting renewable energy and reducing GHG emissions. London has announced 20% Carbon emission reduction by 2010; New York and 200 other U.S. cities have set a similar target.

Tokyo has announced 20% share of renewable in total consumption by 2020 and Australian government has initiated a Solar Cities programme.

Several Indian cities and towns are experiencing 15% growth in the peak electricity demand. The local governments and the electricity utilities are finding it difficult to cope with this rapid rise in demand and as a result most of the cities/towns are facing severe electricity shortages. There is a need to develop a framework that will encourage and assist cities in assessing their present energy consumption status, setting clear targets for and preparing action plans for generating energy through renewable energy sources and in conserving energy utilized in conducting urban services.

The programme on “Development of Solar Cities” would support/ encourage Urban Local Bodies to prepare a Road Map to guide their cities in becoming ‘renewable energy cities’ or ‘solar cities’ or ‘eco/green cities’. The Ministry has already initiated various programmes in the Urban Sector for promoting solar water heating systems in homes, hotels, hostels, hospitals and industry; deployment of SPV systems/ devices in urban areas for demonstration and awareness creation; establishment of ‘Akshya Urja Shops’; design of Solar Buildings and promoting urban and industrial waste/ biomass to energy projects. The programme aims to consolidate all the efforts of the Ministry in the Urban Sector and address the energy problem of the urban areas in a holistic manner.

The Ministry 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. At least one city in each State to a maximum of five cities in a State is being supported by the Ministry. The cities may have population between 0.50 to 50 lakhs

Goals and Objectives

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

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

- ✓ to oversee the implementation of sustainable energy options through public -private partnerships.

The Gwalior Municipal Corporation and the Madhya Pradesh Urja Vikas Nigam with sanction of the Ministry of New and Renewable energy granted the job of development of Master Plan for Gwalior as Solar City to M/s Elpro Energy Dimensions Pvt. Ltd which is an empanelled Solar City Consultant under the Ministry of New and renewable Energy.Hence this study and report.

An effort has been made to keep all practical projects and implementable projects. There is sufficient case for private participation in PPP mode and also all financing and funding opportunities are also listed exhaustively. The underlying principle behind preparation of the master plan is to enable rapid deployment of recommendations and Pilot Projects.

2. **Executive Summary**

The Master plan to develop Gwalior as solar city provides insights into the challenges and opportunities for implementing energy efficiency strategies and outlines a set of actions for how best to proceed to achieve the aim of reducing 10% of energy consumption in the next five years.

It is actively addressing energy efficiency for the Gwalior municipal corporation which can significantly reduce Gwalior's future energy growth, improve community resiliency, and position Gwalior as a competitive place to invest, live and grow. To allow Gwalior to advance with reducing energy demand and greenhouse gas emissions, key focus areas for deploying energy efficiency in major sectors were identified as

1. Residential Sector
2. Commercial and Institutional Sector
3. Industrial Sector
4. Municipal Sector

Solar energy is very large, inexhaustible source of energy. Currently Gwalior is taking electricity from the state electricity board. The energy demand is increasing day by day. Keeping each point in the mind (cost of power, different losses, uncertain power cut) Extracting power from the solar is the one way to become independent for the need of power. To foster the energy efficient techniques the report addresses the advancing method which is as follows.

a) Develop an action plan with key stakeholder's and Utilities
b) Continue To Improve Local Energy Information for Gwalior
c) Invest in the Resources and Knowledge to Advance Energy Efficiency\
d) Introduction

Aim of the Master plan

Ministry of New and Renewable Energy (MNRE), Government of India has launched a program on "Development of Solar Cities" in India. 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. A total of 60 cities/towns are proposed to be developed as “Solar Cities” during the 11thPlan period. At least one city in each State to a maximum of five cities in a State will be supported by the Ministry. The cities/towns included in the program will have population between 0.50 lakh to 50 lakh which includes the floating population. Gwalior is one of the towns to be developed as solar city in pan India.

The following tables denote the planned energy efficiency and renewable energy measures to achieve the above objective as per the Solar City master Plan developed for Gwalior City.

RENEWABLE ENERGY INITIATIVES

No	Project Details	Investment (Rs. In Lakhs)	Energy Generated in lakh kWh PA	Annual GHG t Co2	Energy Generated/ Saved upto 2013
	RESIDENTIAL SECTOR				0
1	RESIDENTIAL SOLAR WATER HEATERS	1050	95.5	14325	191
2	ROOFTOP PV & SMALLSOLAR POWER GENERATION PROGRAMME(RPSSGP)	10500	75	6975	150
3	SOLAR COOKER - BOX AND PARABOLA*	200	422	1670	844
4	PASSIVE BUILDING TECHNIQUES AND GREEN BUILDINGS				0
	Residential Sector Sub Total	11750	592.5	22970	1185
	COMMERCIAL & INSTITUTIONAL SECTOR				0
5	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOTELS	93.6	4.849	497.1	9.698
6	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOSPITALS	106	4.58	469.9	9.16
7	250 KWP SOLAR PV AND 30,000 LPD SOLAR WATER HEATER AT BORDER SECURITY FORCE(BSF) ACADEMY GWALIOR	717	5.91	496.5	11.82
	Commercial Sector Sub Total	916.6	15.339	1463.5	30.678
	INDUSTRIAL SECTOR				0
8	IMPLEMENTATION OF PILOT BIOGAS PLANT IN TANNING INDUSTRY	375	2.54	236	5.08
9	USE OF SOLAR PRE HEATED WATER FOR BOILERS	TBA			0
10	USE OF SOLAR PV LED STREET LIGHTING	250	5.47	508.71	10.94
11	USE OF PARABOLIC STEAM GENERATORS	TBA			0
12	IMPLEMENTATION OF BIOMASS COGENERATION IN COLD STORAGES FOR PRODUCING POWER AND CHILLING	TBA			0
	Industrial Sector Sub Total	625	8	745	16
	MUNICIPAL SECTOR				0
13	MUNICIPAL SOLID WASTE (MSW) TO ENERGY	7160	518	190859	1036
14	SEWAGE TO ENERGY	2185	32.93	17495	65.86
15	SOLAR PV POWER GENERATING SYSTEM	8450	74.1	5928	148.2
16	SOLAR STREET LIGHTING	260	5.689	529.06	11.38
17	SPECIAL AREA DEMONSTRATION PROJECTS				0
	GWALIOR FORT	55	0.55		1.1
	LAKSHMI BAI STATUE	5	0.06		0.11
	ITALIAN GARDEN	40	0.44		0.88
	SCINDIA SCHOOL	25	0.28		0.55
	Municipal Sector Sub Total	18180	632	214811	1264
	Total	**31472**	**1248**	**239989**	**2496**

*LPG substitution

TBA-To Be Assessed

ENERGY EFFICIENCY MEASURES

No	Project details	Investment (Rs. lakhs)	Savings(Rs lakhs p.a.)	Savings(la kh kWh p.a.)	Savings(Ton nes of carbon/year)	Savings kwh upto 2013
	RESIDENTIAL SECTOR					
1	USE OF CFL-BACHAT LAMP YOJANA	1.5	41.745	7.59	692.8	15.18
2	IMPLEMENTATION OF T-5 INLINE BALLAST	93.5	105	15.97	1456.9	31.94
3	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS	500	208.137	31.54	2877.7	63.08
4	IMPLEMENTATION OF DUCTED AIR COOLERS	1000	424.49	77.18	7600	154.36
5	ENERGY STAR RATED REFRIGERATORS	2000	337.15	61.3	5700	122.6
6	DEVELOPMENT OF A ZERO ENERGY HOME/OFFICE	1000				
7	ESTABLISHMENT OF ENERGY CENTRE FOR SERVICE AND DEMONSTRATION	135				
	Awareness Campaign	58				
	Residential Sector Total	4788	1116.522	193.58	18327.4	387.16
	COMMERCIAL & INSTITUTIONAL SECTOR					
8	IMPLEMENTATION OF T-5 INLINE BALLAST IN COMMERCIAL BUILDINGS	93.5	105	15.96	1456.9	31.92
9	IMPLEMENTATION OF CFLs IN PLACE OF ICLS IN COMMERCIAL BUIDINGS	10	25.05	3.8	346.4	7.6
10	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS IN COMMERCIAL BUILDINGS	500	208.13	3.154	2877.7	6.308
11	SOLAR HEAT-REFLECTING CLEAR WINDOW FILMS	480	139	21.12	3263	42.24
12	LED BULBS	900	636.24	96.4	9000	192.8
13	UPVC WINDOWS COMMERCIAL BUILDINGS	750	288.35	43.69	4.3	87.38
	Commercial Sector Sub Total	2733.5	1401.77	184.124	16948.3	368.248
	INDUSTRIAL SECTOR					
14	ENERGY EFFICIENCY AUDITS AND IMPLEMENTATION*	2184.27	1092.13	198.57	19850	397.14
	Industrial Sector Sub Total	2184.27	1092.13	198.57	19850	397.14
	MUNICIPAL SECTOR					0
15	STREET LIGHTING ENERGY CONSERVATION	371.25	188.32	50.63	4050	101.26
16	WATER TREATMENT AND PUMPING SYSTEMS	85	43.92	14.63	1360	29.26
	Municipal Sector Sub Total	456.25	232.24	65.26	5410	130.52

Total	**10162.02**	**3842.66**	**641.53**	**60535.70**	**1283.07**

Sector Wise Summary upto 2013

Sector	Energy Conservation in Lakh Kwh		Renewable Energy in Lakhs Kwh		Total in Lakh Kwh
	upto 2013	Annually	Upto 2013	Annually	Upto 2013
Residential	387.16	193.58	1185.00	592.50	1572.16
Commercial	368.25	184.12	30.68	15.34	398.93
Industrial	397.14	198.57	16.02	8.01	413.16
Municipal	130.52	65.26	1264.08	632.04	1394.60
Total	1283.07	641.53	2495.78	1247.89	3778.84

Solar City Master Plan Target versus Planned measures in MToE

Sector	Energy consumed in Million Tonnes of Oil Equivalent		Percentage savings	
	upto 2013	Baseline	%	
Total	0.03249	0.15603	20.82	

3. Introduction

Ministry of New and Renewable Energy (MNRE), Government of India has launched a program on “Development of Solar Cities” in India. 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. A total of 60 cities/towns are proposed to be developed as “Solar Cities” during the 11^{th}Plan period. At least one city in each State to a maximum of five cities in a State will be supported by the Ministry. The cities/towns included in the program will have population between 0.50 lakh to 50 lakh which includes the floating population. Gwalior is one of the towns to be developed as solar city in pan India.

Gwalior at glance

Gwalior is a historical city in the state of Madhya Pradesh, India and located at 26.22 N 78.18 E .It has an average elevation of 197 meters (646 feet) and it is 122 km south of Agra and 423 km north of Bhopal, the capital of state. Gwalior occupies largest location in the grid region of the India and its city and it fortress have severed as the center of the several of historic northern Indian Kingdom. Gwalior is the administrative headquarter of Gwalior district and Gwalior division. Gwalior is spread over 5214 sq. km area having population more the 16 lakhs, is one of the most populated city of India. Main statistic of the city is given below.

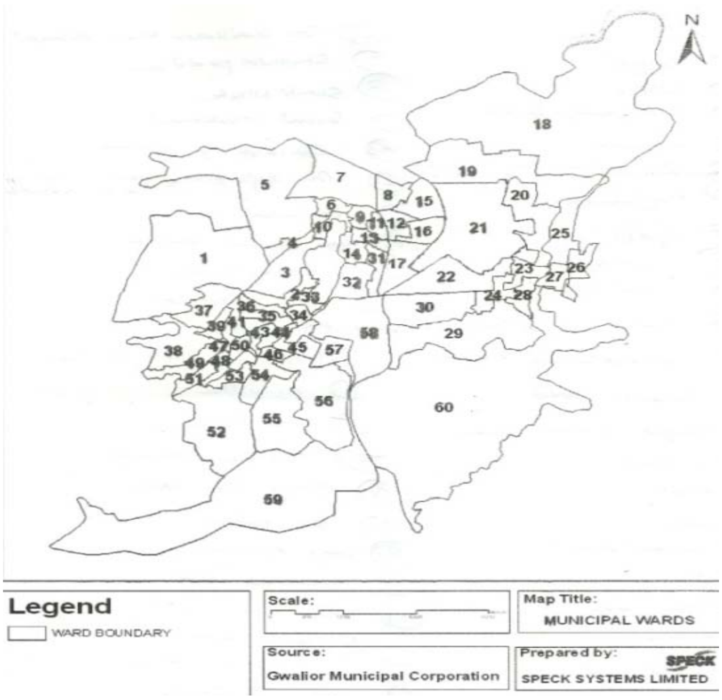
Total Area	5214.00	Sq. Km
Forest Area	1019.79	Sq. Km
Net Sown Area	2601.42	Sq. Km
No. of Households	209.12 Thousands	
Net Irrigated Area	911.93 Sq. Km	
Population	1629881	
Male	882258	
Female	747623	

Literacy Rate

Male	80.83%
Female	56.76%
Per Capita Income	13456

Figure 1: Gwalior Corporation Area

No. of Wards: 60



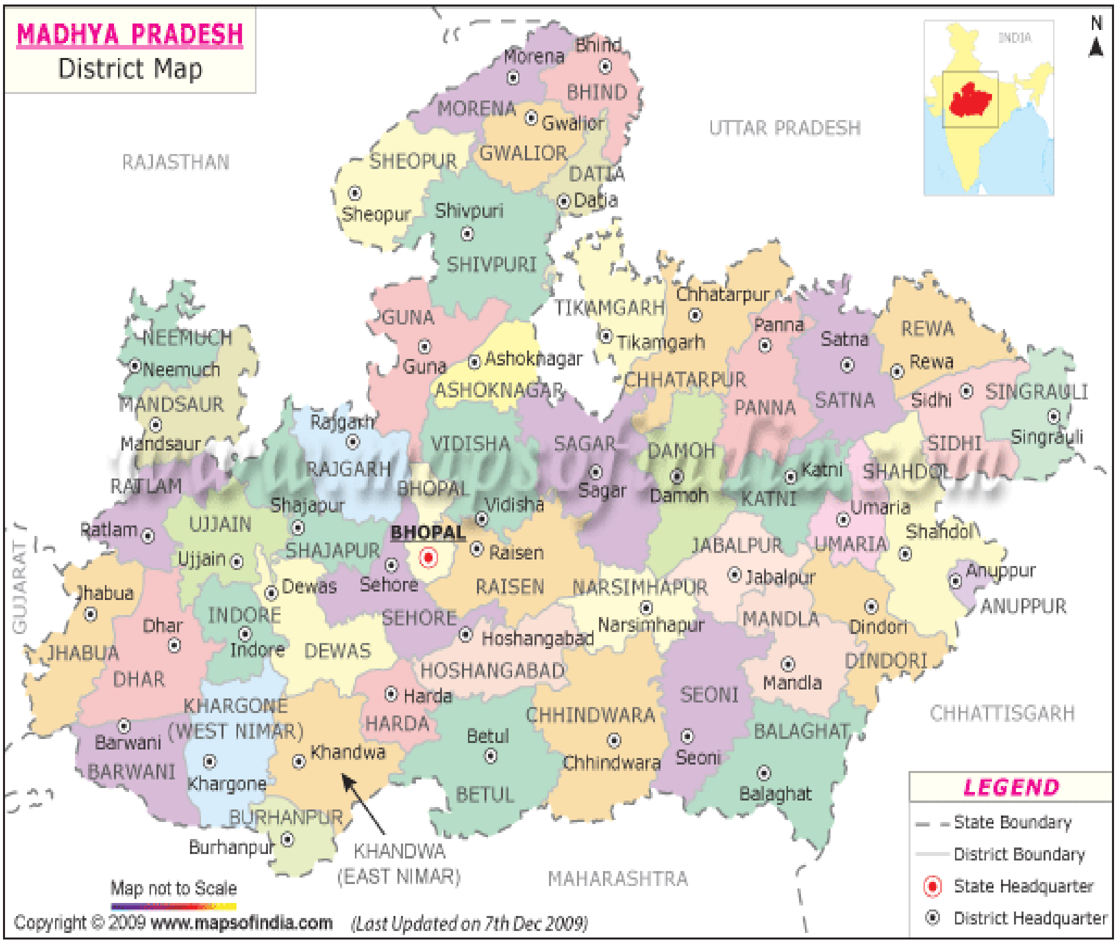


Figure 2:Madhya Pradesh District Map

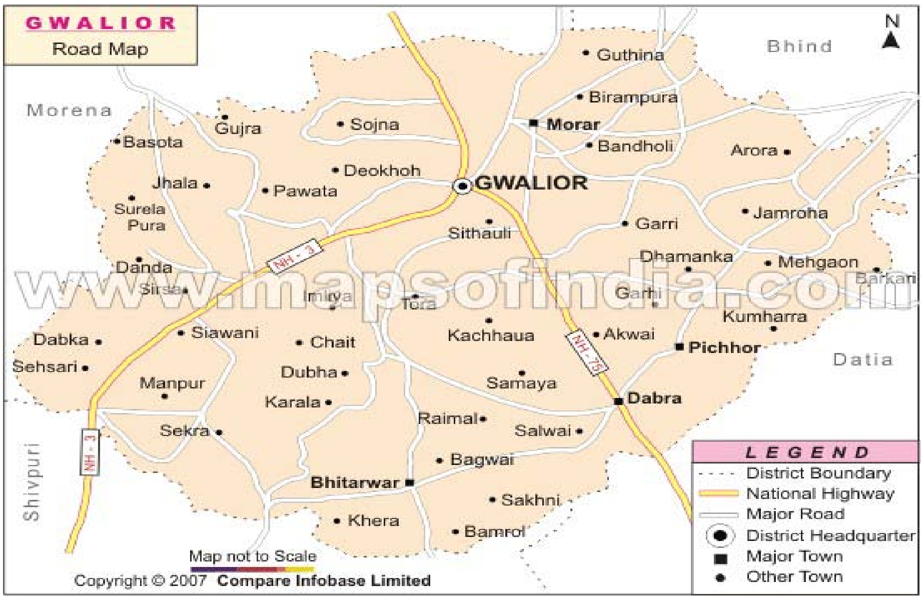


Figure 3: Gwalior Location

4. The role of energies in Cities

Energy comes in many forms. We use electricity to light our homes, our streets and the exterior of buildings. We also generate heat from the burning of fossil fuels to condition our homes and offices and to heat domestic hot water. Energy is also used to extract raw materials, to manufacture and distribute consumer goods, to grow food and to treat and pump water, transportation. Energy is central to the daily functions and actions of every community. Energy is an essential building block of economic development. Urbanization and economic development are leading to a rapid rise in energy demand in urban areas.This requires a tremendous shift in energy resources in urban areas. In recognition of this, various cities around the world are setting targets and introducing polices for promoting renewable energy and reducing GHG emissions.

What is Energy Planning and Why is it Important?

As population and employment in a city grows, more fuel and materials are needed for generation, transmission and distribution of energy. Taking steps to reduce the amount of electricity or fossil fuels that is used in a home or business helps to lower individual utility costs and conserve natural resources. Improving energy efficiency means using less energy to accomplish an activity or goal. Some city goals could be to provide comfortable living and working spaces for residents, to enable residents and visitors to travel easily around the city or to promote economic prosperity. Among the drivers for incorporating energy efficiency and renewable as part of short-term and long-term community planning and economic development includes:

Response to climate change.

As part of the response to climate change, the local municipal corporations and local public sector are now exploring the role of energy efficiency and community renewable energy systems to improve adaptation and mitigation capacity of fossil fuels.

Sustainable energy planning.

Planning for energy can contribute to the sustainability of a community by reducing energy costs and lowering environmental impacts. Energy use, supply and demand not only depend on, but also can help shape the design and development of a community, and the activities of its citizens, businesses, institutions, government agencies and industry.

Energy efficiency and the use of Renewable energy is now considered an important component of achieving successful long-term growth objectives for a community.

Transiting to new energy sources.

Power density is a measure that captures the rate of energy produced per unit of earth area and is usually expressed in watts per square metre (W/m2). Fossil fuel deposits are by far the highest concentration of high quality energy in the magnitude of 102 or 203 W/m2. Hence only a small land area is needed to supply vast amounts of energy. Today's power producing techniques ensure that we receive fuels and electricity with power densities that are in the order of one to three magnitudes higher than regular power densities required to operate our buildings and cities.

Indian city environment is designed around access to inexpensive fossil fuels. Reducing reliance on fossil fuels will require creating a environment that is energy efficient and supports renewable technologies, such as photovoltaics, solar hot water and wind.

Understanding where energy is used in a community and where energy supply opportunities might exist can contribute to making effective energy efficiency decisions. Integrated energy mapping is grounded on assembling a wide range of data inputs that are used to help baseline energy consumption in a community and evaluate the long-term effectiveness of energy reduction strategies.

An important component of the process involves financial assessment and cost sensitivity testing. Key financial indicators allow for identified energy strategies to be ranked against one another in terms of cost effectiveness in achieving a desired target for energy, GHGs, energy cost or other objective. The integrated energy mapping process also allows Gwalior Municipal Corporation to evaluate various types of energy goals.

For instance, scenario building can be undertaken – the evaluation of different energy efficiency strategies that are compared and can be ranked against criteria relevant to a community or other identified factors.

The scenarios allow municipal and utility decision makers and other key community stakeholders to assess a wide range of combinations of pricing, technologies, land-use and energy efficiencies and building improvements from a numerical standpoint to advance energy efficiency.

5.Elpro's integrated energy mapping approach - Methodology

Overview

The integrated energy mapping process uses a combination of actual energy consumption data and energy simulation models to show where and how much energy is consumed by the entire City of Gwalior. All energy consumed by Commercial buildings, industry, residential and municipal is included in the analysis. Energy baseline is created for both 2008 (baseline), and for the future development that is expected to occur between today and the year 2013/2018, according to the Gwalior city's Official Plan and Growth Management Strategies enumerated in the Gwalior CDP.

In the energy mapping process, we divided the energy consumption of Gwalior city into four major sectors – Commercial/Institutional buildings, Industry, residential and municipal. In addition to calculating how much energy is consumed by the City for each case, total GHG emissions for the City and for each case are calculated as well. Alternative energy generation technologies are modeled for the potential to further reduce GHG emissions. Capital costs, operating costs, and operating cost savings are evaluated for each new building standard, building retrofit, and alternative energy generation technology. Cost sensitivity is applied to potential increases in energy prices, and additional cost metrics such as Internal Rate of Return (IRR) are calculated. In this way, alternative practices and cases can be compared and contrasted according on a cost-benefit basis. The outputs of the energy model –energy, costs, and GHGs, of the different scenarios and best alternative technology (BAT) options –are used to inform policy directions and decisions that are intended to reduce energy and GHG emissions for the entire City. The process can also be used to provide insight into the most cost effective ways of achieving a community energy reduction and/or GHG reduction goal. Figure 4 outlines the major pieces of the energy mapping process.

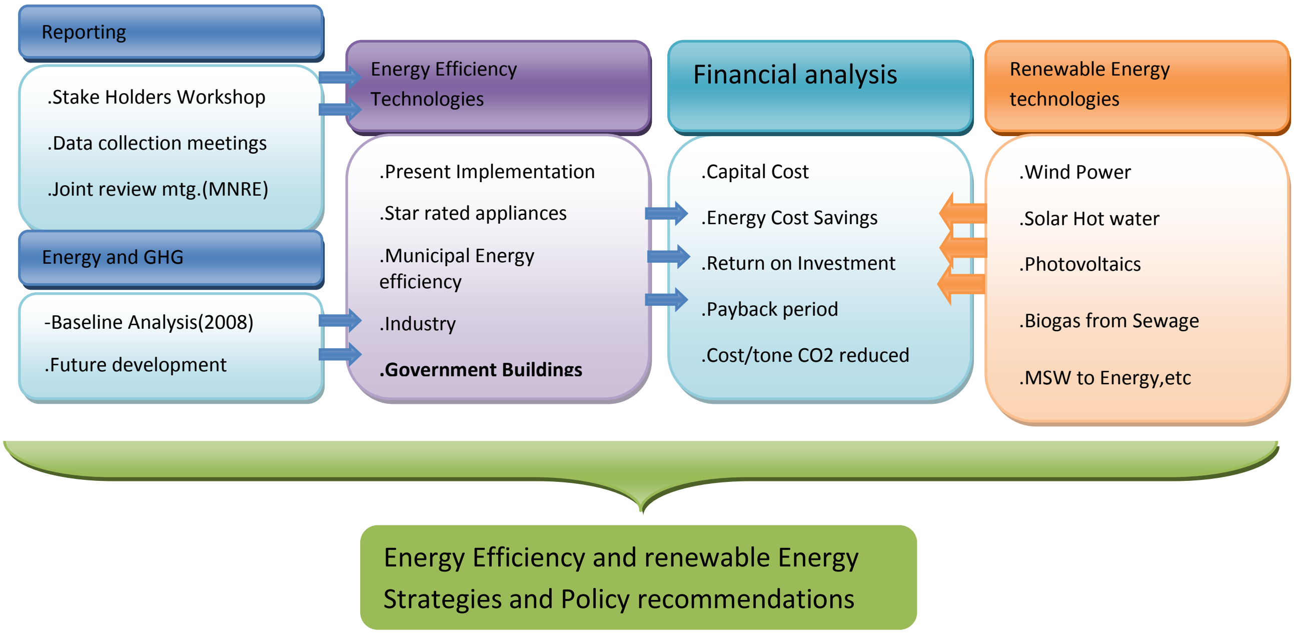


Figure 4: Energy mapping Approach

Future Development (2013/2018)

Population and land use projections were used to calculate the total amount of additional Load the city would be installing and that would be developed between present day and 2013/2018, and this was used to calculate the total amount of future energy demand for Gwalior City. Figure 5 shows the future development energy mapping process:

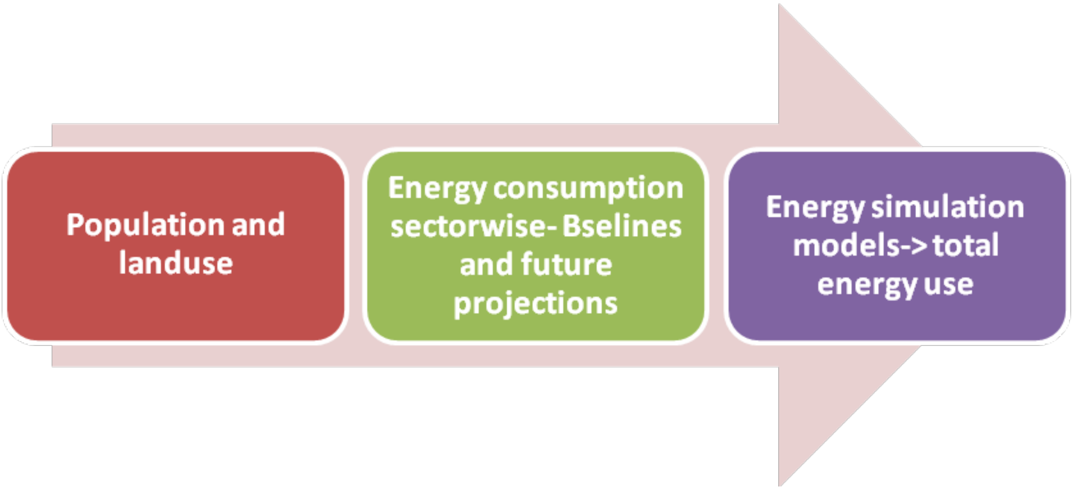


Figure 5: Future Development Energy Mapping Process

Population projections were obtained from the CDP of Gwalior City and the energy usage details were collected from different departments like Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Limited, Main Agencies and depot of oil companies like HPCL (Hindustan Petroleum Corporation Limited). BPCL (Bharat Petroleum Corporation Limited), IOCL (Indian Oil Corporation Limited),Civil supplies department, field surveys, etc.

6. Existing Energy use and production in Gwalior - Baseline Analysis

6.1 Overview

The objectives of this study are to provide baseline information for benchmarking the energy situation in Gwalior; conducting a situation analysis in terms of planning and budgeting process in meeting 10 % of required energy through renewable energy sources, economic growth, equitability and environmental sustainability. An analysis of the current energy consumption is presented. Sector wise energy consumption data were collected for different energy sources. The result showed that electricity (15.39%),diesel (42.99%), petrol(20.37%), and LPG (11.52%) are the main source of energy. Apart from that other sources of energy are coal(3%), Furnace oil (0.08%), kerosene(6.72%) and fire wood (0.01%). Total consumption of the city is 0.15 MTOE (Million tones oil equivalent) per year, and entire GHG emission for the city is 901789.23 tons per annum.

6.2 Introduction

This Document includes the detail of the base line energy utilization under the scheme of MNRE (Ministry of New and Renewable Energy), Government of India and GMC (Gwalior Municipal Corporation). Ministry of New and Renewable Energy (MNRE) has started an ambitious program as Solar City. Gwalior is one of the 60 cities from all over India chosen to be developed as a Solar City. Main goal of this program is promote the use of renewable energy in the urban areas.

Elpro Energy Dimensions Pvt. Ltd. first took up the task of preparing the base line energy utilization for the Gwalior City. Data for the last three years has been collected and data for the year 2008 has been selected for the baseline estimation. For making this base line Elpro team has surveyed all sectors of Gwalior City. Documents and data on energy consumption (electrical, petroleum product, coal, biomass,etc) have been collected from residential, commercial, institutional, industrial and municipal sectors.

India is a Developing country and most of the population lives in the urban area. In present trend, energy demand for public services, home powering, transport systems, industries and commerce people are dependent on the fossil fuel. The source of fossil fuel is limited and seems to be deployed completely in next 60 years, thus resulting in increasing price of fuel and not meeting the demand.

The baseline energy utilization is finalized on the basis of data collected from different concerning department and oil companies' agencies and depot, etc. On the basis of this energy forecasting has been done and according to the energy demand the measures will be given to fulfill the aim of the project that Is reduction in energy consumption by 10% by the end the year 2013.

6.3 Categorization of Different Sectors

This base line of Energy utilization is based on the data on all forms of energy including electrical, petroleum product, coal and biomass from all sectors.
We have categorized the City in following main sectors.

I. Residential
II. Commercial and Institutional
III. Industrial
IV. Government

6.4 Sector wise Energy utilization Survey

6.4.1 Residential Survey

City is having 505827 Households as per metered energy users and records provided by the State Electricity Distribution company. Residential Survey targets the information about the electrical energy, LPG, petrol diesel, kerosene and biomass consumption in this sector. This is an important to assessing the potential to increase energy efficiency and to use renewable energy. Residential sector include all the house holds in the City, government quarters and apartments. Electricity is playing main role in energy consumption. LPG, petrol and diesel come are the second major fuel in residential sector. A small quantity of biomass is being used in the City.

6.4.2 Commercial and Institutional Survey

Commercial sector includes all offices, shop, bank, shopping malls and complexes etc. The main consumption of this sector is electricity and diesel in DG sets and petrol in transport. All the data of electricity, petrol and diesel consumption have been collected. The goal of the survey is to find out the total consumption as well as make an analysis on the characteristics of energy use in Commercial buildings and institutions.

6.4.3 Industrial

Coal, Electricity, Petrol, Diesel, LDO, Furnace Oil are some major sources of the energy in the industries. We procured a list of industries in Gwalior City and collected data of all forms of the energy being used in the sector from various agencies.

6.4.4 Municipal Survey

Municipal sector include water pumping, waste water treatment, and street lighting .Electricity play the major role of source of energy. A detailed energy audit of the street lighting, Public buildings and water pumping was carried out to assess the energy conservation and renewable energy potential.

GHG Emission

Green house gases are the gases that trap in the atmosphere and cause increase atmospheric temperature. We have experienced a great climate change in past few decades. GHG are the main reason for Ozone depletion and climate change. We have analysed the sector wise GHG emission by evaluating the source and recommend suitable measures to reduce the emission. This report also includes a comparative study of the GHG emission from different fuels in the various sectors.

Note: *Electricity, liquid fuels and LPG consumption for the year 2008 has been considered*

6.5. Sector Wise Energy Consumption

6.5.1 Residential Energy Consumption and GHG Emission

Energy Consumption

Total energy consumption in the residential sector is given in the following Table 1. The main consumption in the residential sector is electricity, LPG Petrol, Diesel and kerosene respectively. Data was collected from different departments like Madhya Pradesh Madhya Kshetra Vidyut Vitaran Company Limited, Food and civil supplies department and depots of oil companies like HPCL (Hindustan Petroleum Corporation Limited). BPCL (Bharat Petroleum Corporation Limited), IOCL (Indian Oil Corporation Limited), and summarized in the following table.

LPG consumption is contributing to majority energy consumption in this sector. It contributes around 47.61% of total energy consumption. Electricity is the second main contributor of the energy consumption; it contributes to 42.93% of the total energy consumption in the residential sector. Kerosene is seldom used in houses due to shift towards LPG and Electricity.

No of metered house holds/residential users: 505827

Table 1. Annual Energy consumption details of residential sector

Sl. No.	Type of fuel	Consumption	MTOE	%
1	Electricity(Kwh)	183054847	0.016	42.93
2	LPG(kgs)	31495603	0.017	47.61
3	Kerosene(Litres)	4152000	0.003	9.47
	Total		**0.037**	**100.00**

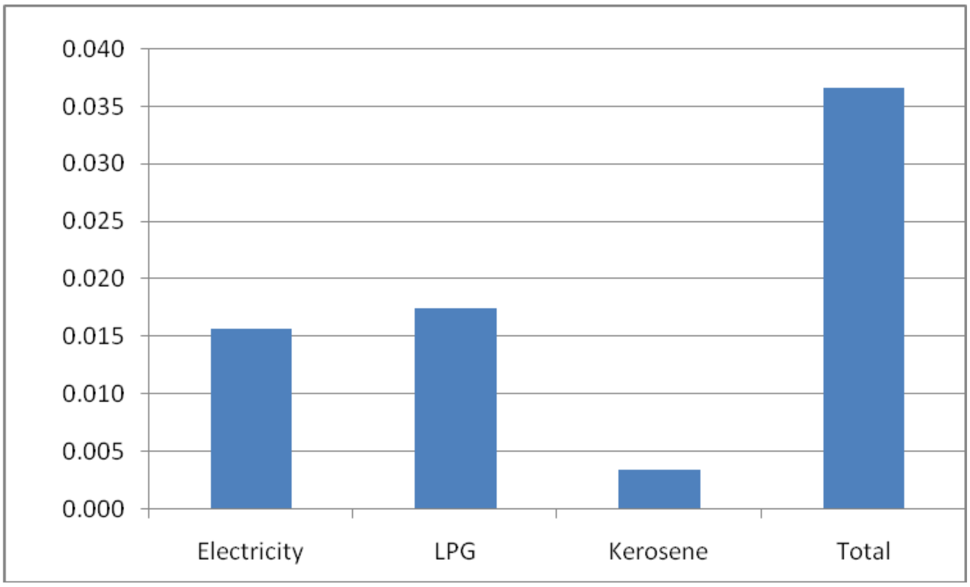


Figure 6: Energy consumption in residential sector

GHG Emission in Residential Sector

Total GHG emission of the residential sector has been tabulated in the following table. It can be seen here that the electrical GHG emission is highest, around 84.84%. The main source of the electricity is thermal power station,where emission from coal is very high. LPG and kerosene are the petroleum products and they contribute 33.2% and 3.8 % respectively.

Table 2: GHG emission in the residential sector

Sl. No.	Type of fuel	unit	Total Consumption per year	GHG Emission in Tone per year	%
1	Electricity	kwh	216303728.8	181695.13	84.84
2	LPG	kg	7477130	21753.96	10.15
3	Kerosene	lit	4152000	10712.16	5.00
	Total			**214161.25**	**100**

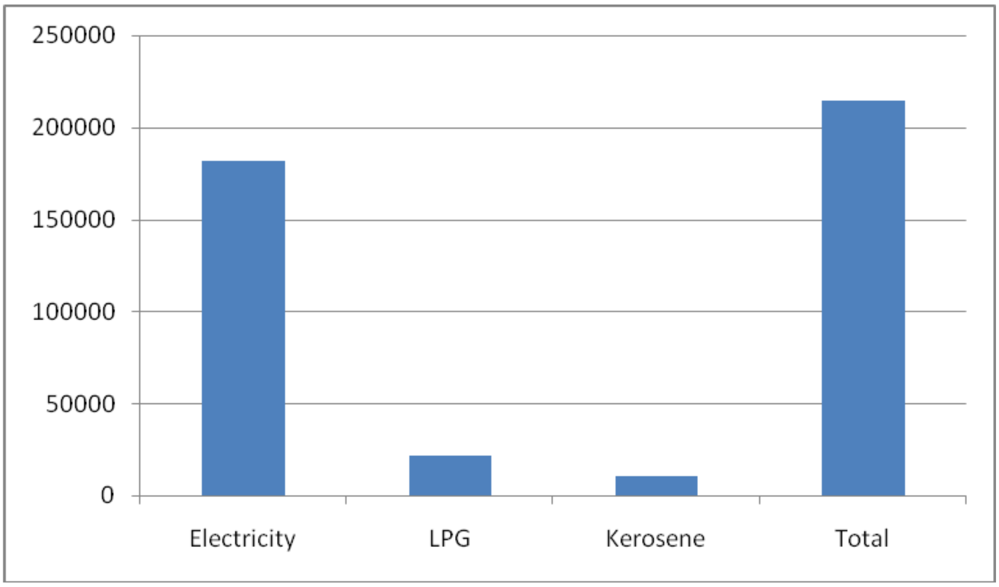


Figure 7: GHG emission in residential sector

6.5.2 Commercial and Institutional Energy Consumption and GHG Emission

Commercial and institutional sector include all the commercial building like shops show room, offices, hospitals, restaurant school, colleges, university and all type of institutions.

Energy Consumption

Electricity, LPG and kerosene are the main contributors to energy consumption in this sector which is tabulated here. Petrol and diesel are the main source for transport and power generation. It is tabulated separately for the entire Gwalior City for all sectors combined as we were unable to determine the sectorial usage individually. It is shown that the contribution of the electricity, LPG and Kerosene are 36.67%, 3.87%, 59.46% respectively. Sources of data are the electricity Distribution Company, oil depots, petrol bunks, gas agencies etc.

The total energy consumption of the Commercial sector is as follows

Table 3: Energy consumption of the Commercial and Institutional sector

Sl. No.	Type of fuel	unit	Consumption	Calorific value	MTOE	%
1	Electricity	kWh	50367653	0.0036	0.004	36.67

2	LPG	kg	824676	0.023205	0.000	3.87
3	Kerosene	lit	8400000	0.035	0.007	59.46
	Total				**0.012**	**100.00**

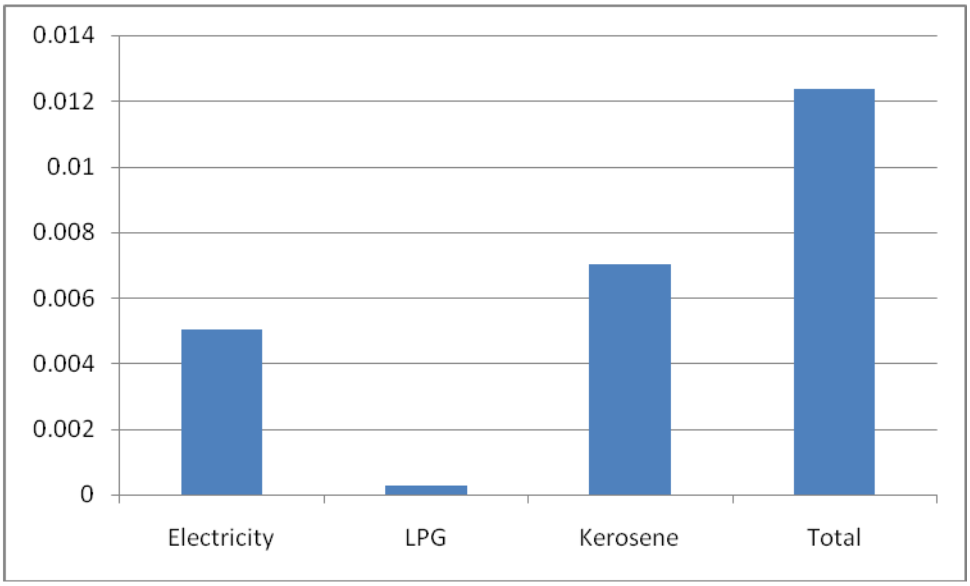


Figure 8: Energy consumption of commercial and institutional sector

GHG Emission

GHG emission for the commercial and institutional sector is tabulated below. Electricity has highest percentage of the GHG emission with 68 %. Kerosene and LPG contribution in GHG emission are 30.13 % and 3.34 % respectively. Graphical representation is also given below.

Table 4: GHG Emission detail of Commercial and Institutional

Sl. No.	Type of fuel	unit	Consumption	GHG Emission in Tone	%
1	Electricity	kWh	58652186.65	49267.83679	68.0
2	LPG	kg	507624.7778	1476.883529	2.0
3	Kerosene	lit	8400000	21672	29.9
	Total			**72416.72031**	**100**

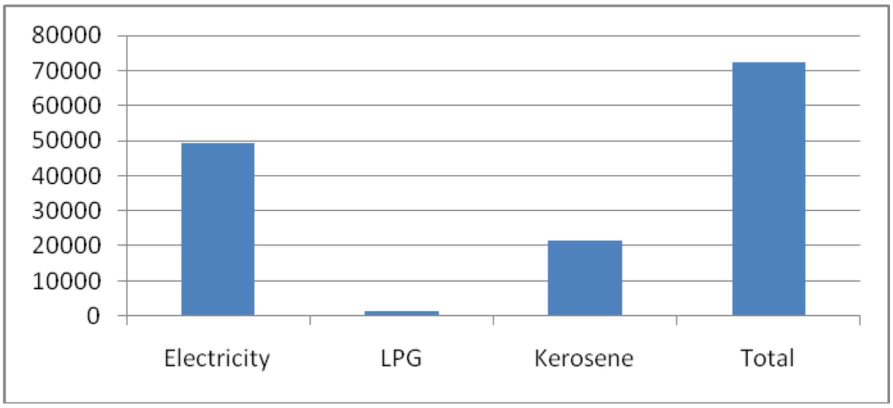


Figure 9: GHG emission in commercial and institution sector.

6.5.3 Industrial Energy Consumption and GHG Emission

Industrial sector is normally the main energy consumer. Small scale industries are located in Gwalior. A list of all industries has been collected from the District Industries department and data on coal consumption, furnace oil consumption, diesel consumption and electricity consumption has been collected. A list of all Industrial consumers has also been tabulated from MPMVNL

Energy Consumption

Data collected is tabulated below

Table 5: Energy consumption detail of the Industries

Sl. No.	Type of fuel	unit	Consumption	MTOE	%
1	Electricity	kWh	25219100	0.002168452	28.7
2	Coal	Tones	8880	0.004453998	59.0
3	LPG	kg	122539	0.000679133	9.0
4	Furnace Oil	litre	504000	0.000123749	1.6
5	Fire Wood	Tones	294	0.000111651	1.4
	Total			**0.007536984**	**100**

Total energy demand is around 0.008 MTOE (Million metric tones of Oil). As denoted in the table , coal consumption is very high as it contributes 59 % of the total energy demand. Electricity contributes 28.7 % and LPG contribution is around 9 % of the total energy required. Rest 4% is being contributed by the furnace oil and fire wood with 1.6 % and 1.4 % percent respectively. Graphical view of the energy consumption is given below.

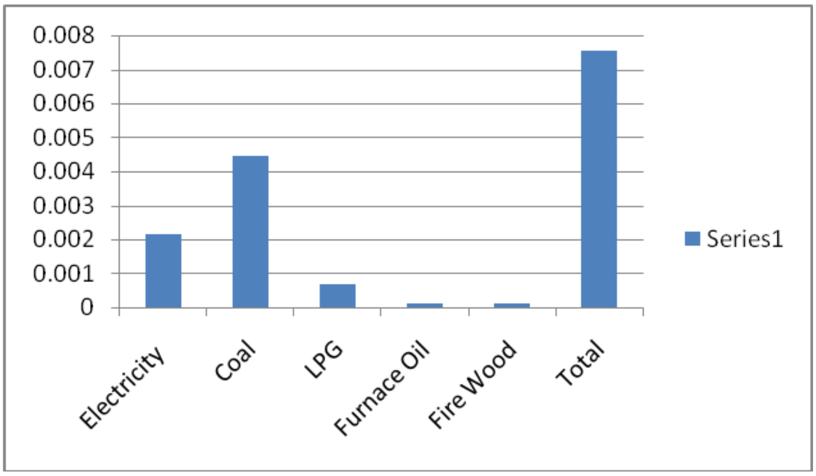


Figure 10 :Energy consumption of industrial sector.

GHG Emission

GHG emission is tabulated below in the table. It is visible from the table that highest GHG emission is being contributed by coal which is 53.8 %, electricity is also contributing more about 41.6%. Rest of the emission is being contributed by LPG, Furnace oil and fire wood. Graph of the same result is given below.

Table 6: GHG emission in the Industrial sector

Sl. No.	Type of fuel	unit	Consumption	GHG Emission in Tone	%
1	Electricity	kWh	25868864	21729.84	41.67
2	Coal	Tones	8880	28104.31	53.89
3	LPG	kg	172592	502.13	0.96
4	Furnace Oil	litre	581333.3333	1756.32	3.36
5	Fire Wood	Tones	294	54.07	0.10
	Total			**52146.69**	**100**

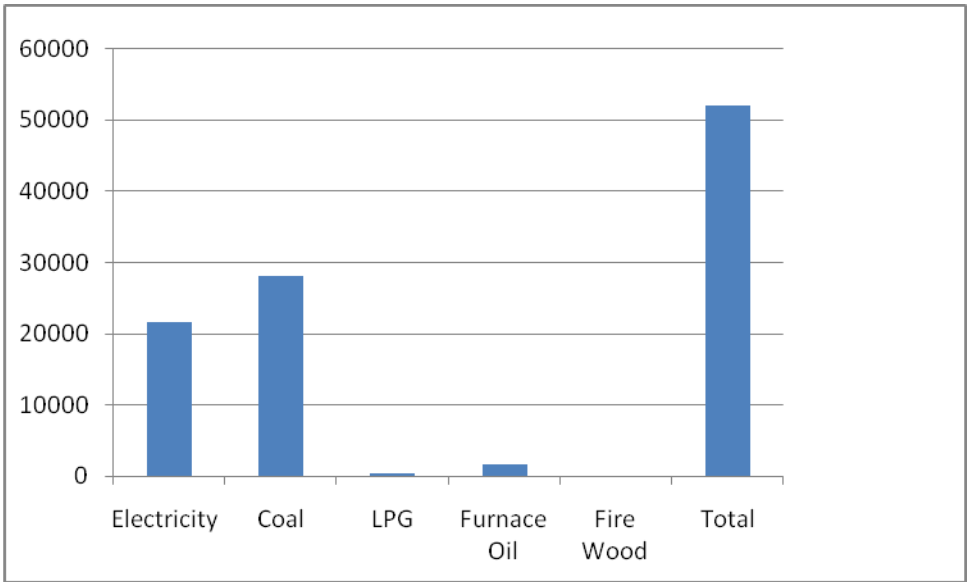


Figure 11: GHG emission of Industrial sector

6.5.4 Municipal Energy Consumption and GHG Emission

Energy Consumption

Municipal sectors comprises of Municipal water works, street lighting, Municipal buildings where electricity is used. Apart from this they consume Diesel and petrol in DG sets and in transport. Total electricity consumption for the municipal is 0.0022 MTOE (Million metric tons). The data of this sector is summarized in the following table and graphical representation is also provided.

Table 7: Energy consumption of municipal sector

Sl.No.	Type of Fuel	Unit	Municipal	MTOE	%
1	Electricity	kWh	20636031	0.001774379	66.66
2	Diesel	Litres	829390	0.000887472	33.34
	Total			**0.002661851**	**100.00**

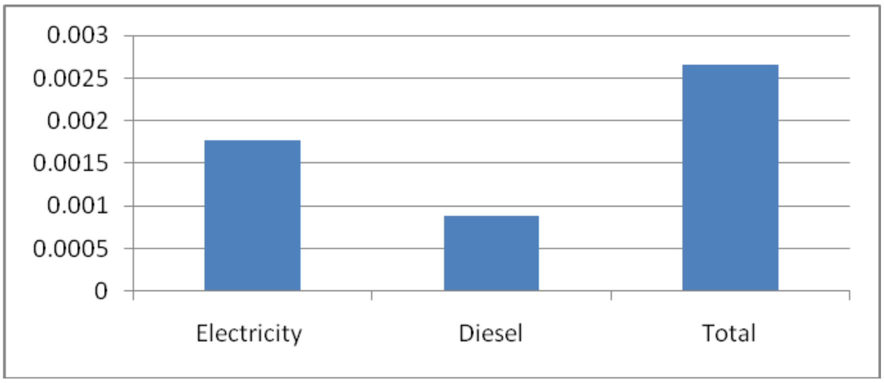


Figure 12 : Energy consumption of municipal sector

GHG emission

GHG emission in the municipal sector is 24962 tones

Table 8: GHG emission of the Municipal sector

Sl.No.	Type of Fuel	Unit	Municipal	GHG emission in ton	%
1	Electricity	kWh	25888124.5	21746.02	90.75
2	Diesel	Litres	829390	2216.13	9.25
	Total			23962.15	100.00

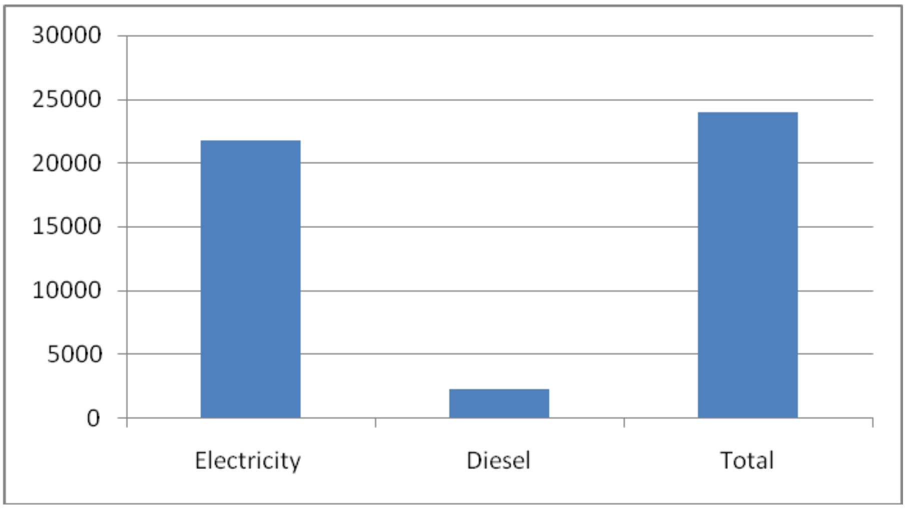


Figure 13: GHG emission of municipal sector

6.6 Petrol and Diesel Consumption and GHG Emission

Consumption of Petrol and Diesel

We have collected this detail separately for Gwalior city. Source of the data are different oil companies depots and offices. Data is summarized in the table. Total consumption of petrol and diesel together is 0.099 MTOE (Million tones oil equivalent)

Table 9: Petrol and diesel consumption

Sl. No.	Type of Fuel	Total	Calorific Value GJ	MTOE	%
1	Petrol (litres)	27719000	0.048	0.032	32
2	Diesel (litres)	62684000	0.0448	0.067	68
	Total			**0.099**	**100**

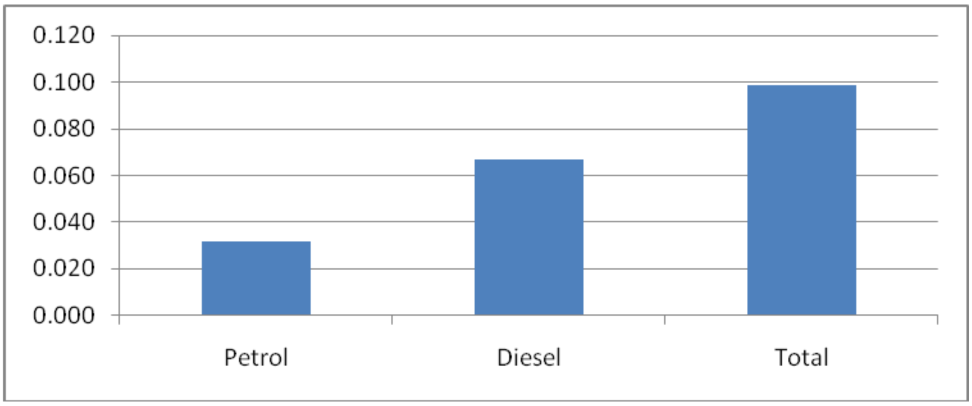


Figure 14: Petrol and diesel consumption

GHG emission

GHG emission due to petrol and diesel consumption is summarized in the below table. Total GHG emission from the petrol and diesel is 494259.50 tonnes out of which 75% emission is coming out from diesel and 25% is coming from petrol. Graphical representation is also given below.

Table 10: GHG emissions due to Petrol and diesel consumption

Sl. No.	Type of Fuel	Total	Calorific Value GJ	GHG emission	%
1	Petrol	27719000	0.048	63753.7	28
2	Diesel	62684000	0.0448	167491.648	72
	Total			**231245.348**	**100**

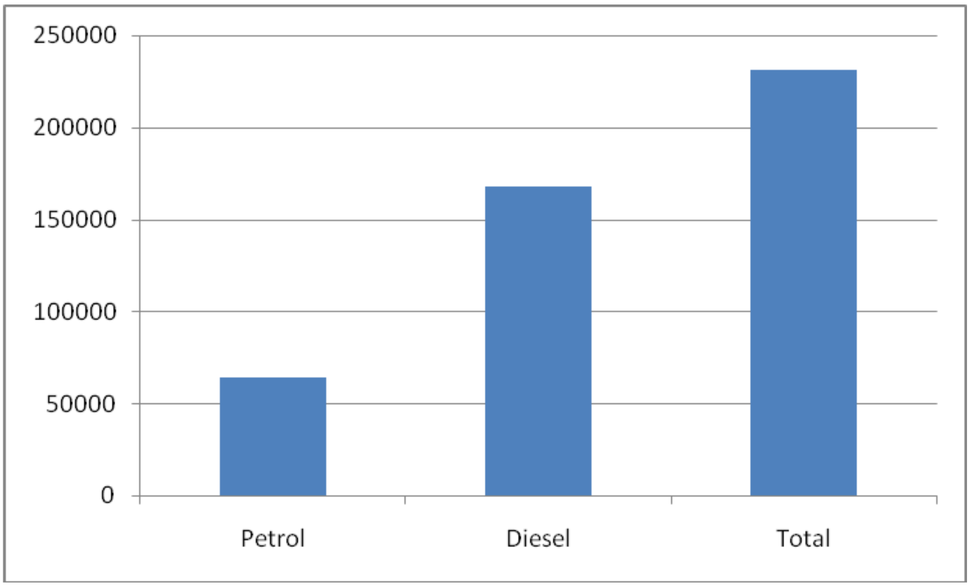


Figure 15: GHG emissions due to Petrol and diesel consumption

6.7 Total Energy Consumption and GHG Emission

Energy consumption

On the basis of the above mentioned details we have arrived on the fact that the total energy consumption of the Gwalior city is around 0.15 MTOE (Million tone oil equivalent). Petrol and diesel contributes more than half of the total energy consumption

Table 11: Summary of Energy consumption – fuel wise

Sl.No.	Type of Fuel	Unit	Total	MTOE	%
1	Electricity	kWh	27 92 77 631	0.024014	15.39
2	Coal	Tones	8880	0.004454	2.85

3	LPG	kg	32442818	0.017981	11.52
4	Furnace Oil	litre	504000	0.000124	0.08
5	Kerosene	litre	12552000	0.010493	6.72
6	Fire Wood	Tones	294	0.000112	0.07
7	Petrol	litre	27719000	0.03178	20.37
8	Diesel	litre	63513390	0.06707	42.99
	Total			**0.15603**	**100**

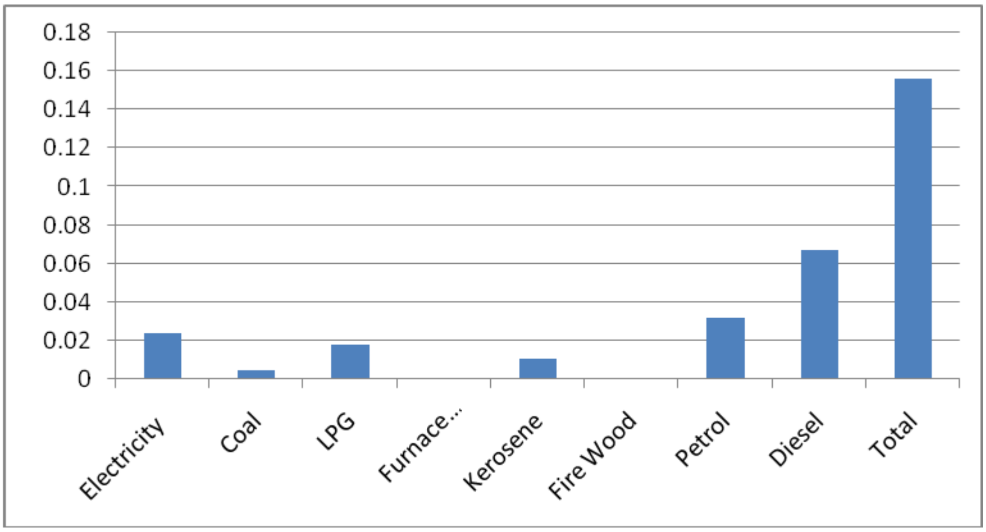


Figure 16: Summary of Energy Consumption- Fuel wise

Total GHG emission

Annual GHG emission for the Gwalior City is given below in the table GHG emission for the city is 901789 tones. Diesel is emitting highest GHG around 370698 tones Co_2 per annum.

Table 12: Summary of GHG emissions – fuel wise

Sl.No.	Type of Fuel	Unit	Total	MTOE	GHG Emission in tone	%
1	Electricity	kWh	326712903.9	0.028092	274438.8	30.43
2	Coal	Tones	8880	0.004454	28096.3	3.12
3	LPG	kg	34932602	0.01936	101685.0	11.28
4	Furnace Oil	litre	581333.3333	0.000143	1755.6	0.19
5	Kerosene	litre	1046000	0.000874	1499.8	0.17
6	Fire Wood	Tones	294	0.000112	54.0	0.01
7	Petrol	litre	53722333.33	0.06159	123561.3	13.70
8	Diesel	litre	138734333.3	0.14845	370698.1	41.11
	Total			**0.263076**	**901789.2**	**100.00**

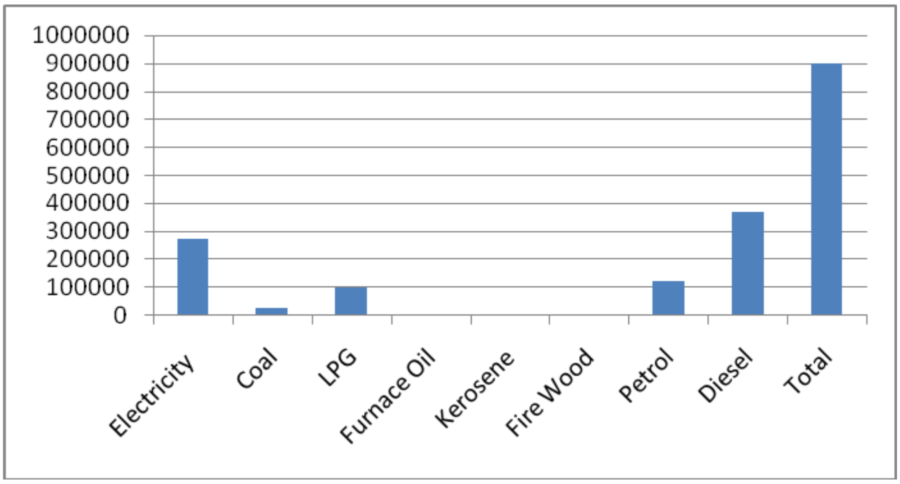


Figure 17: Summary of GHG emissions – fuel wise

7.0 Demand forecasting for the next 5/10 years- Year 2013 and year 2018

Managing electrical energy supply is a complex task. The most important part of electric utility resource planning is forecasting of the future load demand in the regional or national service area. This is usually achieved by constructing models on relative information, such as climate and previous load demand data.

Prediction is a very difficult art, especially when it involves the future
-Neils Bohr (Nobel Laureate Physicist)

INTRODUCTION

Energy management and Planning is a capability required by Municipal planners and electric utilities. Providing the balance between supply and demand in energy market and supplying the customers with more efficiency are available via satisfactory and reliable energy planning and demand forecasting. Demand forecasting is a requirement for successful energy management. An accomplished demand forecasting makes possible the trustiest planning for future. Especially, long term demand forecasting is guidance for maintenance of electricity installations and construction planning. Therefore, Municipal authorities, power system engineers and electricity generation/distribution utilities attach importance to demand forecasting.

Approach

There is a range of variables- affordability, growth in urban housing, Population increase, increase in land use, increased per capita energy consumption which have shaped the demand for energy from time to time. The empirical data, over a period of time, in terms of energy use, its region-wise and sector-wise break-up, and influence of relevant variables does not exist.

In view of this, we have adopted the following approach to demand projection.

- Utilizing learning from the primary survey and stakeholder interviews
- Putting together the present Sector wise energy consumption (2008)

• Estimating Population growth projections from the Gwalior CDP

•Estimating the present consumption of energy- in terms of sector wise requirement and projecting future energy requirement.

•Developing energy consumption growth- estimates, sector-wise, from 2008 to 2018

We have utilized the following key inputs for estimation.

• Population projections

• CAGR: This is annual growth percentage; treating the immediate previous year as base.

Sl. No.	Region	Area (hectare)	Population (1991)	Population (2001)	Population (2011)	Population (2021)
1	Gwalior Municipal corporation	18985	692982	823277	1050000	1400000
2	Nivesh kshetra	42652	860000	942313	1230000	1600000
3	Gwalior Nivesh kshetra and special kshetra	73279	_	1014808	1320000	1800000
Source : Gwalior CDP						

• Land use projection for Gwalior from the Gwalior CDP

Table 13: Population growth projections

We would like to stress that these are rough estimates based on information gathered during the primary survey.

Growth in GDP

This has multiplier effect and impacts disposable income, income-distribution and growth of various electrical appliance usage. Indian GDP, growth over 1999-2009 has averaged 7.1% (CAGR), according to Central Statistical Organization. We expect 7% CAGR in GDP growth under realistic or most likely scenario over 2010-2022 period.

In development plan, on land-use rate of 10 hectare per thousand people, city development plan is proposed in new area with consideration of the balance and systematic development of city, and Distribution 2021 (allotment)

Table 14:Land use projections

Sl. No	Earth – use	Proposed Area 2005 (in hectare)			Developed Area 2008 (in hectare)			Proposed Area 2021(in hectare)		
		Area	%	Rate of land utilization	Area	%	Rate of land utilization	Area	%	Rate of land utilization
1	2	3	4	5	6	7	8	9	10	11
1.	Residential	3992	50.5	3.19	2803	48.0	2.80	6400	49.0	3.9
2	Commercial	428	5.5	0.34	319	5.4	0.32	700	5.5	0.4
3	Industrial	405	5.1	0.32	367	6.3	0.36	1800	8.6	0.7
4	General and semi General	683	8.6	0.55	922	15.8	0.92	1300	10.2	0.8
5	General services and facilities	375	4.7	0.30	222	3.8	0.22	300	2.4	0.2
6	Amusement	598	7.6	0.48	212	3.6	0.21	1200	9.4	0.8
7	Transport	1421	18.0	1.14	997	17.1	0.99	1900	14.9	1.2
	Total	**7902**	**100**	**6.32**	**5842**	**100**	**5.82**	**13600**	**100**	**8.0**

Source : Gwalior CDP

Methodology

Trend method

We have used the Trend Method for forecasting Energy Demand for 2013 and 2018. This method falls under the category of the non-causal models of demand forecasting that do not explain how the values of the variable being projected are determined. Here, we express the variable to be predicted purely as a function of time, rather than by relating it to other economic, demographic, policy and technological variables. This function of time is obtained as the function that best explains the available data, and is observed to be most suitable for short-term projections.

This method has been used by the 16th Electric Power Survey (EPS) of the Central Electricity Authority to forecast the consumption of most consumer categories except HT Industries. The Base Paper of the EPS, detailing the methodological issues, states that in the domestic, commercial and miscellaneous categories, the observed time series in the number of consumers and consumption per capita have been projected into the future, with adjustments for increase in appliance ownership. It is only for the HT industries that an end-use method is used. It also mentions that adjustments have been made to account for unmet demands due to the presence of power cuts though the specific assumptions have not been elaborated upon. Thus, unrestricted demands were worked out for the future.

Table 15:Demand Forecast

Year	unit	2008	2009	2010	2011	2012
Electricity	kWh	287317548	333558221	406529921	448947351	491364781
Coal	Tones	8880	9502	10167	10878	11640
LPG	kg	287328436	333569732	406542098	40931216	43760682
Furnace Oil	litre	504000	984000	256000	860000	1464000
Kerosene	litre	12552000	13430640	14370785	15376740	16453112
Fire Wood	Tones	294	315	337	360	385
Petrol	litre	27719000	31762000	34854000	38421500	41989000
Diesel	litre	62684000	84089000	87746000	100277000	112808000

Year	2013	2014	2015	2016	2017	2018
Electricity	533782211	576199641	618617071	661034501	703451931	745869361
Coal	12455	13326	14259	15257	16326	17468
LPG	46590148	49419614	52249080	55078546	57908012	60737478
Furnace Oil	2068000	2672000	3276000	3880000	4484000	5088000
Kerosene	17604829	18837167	20155769	21566673	23076340	24691684
Fire Wood	412	441	472	505	541	578
Petrol	45556500	49124000	52691500	56259000	59826500	63394000
Diesel	125339000	137870000	150401000	162932000	175463000	187994000

8.0 RE Resource Assessment

Table 16: Monthly Averaged Clear Sky Insolation Incident On A Horizontal Surface (kWh/m2/day)

Lon 78.18	Average Insolation
Jan	7.27
Feb	7.6
Mar	7.65
Apr	7.47
May	7.07
Jun	6.74
Jul	6.8
Aug	7.21
Sep	7.48
Oct	7.53
Nov	7.27
Dec	7.12
Annual Average	**7.26**

Fig 18 : Avg Insolation in clear sky day kWh/m2/day

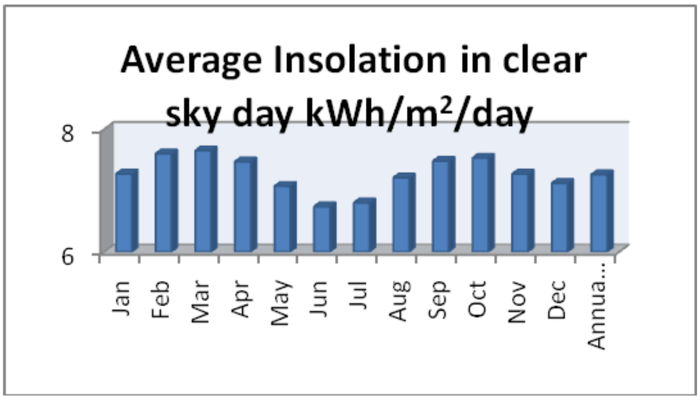


Table 17: Average Solar Insolation

Lon 78.18	**Average insolation**
Jan	5.28
Feb	6.17
Mar	6.28
Apr	5.72
May	5.37
Jun	5.18
Jul	4.99
Aug	5.09
Sep	5.21
Oct	5.38
Nov	5.57
Dec	5.38
Annual Average	**5.46**

Fig 19 : Avg Insolation kWh/m2/day

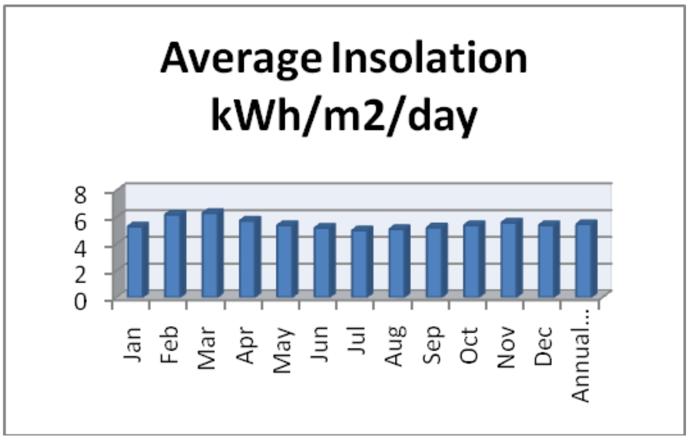
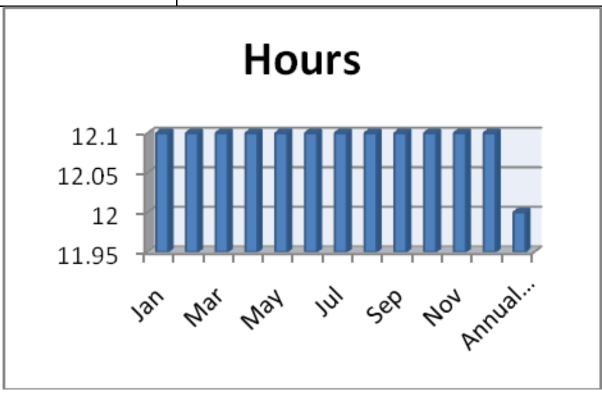


Table 18: Monthly Averaged Daylight Hours (hours)

Lon 78.18	Hours
Jan	12.1
Feb	12.1
Mar	12.1
Apr	12.1
May	12.1
Jun	12.1
Jul	12.1
Aug	12.1
Sep	12.1
Oct	12.1
Nov	12.1
Dec	12.1
Annual Average	**12**



Highest Resolution Energy Resource Estimate at 26.23° North Latitude 78.15° East Longitude

Concentrating Solar Collectors: Direct Normal Irradiance (DNI):	5.02 kWh/m sq
Horizontal Flat Plate Collectors: Global Horizontal Irradiance (GHI):	5.45 kWh/m sq
Tilted Flat Plate Collectors: Latitude Tilt Irradiance (TILT):	6.02 kWh/m sq
Wind Speed at 50m Above Ground:	3.25 m/s

Air Temperature at 10m Above Ground:	25.25 degree C
Earth Skin Temperature:	27.56 degree C
Cooling Degree Days Above 10 degrees Celsius:	5583 degree days
Heating Degree Days Below 18 degrees Celsius:	136 degree days
Atmospheric Pressure:	98.46 kPa
Relative Humidity:	50.86 %

Source : Renewable Energy Resource Explorer(RREX)

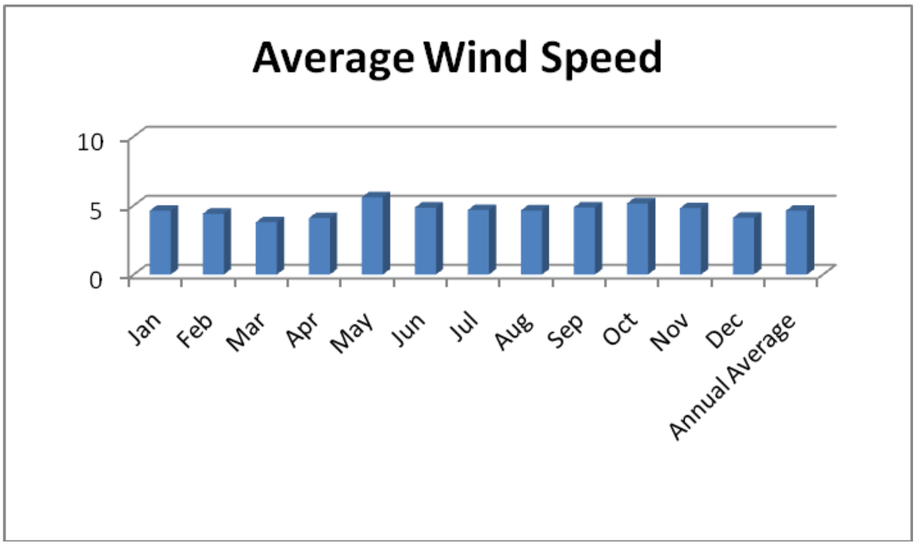
Madhya Pradesh is the centre of India. Gwalior is the one of major district in Madhya Pradesh located on latitude 26.22^o N and longitude 78.18 ^{o} E. Here average annual solar insolation is greater than 5.2 kw/m^2 /day. Solar potential is high on this place compare to other part of India.

Wind resource Assesment:

Table 28 : Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth (m/s)

Lon 78.18	**Average**
Jan	4.62
Feb	4.4
Mar	3.78
Apr	4.08
May	5.59
Jun	4.84
Jul	4.67
Aug	4.63
Sep	4.86
Oct	5.14
Nov	4.8
Dec	4.11
Annual Average	**4.62**

Fig 27: Avg. Wind Speed

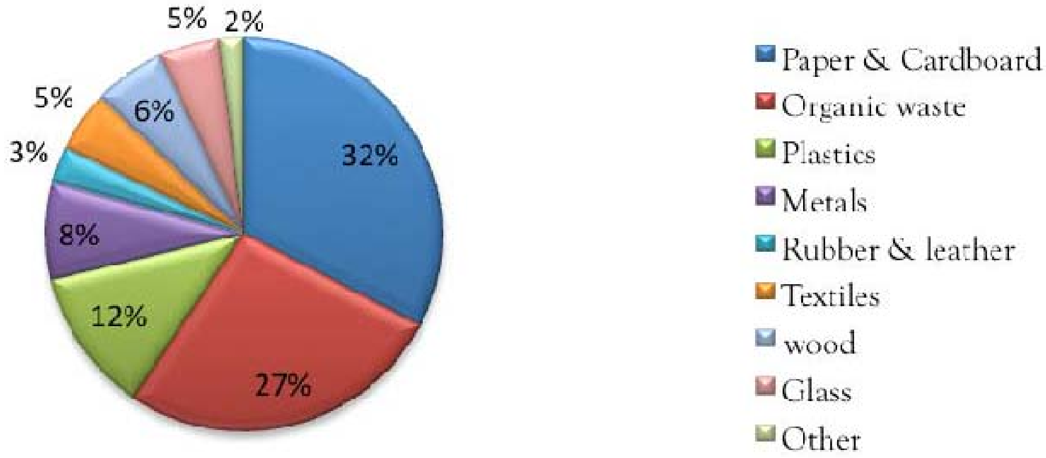


The average wind speed needs to be above 5m/s (18km per hour) to make installing a wind turbine worthwhile.

Hence it is clear from the assessment table that Wind energy feasibility is very poor for implementation in this city

Municipal Solid Waste(MSW) to energy

The waste production rate of the Gwalior is estimated to be 735 tones per day from waste stream, primary households, business and commercial waste, collectively termed as Municipal Solid Waste, MSW. A huge potential of the power generation from this waste is estimated to be 110250 MW per year. If it will be utilized fully then it can meet up to 33 % of annual energy required. Net calorific value off the MSW is 11508 Kcal/kg.the composition of the solid waste is as follow:



Energy generation Aspects

Daily production of the MSW is 785 Tones. It is expected that up to 75% of the total generated MSW will be collected successfully. On this basis we can say around 600 tones will be collected. It is shown from the below calculation that 8 MW power plant can be installed

Quantity of MSW - 600 tones

Net calorific value - 11508 Kcal/kg

Energy Recovery Potential (kWh) - NCV x W x 1000/860 = NCV x W x 1.16

Power Generation Potential (in kW) = 1.16 x NCV X W/24 = 0.048 X NCV x W

Conversion Efficiency (in percentage) = 25%

Net Power Generation Potential (kW) = 0.012 x NCV x W

The Power Generation Potential in the above case shall be = 82857.6

= 8.23 MW

In all the above cases, for computation purpose we have taken conversion efficiency as 25% only in order to validate power potential conservatively**.**

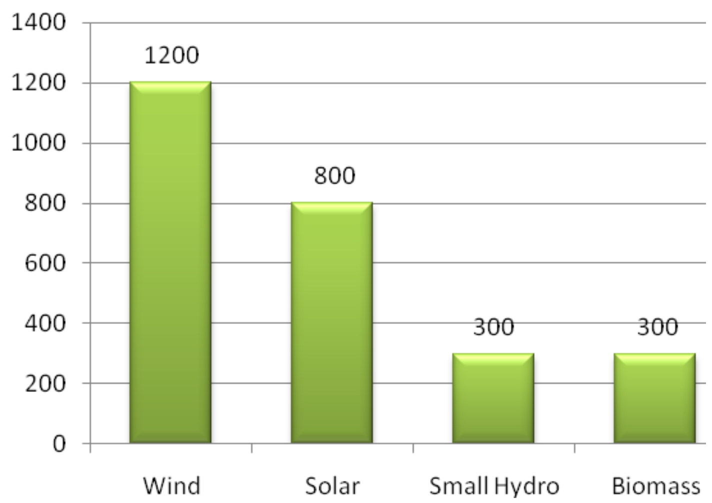
Biomass Resource Assessment:

Biomass Resource for Total Gwalior city is not available exactly. The major agricultural products from Gwalior are Paddy, Bajra, Urid, Soyabean. The total cultivable area is 22906 ha. The total biomass power generation estimate is more than 6MW in Gwalior but the process of implementation is still into consideration.

Overall assessment conclusion:

This city has the huge potential of generating electricity through solid waste and municipal waste annually. The solar power is also plays a good role in generating electricity for the street lights and roof top PV for self grid generation of electricity. This two major renewable energy technologies are more implementable and advisable for utilization of Renewable energy power.

Grid Interactive RE installed capacity (MW):



The installed capacity data collected for total Madhya Pradesh and particularly in that the contribution of Solar and Biomass energy are major from the Gwalior city. Hence the more upcoming projects of renewable energy from solar power and through the Solid waste management.

9. Residential Sector

9.1 Background and description

Gwalior is a historical city in the state of Madhya Pradesh, India and located at 26.22 N 78.18 E .It has an average elevation of 197 meters (646 feet) and it is 122 km south of Agra and 423 km north of Bhopal, the capital of state. Gwalior occupies largest location in the grid region of the India and its city and it fortress have severed as the center of the several of historic northern Indian Kingdom. Gwalior is the administrative headquarter of Gwalior district and Gwalior division. Gwalior is spread over 5214 sq. km area having population more the 16 lakhs, is one of the most populated city of India. Main statistic of the city is given below.

Total Area	18,985 hectare
No. of Households	505827 as per no. of meters residential
Net Irrigated Area	911.93 Sq. Km
Population	1629881
Literacy Rate	
Male	80.83%
Female	56.76%
Per Capita Income	13456

Fig 20: Gwalior Wards

Currently Gwalior comprises off 60 wards with population density 43.3 person per hectare. The average male female ratio in Gwalior is 870 female on per 1000 male.

Population as per census and projections in CDP

1991- 622982

2001- 823277

2011- 10,50,00

2021- 14,00,00

9.2 Summary of recommendations

RENEWABLE ENERGY INITIATIVES

No	Project Details	Investment (Rs. In Lakhs)	Energy Generated in lakh kWh PA	Annual GHG t Co2	Energy Generated /Saved upto 2013
	RESIDENTIAL SECTOR				0
1	RESIDENTIAL SOLAR WATER HEATERS	1050	95.5	14325	191
2	ROOFTOP PV & SMALLSOLAR POWER GENERATION PROGRAMME(RPSSGP)	10500	75	6975	150
3	SOLAR COOKER - BOX AND PARABOLA*	200	422	1670	844
4	PASSIVE BUILDING TECHNIQUES AND GREEN BUILDINGS				0
	Residential Sector Sub Total	11750	592.5	22970	1185

ENERGY EFFICIENCY MEASURES

No	Project details	Investment (Rs. lakhs)	Savings(Rs lakhs p.a.)	Savings(lakh kWh p.a.)	Savings(Tonnes of carbon/year)	Savings kwh upto 2013
	RESIDENTIAL SECTOR					
1	USE OF CFL-BACHAT LAMP YOJANA	1.5	41.745	7.59	692.8	15.18
2	IMPLEMENTATION OF T-5 INLINE BALLAST	93.5	105	15.97	1456.9	31.94
3	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS	500	208.137	31.54	2877.7	63.08
4	IMPLEMENTATION OF DUCTED AIR COOLERS	1000	424.49	77.18	7600	154.36
5	ENERGY STAR RATED REFRIGERATORS	2000	337.15	61.3	5700	122.6
6	DEVELOPMENT OF A ZERO ENERGY HOME/OFFICE	1000				
7	ESTABLISHMENT OF ENERGY CENTRE FOR SERVICE AND DEMONSTRATION	135				
	Awareness Campaign	58				
	Residential Sector Total	4788	1116.522	193.58	18327.4	387.16

9.3 Renewable energy Initiatives

9.3.1

RE-1

- RESIDENTIAL SOLAR WATER HEATERS

Background and Justification of the project

Water heating in Indian Households

Hot water is required in households for bathing, cleaning of utensils, washing of clothes, cooking, preparation of cattle feed, etc. In majority of the households in the country, water heating is carried out using the device (stove) used for cooking. While in rural areas, biomass is the main fuel that is used for water heating, in urban households, LPG stove, electrical immersion rod, electric geyser, LPG/PNG geyser are the main appliances that are used for water heating. Penetration of electric geysers is still low in the country and is mostly restricted to urban areas. Studies on ownership of appliances conducted by NSSO indicate that while the ownership of basic appliances like fans and TV are distributed across different income categories. Appliances like electric geysers, washing machines and air-conditioners which can be considered as more luxurious goods are owned by households with the highest level of income. As per the estimates of electric geyser industry, the current sale of electric geysers (mostly 15 and 25 liter capacity) in the country is 1.5-1.8 million pieces/ year and the annual growth in sale is around 20%18. A study on energy use in residential sector carried out by Ernest Orlando Lawrence Berkley Laboratory , USA estimates that in the year 2010, around 17 million households in India (6.5% of the total households) would be using electric geysers. This number is estimated to increase sharply to 56 million households (17.6% of the total households) by the year 2020. The sharp increase is mainly attributed to increase in household incomes, with greater percentage of population being able to afford an electric geyser.

Solar water heaters are also an integral part of the recently announced Jawaharlal Nehru National Solar Mission (JNNSM) of Government of India. The Mission targets to have 20 million m2 of Solar Water Heater collectors by the year 2022
(Table 19)

Table 19:Capacity addition target under JNNSM

Cumulative Target Addition during the Phase		
Phase I (2010-13)	7 million m2	3.45 million m2
Phase II (2013- 17)	15 million m2	8 million m2
Phase III (2017-22)	20 million m2	5 million m2

Source: JNNSM document, MNRE

Residential Sector

Residential sector is the largest sector both in terms of installations as well as sales. As per industry estimates, currently, almost 70-80% of the SWH sales occur in the residential sector. In the year 2001, almost 80% of the SWH installations in India were in the commercial and industrial sectors, since then, residential sector has overtaken commercial and industrial sectors and has become the main driver of growth of SWH in India. It is estimated that in 2009 around 7 lakh households (around 0.4% of the total households) in the country were using SWH systems. More than 95% of these households are located in the urban areas.

Growth of SWH in Residential Sector

The main reasons for growth in SWH in residential sector in recent years are:

• **Growth in new housing**: During 1991-2001 period, 54 million new housing units were added. In recent years, the demand for new housing has shown rapid increase. This is attributed to: increase in disposable incomes, easy availability of credit, trend towards smaller household size, and urbanization. A recent study predicts the demand for new housing units to range between 6.9 million to 9.7 million per year for the period 2005-203014.

• **Rising income and increased propensity for consumer durables**:
India has been experiencing consistent economic growth since early 1990’s, this is reflected also in the household incomes. The number of households having an annual income > Rs 5 lakh/ year has been estimated to grow 10 times -- from around 1 million households in 1995-96 to 10 million households in 2009-10. Increase in household incomes has resulted in increased penetration of consumer durables in households e.g. the penetration rate of cars has been estimated to triple from 3% in 2001-02 to over 9% in 2009-10. It is fair to assume that the demand for SWH in the residential sector has been fuelled by rising incomes.

Factors Influencing SWH Market in Residential Sector

Demand for hot water:

Type of house: Low-rise independent houses with clear ownership of the roof offer most favourable conditions for installation of SWH. A majority of existing SWH installations fall under this category. In recent years, SWH have been installed on multi-storey apartment buildings. The general perception amongst stakeholders is that SWH are more suitable for independent house. Some of the apprehensions about the feasibility of a centralized solar water heating system in multi-story buildings are related with:

• Inadequate area on the roof for installation of SWH.

• Non-availability of technical solutions to ensure equitable distribution, metering of hot water

• Problems associated with the management of a community system.

SWH supply chain:

The numbers of active dealers of SWH in Gwalior are very small. Most of these dealers were found to be small and part-timers, pursing SWH business along with other businesses. Weakness in supply chain is a significant barrier in increasing penetration of SWH.

Electricity supply situation: Electric geysers were found to be the most common water-heating device in the surveyed households. As a result, electricity shortages particularly power-cuts during morning hours influences the demand for SWH.

SWH Size

Generally the size of a domestic SWH installation is taken as 100 lpd.

Thus for calculating number of SWH household and for projecting demand for SWH, the average collector area of a domestic SWH system is taken as 2 m2 collector area.

Implementation of Solar Water heater in Gwalior

We are blessed with Solar Energy in abundance at no cost. The solar radiation incident on the surface of the earth can be conveniently utilized for the benefit of human society. Gwalior receives an average solar radiation in the range of 5.2 to 5.75 kilowatt hours per square meter per day, with about 250-300 sunny days in a year. Solar energy is fundamentally tapped in two different ways; by directly using the heat that is received from the sun and by application of photovoltaic to convert light energy into electricity. Thermal energy is required to fulfill several purposes in the domestic, agricultural, industrial, and commercial sectors of Gwalior.

Basics of Solar Water heating System

One of the popular devices that harness the solar energy is solar hot water system. A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. The solar energy incident on the absorber panel coated with selected coating transfers the hat to the riser pipes underneath the absorber panel. The water passing through the risers get heated up and are delivered the storage tank. The re-circulation of the same water through absorber panel in the collector raises the temperature to 80 C (Maximum) in a good sunny day. The total system with solar collector, storage tank and pipelines is called solar hot water system.

Broadly, the solar water heating systems are of two categories. They are: closed loop system and open loop system. In the first one, heat exchangers are installed to protect the system from hard water obtained from bore wells or tap water. In the other type, either thermosyphon or forced circulation system, the water in the system is open to the atmosphere at one point or other. The thermosyphon systems are simple and relatively inexpensive. They are suitable for domestic and small institutional systems, provided the water is treated and potable in quality. The forced circulation systems employ electrical pumps to circulate the water through collectors and storage tanks.

The choice of system depends on heat requirement, weather conditions, heat transfer fluid quality, space availability, annual solar radiation, etc. The SHW systems are economical, pollution free and easy for operation in warm countries like ours.

Based on the collector system, solar water heaters can be of two types.

Flat Plate Collectors (FPC) based Solar Water Heaters

The solar radiation is absorbed by Flat Plate Collectors which consist of an insulated outer metallic box covered on the top with glass sheet. Inside there are blackened metallic absorber (selectively coated) sheets with built in channels or riser tubes to carry water. The absorber absorbs the solar radiation and transfers the heat to the flowing water.

Evacuated Tube Collectors (ETC) based Solar Water Heaters

Evacuated Tube Collector is made of double layer borosilicate glass tubes evacuated for providing insulation. The outer wall of the inner tube is coated with selective absorbing material. This helps absorption of solar radiation and transfers the heat to the water which flows through the inner tube. There are 44 MNRE approved ETC based solar water heating suppliers. Solar water heating is now a mature technology. Wide spread utilization of solar water heaters can reduce a significant portion of the conventional energy being used for heating water in homes, factories and other commercial and institutional establishments.

Salient Features of Solar Water Heating System

Solar Hot Water System turns cold water into hot water with the help of sun's rays.

- Around 60 deg. – 80 deg. C temperature can be attained depending on solar radiation, weather conditions and solar collector system efficiency
- Hot water for homes, hostels, hotels, hospitals, restaurants, dairies, industries etc.
- Can be installed on roof-tops, building terrace and open ground where there is no shading, south orientation of collectors and over-head tank above SWH system
- SWH system generates hot water on clear sunny days (maximum), partially clouded (moderate) but not in rainy or heavy overcast day
- Only soft and potable water can be used
- Stainless Steel is used for small tanks whereas Mild Steel tanks with anticorrosion coating inside are used for large tanks
- Solar water heaters (SWHs) of 100-300 litres capacity are suited for domestic application.

- Larger systems can be used in restaurants, guest houses, hotels, hospitals, industries etc.

Fuel Saving

A 100 litres capacity SWH can replace an electric geyser for residential use and saves 1500 units of electricity annually.

Avoided utility cost on generation

The use of 1000 SWHs of 100 litres capacity each can contribute to a peak load saving of 1 MW.

Environmental benefits

A SWH of 100 litres capacity can prevent emission of 1.5 tonnes of carbondioxide per year.

Life : 15-20 years

Approximate cost :

Rs.15000- 20,000 for a 100 litres capacity system and Rs.110-150 per installed litre for higher capacity systems

Payback period :

3-4 years when electricity is replaced

4-5 years when furnace oil is replaced

5-6 years when coal is replaced

Though the initial investment for a solar water heater is high compared to available conventional alternatives, the return on investment has become increasingly attractive with the increase in prices of conventional energy. The pay back period depends on the site of installation, utilization pattern and fuel replaced.

Proposed initiatives for rapid deployment of Solar Water heaters in residential sector

1. **Implementation through Electricity Distribution Companies**

There is a need to provide soft-term loan and, depending on the region and building vintage, a financial incentive to promote the market over next 5 to 8 years.

Electricity distribution companies are the most appropriate vehicle to operate the package. The customer will appreciate readily the proposition of electricity-saving, rebate on electricity bill and outgo on account of SWH- purchase for a specified period because the company will make a single, consolidated proposal; smoothening all transactions.

The distribution companies are also best equipped to operate compulsory installation policy for new buildings as well as old ones requiring extra power. They will build a clear database of installations, loan/rebate provided, SWH- performance and electricity saving. GMC should set-up a working group to initiate a dialogue with State Electricity Board and MP Urja Vikas Nigam to develop a SWH programme for implementation through Electricity Distribution Company by 2013/2018.

2. Implementation-Oriented Mandatory Regulations

Mandatory regulations would remain a very important tool for developing market for SWH. Thus, it is imperative that the SWH mandatory regulations addresses the essential legal, administrative and technical issues and outlines the implementation mechanism. A notification has already been passed by the Government of Madhya Pradesh for providing incentives ranging from Rs.3000 to Rs.3300 per solar water heater as a State Financial Assistance to promote the use of solar energy in Madhya Pradesh.

3. Strategy for Multi-storied Buildings

Given the shift towards multi-storey residential buildings, addressing water heating in multi-storey residential buildings through solar water heaters would be the key to realize potential in residential sector. A package of mandatory regulations, technomanagerial solutions, working models and best practices and incentives is essential for multi-storied buildings.

4. Promoting Energy Service Company (ESCO) based models

For setting-up large SWH installations in commercial buildings, industries and large residential developments, ESCO approach has the potential to become the most preferred implementation arrangement. GMC should develop an action plan to develop feasible ESCO models and create conducive environment for development of sustainable SWH ESCO businesses.

There are 505 827 metered households. Assuming that approximately 10 000 households implement solar water heaters with favorable policies and incentives offered by the Gwalior Municipal Corporation, the following will be the benefits.

Table 20 Year wise Programmed target for Rapid deployment of solar water heaters

Year	Number of Installations	Capacity in thousand Litres	Cost(in Lakhs Rs.)	Savings in kwhrs P.a		GHG Savings in Tonnes
1	100	10	11	100000	5	150
2	200	20	22	200000	10	300
3	500	50	55	500000	25	750
4	750	75	82.5	750000	37.5	1125
5	1000	100	110	1000000	50	1500
6	1000	100	110	1000000	50	1500
7	1000	100	110	1000000	50	1500
8	1500	150	165	1500000	75	2250
9	1500	150	165	1500000	75	2250
10	2000	200	220	2000000	100	3000
Total	9550	955	1050.5	9550000	477.5	14325

Key Financials

Total Investment in 10 years: Rs.1050.00 lakhs

Total Subsidy

Total subsidy@3000 Rs/system:Rs. 286 lakhs

Savings:

Energy Savings till Year 2013:23050 Mwhrs

Energy Savings in 10 years: 36550 Mwhrs

Savings in Rs(lakhs):Rs.477.5

Study of Major Government Legislations in India

Study of Policy across India:

The highlights of the present policy environment are as follows:

• Several of the municipal corporations have issued orders making SWH use compulsory for new multi-story housing and houses constructed on plots having area more than 500 sq. yards.

• A few of the municipal corporations are offering rebate in property tax

• A few of electricity distribution companies offer rebate in monthly electricity bills

• Several states offer upfront subsidy for residential systems

• IREDA through banks is operating an interest subsidy scheme to offer concessional finance for installation of SWH.

If certain policy measures are implemented rigorously it has the potential to become an important driver in market development.

1. **Upfront Subsidies**

Upfront subsidies by states/towns through their local urban bodies do assist in development of market in the initial stages but the process of availing subsidy is generally long and cumbersome and in the states where it is offered only a fraction of the SWH owner households are availing subsidies due to delay in disbursement.

To overcome this hurdle, the GoMP has initiated the TATKAL SCHEME in Madhya Pradesh for availing the Solar Water heater subsidies.

Highlights

. Bank Guarantee based allocation of subsidy

.Subsidies to be released within 3 working days if all conditions are met

2. **Rebate on Property Tax**

Rebate on property tax is being offered by only few cities, the amount of rebate available is small; the effectiveness of this instrument is yet to be tested. It is advisable for GMC to initiate a rebate in property tax for households installing solar water heaters ranging for 2-5% of the property tax.

3. **Rebate in Electricity Bills**

Rebate in electricity bills is a useful instrument to promote SWH, MPUVN can initiate a reduction in 5 ps per unit tariff subject to a maximum of Rs50 per month in the electricity bill.

4. **Soft loans from Commercial Banks**

Only a few banks and financial intermediaries are putting effort in implementing IREDA interest subsidy scheme. The scheme is being implemented successfully in some pockets; however, there is a scope to improve implementation of this scheme. Existing.

Notification issued for judicious use and conservation of power in state

13 March 2010 : Bhopal

The state government has issued a notification for judicious use and conservation of power in Madhya Pradesh. In the wake of this notification, now it will be mandatory to use power judiciously and conserve it as per provisions of Urja Sanrakshan Adhiniyam 2001.

As per the notification, the use of solar water heating system will be mandatory in buildings and places of various categories. These buildings include commercial and industrial establishments where warm water is required for processing apart from private and government hospitals, nursing homes, all the private and government sector hotels, motels, rest houses, restaurants and canteens. The buildings of business and industrial establishments, whose capital exceeds Rs 50 lakh and where warm water is used, will have to cater to their 25 per cent hot water requirement through solar water heating system within one year of the issuance of the notification.

All the government departments will amend their laws and bylaws within two months after issuance of the notification for making solar water heating system mandatory in their buildings. Madhya Pradesh Energy Development Corporation will function as the nodal agency for ensuring installation of solar water heating systems.

Incandescent bulbs have been banned in all the newly constructed buildings in the government sector and the sectors which are financially aided by the government.

Now, energy-saving lighting instruments such as CFL, LED-based light, electronic blast, regulators and tube lights will be used in these buildings. Necessary changes will have to be made in all other buildings of government sector and the sectors which are aided by the government to ensure use of energy-efficient lighting devices within two months of the issuance of the notification.

As per the notification, all the government sector and government-aided institutions, municipal corporations, municipalities, Nagar Panchayats, Gram Panchayats, cooperative bodies, housing societies, development boards, development authorities etc will have to use only ISI/BEE-certified pumps sets, motors, valves, power capacitors, streetlights etc.

The concept of energy-efficient designs will be incorporated in the layouts of all the new buildings to be constructed in government and government-aided sectors.

The state government has made Madhya Pradesh Energy Development Corporation as the nodal agency for the implementation of this notification.

Proposed Incentives and Policy recommendations for implementation in GMC area

Policy

• Loan @ 2%, 3% and 5% respectively to residential, institutional and industrial/commercial customers.

• Capital subsidy equivalent to upfront interest subsidy to institutional and industrial/commercial customers who do not avail of concessional interest

Loan to be highlighted by GMC in association with MPUVN

• Capital subsidy @ Rs.3000-3300 per 100 lpd, in addition to concessional interest loans, to residential customers

• Accelerated depreciation @ 80% to profit-making industrial/commercial customers

• Rebate in electricity bill, @ Rs. 50 to 150 per month, to residential customers

• Rebate in municipal property tax @ 6% to 10%, to SWH- owners

•Gwalior Municipal Corporation regulations making installation of SWH compulsory for

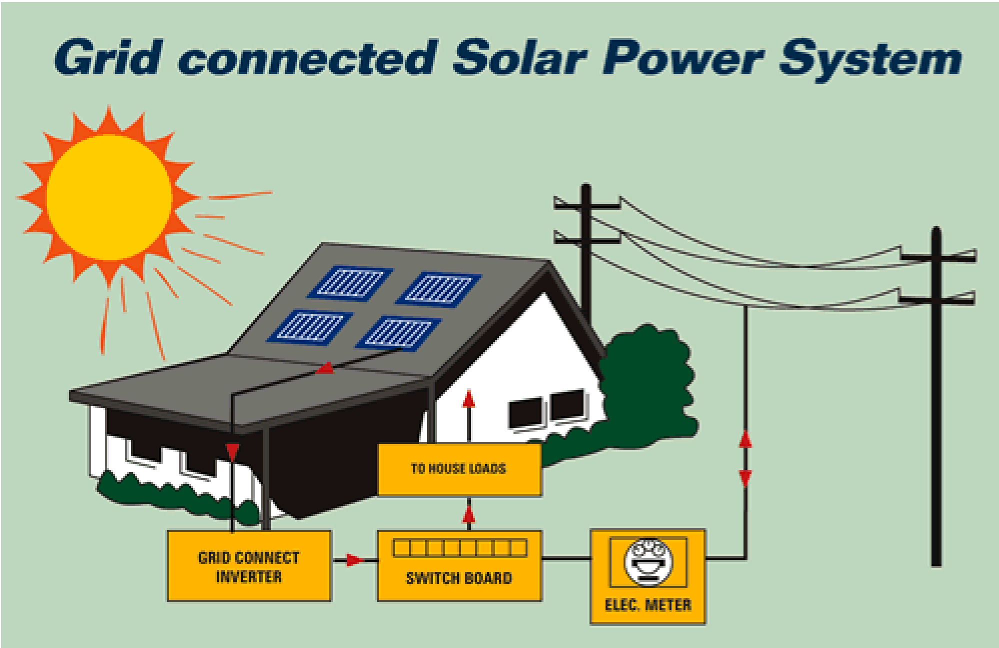
- Housing units above a cut-off size
- hospitals & nursing homes,
- hotels, lodges and guest houses,
- hostel, school, colleges, training centers and other institutes,
- barracks of armed forces, paramilitary forces and police

The announcement has been done to make SWH mandatory by MPUVN as per MNRE guidelines. There is no property tax rebate, nor any electricity rebate.

9.3.2

RE-2

- ROOFTOP PV & SMALL SOLAR POWER GENERATION PROGRAMME(RPSSGP)



Background and Project Justification

Solar PV power Generating System

Solar power is the conversion of sunlight to electricity. Sunlight can be converted directly into electricity using photovoltaic (PV). Solar PV system is an arrangement of photovoltaic array, solar charge controller PCU, Battery bank and protection devices in **which solar energy is converted into direct current electricity via Photovoltaic effect.**

Photovoltaic is the most direct way to convert solar radiation into electricity and is based on the photovoltaic effect. It is quite generally defined as the emergence of an electric voltage between two electrodes attached on a solid or liquid system upon shining light on to this system. Practically all photovoltaic devices incorporate a pn junction in a semiconductor across which the photovoltage is developed. These devices are also known as solar cell.

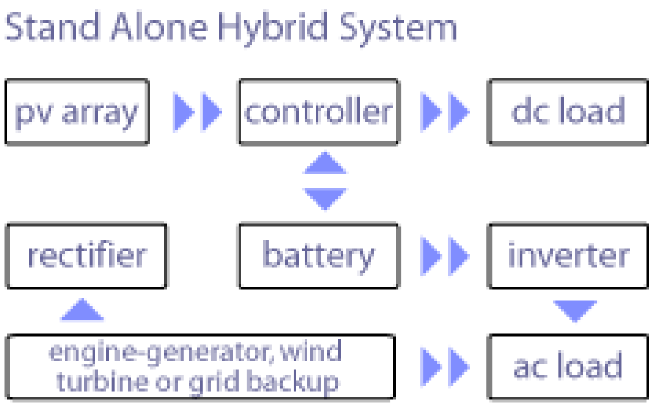
Types of the system

1. Hybrid system
2. Stand alone system
3. Grid connected system.

1. Hybrid system

Photovoltaic hybrid system is the system with battery storage powering DC or AC loads and using backup power source (wind, engine-generator, utility power)

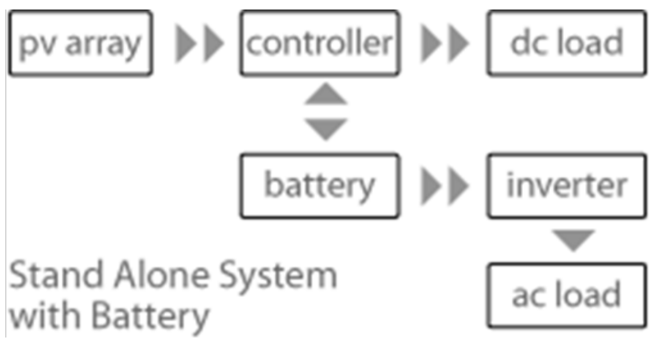
Fig 21: Hybrid System



2. Stand alone system

Stand alone PV system are designed to operates independently from the grid and are designed and sized to supply certain DC or AC load.

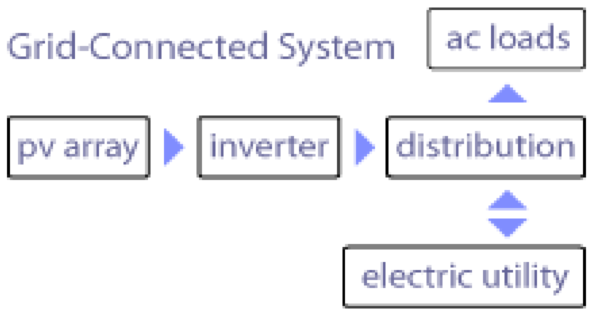
Fig 22: Stand alone system



3. Grid connected system

Grid-connected PV system are designed to operate in parallel with and interconnected with electric utility grid.

Fig 23: Grid Connected System



4 Balance of system (BOS):

BOS includes mounting systems and wiring systems used to integrate the solar modules into the structural and electrical systems of the home. The wiring systems include disconnects for the dc and ac sides of the inverter, ground-fault protection, and overcurrent protection for the solar modules.

The BOS is defined as everything except the PV modules and the load. The BOS includes:

- The land, fencing, buildings etc
- Module support structures
- External wiring & connection boxes
- Power Conditioning equipment, inverter, charge controllers, transformers, etc.
- Safety & Protective equipment- diodes, switches, lighting protection, circuit breakers, ground rods and cables etc.
- Energy Storage batteries
- Utility Grid Interface and Connective devices
- Wretches monitoring instruments and associated sensors (pyranometers, thermometers, anemometer etc)

- Data acquisition equipment for monitoring & evaluating the PV system performance

Project justification:

Madhya Pradesh is the centre of India. Gwalior is the one of major district of Madhya Pradesh located on latitude 26.22^{o} N and longitude 78.18 ^{o} E. Here average annual solar insolation is greater than 5.2 kw/m^{2} /day. Solar potential is high on this place compare to other part of India.

Setting a Power System based on solar will not only help to additional power requirement but serve the salient features

- A clean. Silent and eco- friendly source of power
- Negligible maintenance as there are no moving parts
- Long life spam of solar modules
- Simple installation: Can be mounted on the roof to of ground.
- Can be installed at point of use to avoid the transmission losses.

Today when country is facing scarcity of the power. Solar energy is very large, inexhaustible source of energy. Currently Gwalior is taking electricity from the state electricity board. It energy demand is increasing day by day. Keeping each point in the mind (cost of power, different losses, uncertain power cut) Extracting power from the solar is the one way to become independent for the need of power.

Objective of this project

Objectives of the project are

1. To implement a 5 Mw Rooftop PV & Small Solar Power Generation Programme(RPSSGP) in Gwalior City
2. To use the most effective and environmental friendly power saving method.
3. Shift portion of day time lighting load to Solar Power.
4. Reduce the pollution.
5. Reduce the GHG emission.

Solar Energy Potential in Gwalior

Solar Energy resource assessment is the primary & essential exercise for solar energy projects because of its intermittent nature.

The maximum possible values of solar radiation on earth are solar Constant (1367 W/m2)

To know the Solar Energy Potential in Gwalior following resources have been used

1) Average Sunshine Hours
2) Average wind speed
3) Average rainfall
4) Average ambient air temperature
5) Average maximum solar radiation
6) Average minimum solar radiation
7) Average solar radiation on Horizontal Surface
8) Average solar radiation on tilted surface

Table 21: Monthly Averaged Insolation Incident on A Horizontal Surface ($kWh/m^2/day$)

Lon 78.18	22-year Average
Jan	5.28
Feb	6.17
Mar	6.28
Apr	5.72
May	5.37
Jun	5.18
Jul	4.99
Aug	5.09
Sep	5.21
Oct	5.38
Nov	5.57
Dec	5.38

Annual Average	**5.46**

Project Site Details

Site Details

(1) Location/Address Gwalior

(2) Altitude 207 M

(3) Latitude 26.22° N

(4) Longitude 78.18 ° E

(5) Av rainfall 88.9 cm

(6) Temperature

Summer: 33°C - 45°C,

Winter: 1 °C - 20 °C

Fig 24: Avg Insolation kWh/m2/day

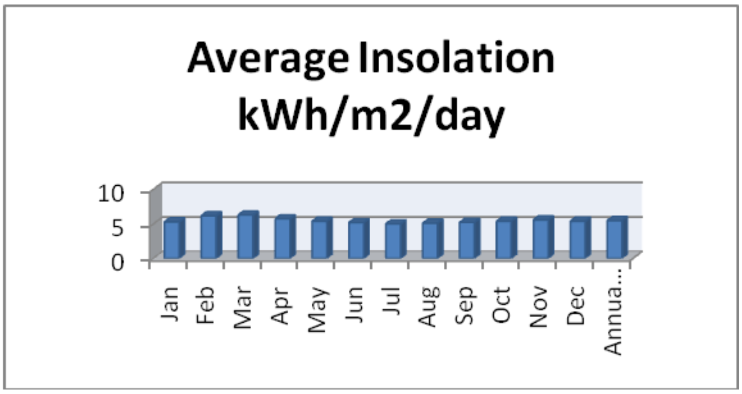


Table 22: Monthly Averaged Clear Sky Insolation Incident on A Horizontal Surface (kWh/m2/day)

Lon 78.18	Average Insolation
Jan	7.27
Feb	7.6

Mar	7.65
Apr	7.47
May	7.07
Jun	6.74
Jul	6.8
Aug	7.21
Sep	7.48
Oct	7.53
Nov	7.27
Dec	7.12
Annual Average	**7.26**

Fig 25: Avg Insolation in clear sky day kWh/m2/day

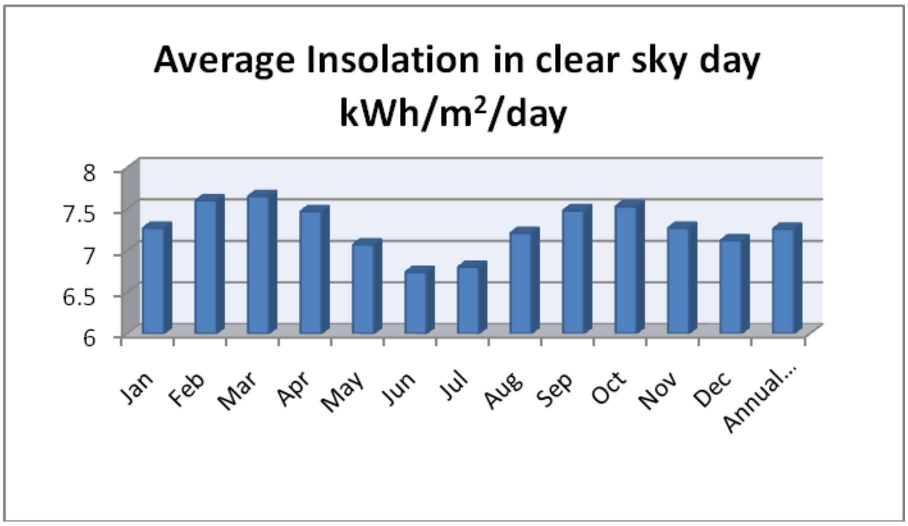


Table 23: Monthly Averaged Daylight Hours (hours)

Lon 78.18	Hours
Jan	12.1
Feb	12.1
Mar	12.1
Apr	12.1
May	12.1
Jun	12.1
Jul	12.1
Aug	12.1
Sep	12.1
Oct	12.1
Nov	12.1
Dec	12.1
Annual Average	**12**

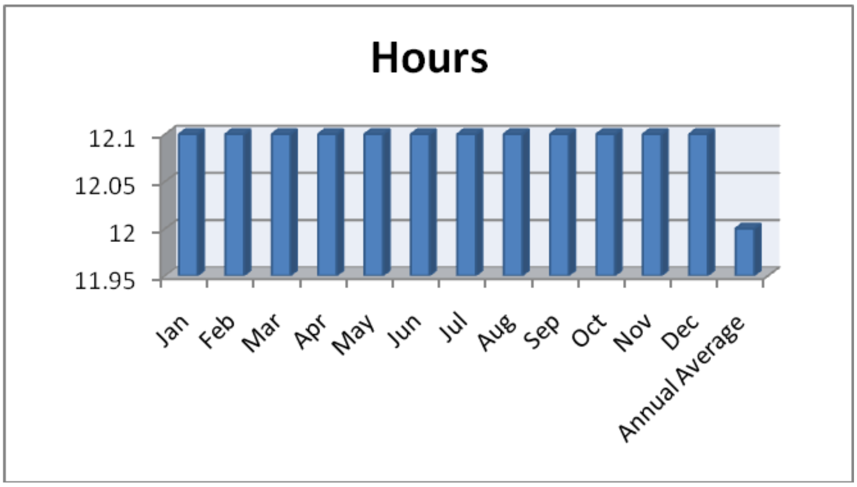


Table 24 : Monthly Averaged Declination (degrees)

Lon 78.18	degrees
Jan	-20.7
Feb	-12.3
Mar	-1.8
Apr	9.71
May	18.8
Jun	23
Jul	21.2
Aug	13.7
Sep	3.08
Oct	-8.45
Nov	-18.1
Dec	-22.8

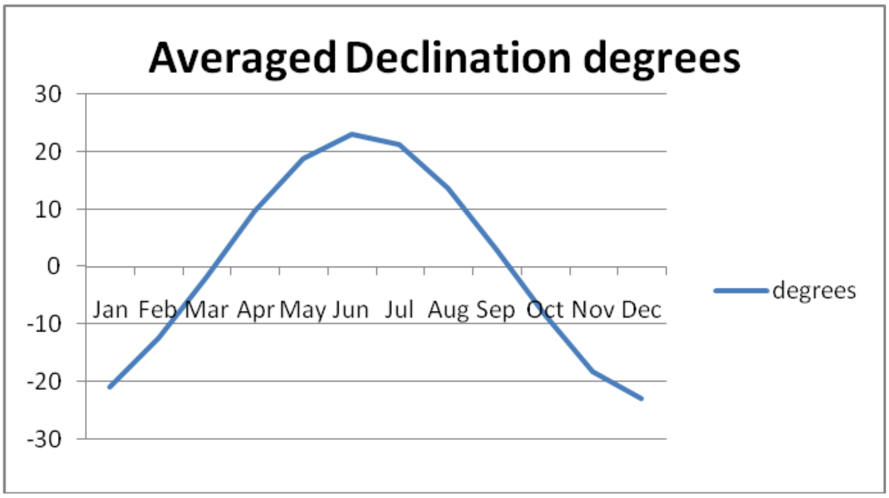


Table 25: Minimum Radiation Incident on an Equator-pointed Tilted Surface (kWh/m2/day)

Lon 78.18	Direct	Tilt 0	Tilt 15	Tilt 90

Jan	4.15	4.45	4.66	2.71
Feb	5.03	5.06	5.18	2.51
Mar	4.9	5.1	5.03	1.83
Apr	4.52	4.99	5	2.05
May	4.07	4.24	4.34	2.2
Jun	4.22	4.29	4.45	2.41
Jul	3.72	4.16	4.29	2.26
Aug	3.16	3.92	3.94	1.87
Sep	3.34	4.36	4.28	1.64
Oct	3.68	4.5	4.54	2.1
Nov	3.78	4.05	4.19	2.35
Dec	4.3	4.55	4.82	2.92
Annual Average	**4.07**	**4.47**	**4.56**	**2.24**

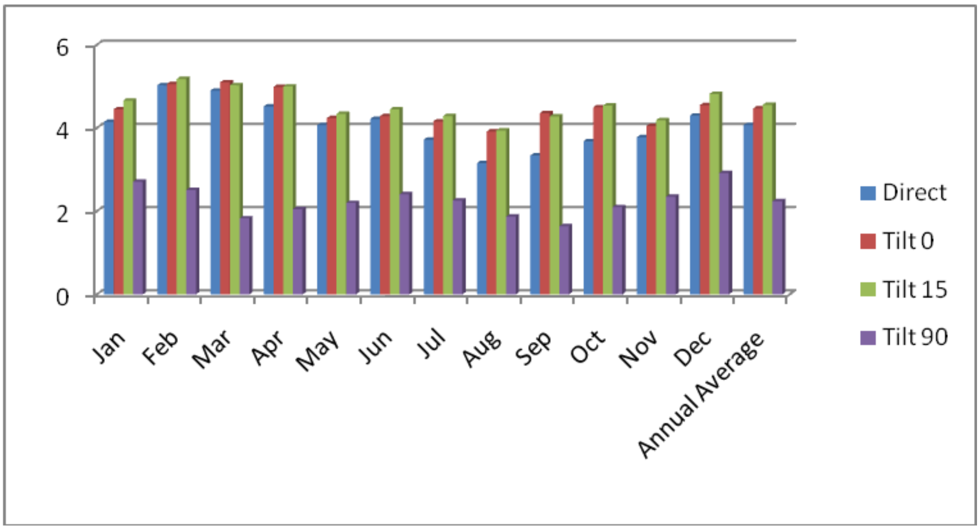


Table 26: Optimum Tilt

Lon 78.18	**Tilt 15**
Jan	4.66
Feb	5.18
Mar	5.03
Apr	5

May	4.34
Jun	4.45
Jul	4.29
Aug	3.94
Sep	4.28
Oct	4.54
Nov	4.19
Dec	4.82
Annual Average	**4.56**

Fig 26 : Optimum Tilt

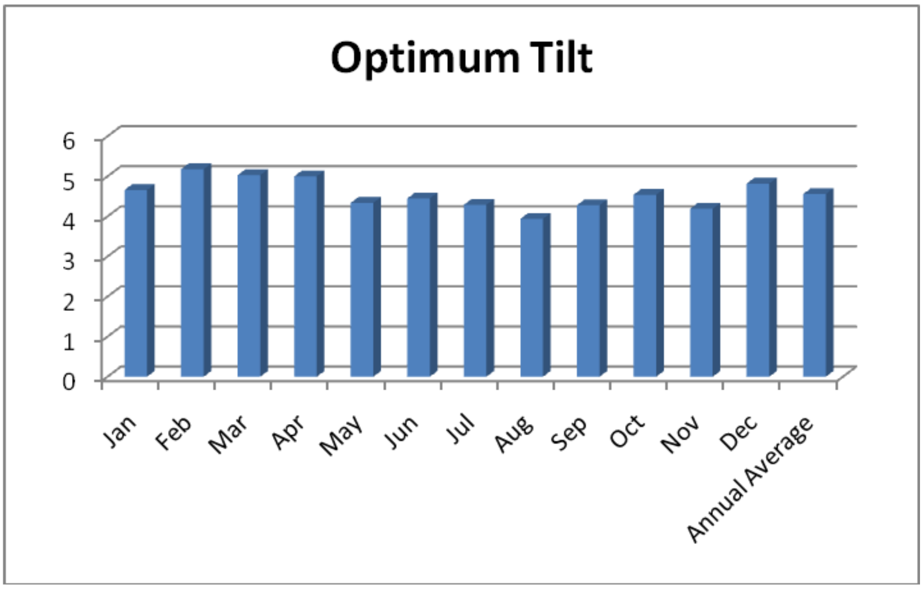


Table 27 : Monthly Averaged Air Temperature At 10 m Above The Surface Of The Earth (°C)

Lon 78.18	Average	Minimum	Maximum
Jan	26.9	26.2	27.6
Feb	26.8	26.1	27.5
Mar	27.2	26.5	27.8
Apr	27.5	26.8	28.1

May	27.7	27.1	28.3
Jun	27.3	26.6	27.9
Jul	27	26.3	27.6
Aug	26.7	26.1	27.3
Sep	26.7	26.1	27.3
Oct	26.7	26.1	27.3
Nov	26.7	26.1	27.3
Dec	26.7	26	27.4
Annual Average	**27**	**26.3**	**27.6**

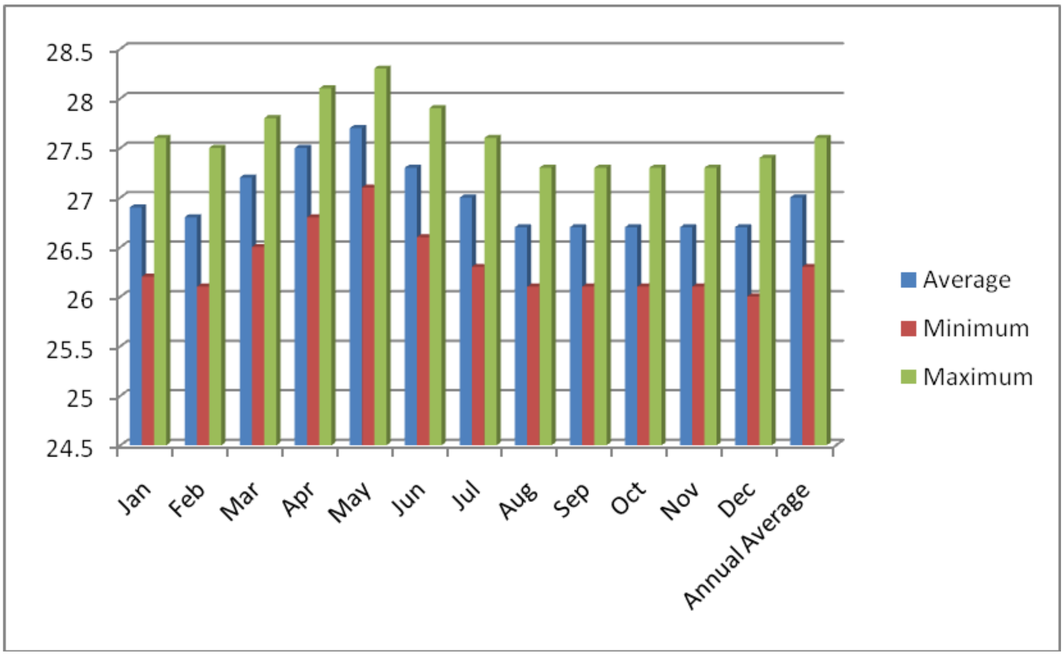
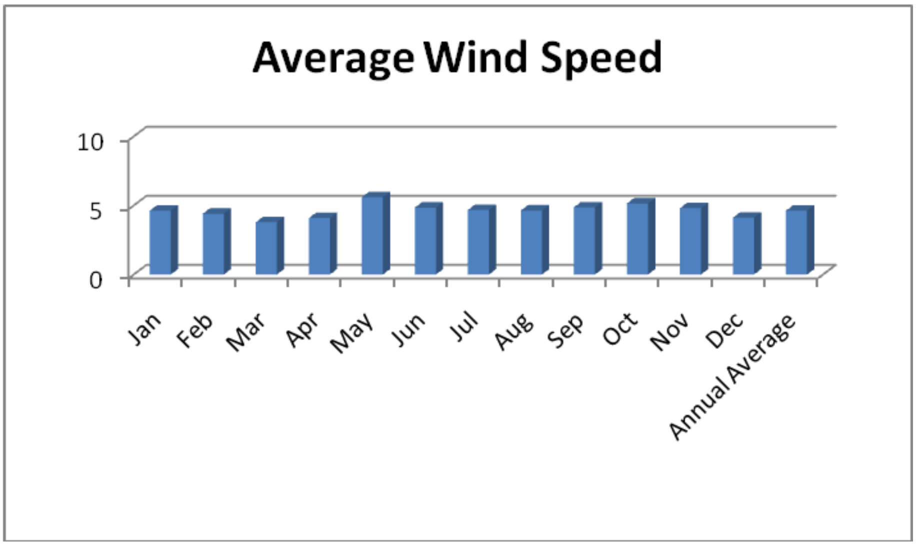


Table 28 : Monthly Averaged Wind Speed At 50 m Above The Surface Of The Earth (m/s)

Lon 78.18	**Average**
Jan	4.62
Feb	4.4
Mar	3.78

Apr	4.08
May	5.59
Jun	4.84
Jul	4.67
Aug	4.63
Sep	4.86
Oct	5.14
Nov	4.8
Dec	4.11
Annual Average	**4.62**

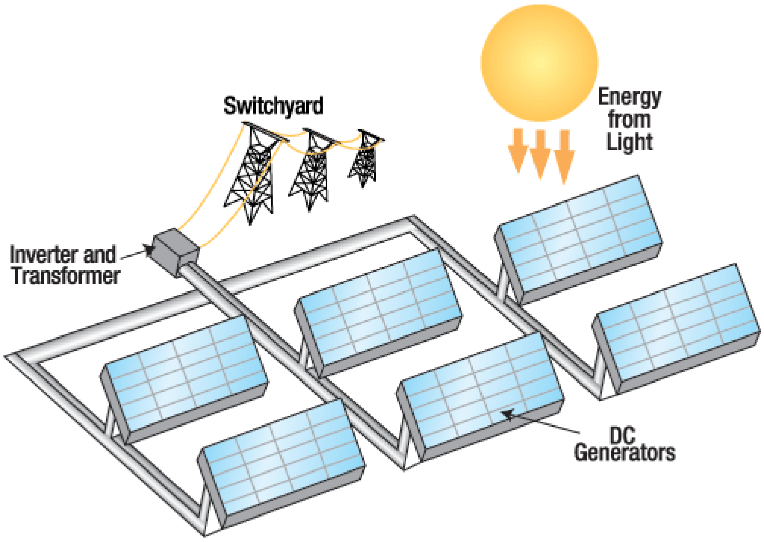
Fig 27: Avg. Wind Speed



Technical and Plant Design

It is proposed to install 1Kw/2Kw grid connected rooftop Solar PV generating Systems on participating households in Gwalior

Fig 28: Working Principal of Solar PV



Component of Solar PV System:-

1 **Solar Module:-**

A solar module is a packaged, interconnected assembly of solar cells also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.

2 **Combiner box& main junction box (CB & MJB):-**

The Combiner Box is an electrical distribution box where the DC circuit breakers are placed. Note that the breakers are usually sold separately. The Combiner Box combines the multiple DC inputs coming from the panel terminations and converts these into one DC output. The output of the combiner box is connected to the charge controller or the inverter, depending on the type of system installed.

3 **Solar module mounting structure**

The fabricated galvanized steel structure is used to support the solar modules. Tilt is approximately equal to the site latitude with a minimum of 10 degrees for self-cleaning & water runoff, unless otherwise specifically stated.

Fig 29: Solar module mounting structure

4 **ACDB and DCDB**

AC and DC distribution board refers to an equipment which consist of bus bar, and possible switches, fuse links and automatic protective equipment, bypass equipment for connecting, controlling and protecting a number of branch circuits fed from main circuit.

5 Inverter

Inverter is a device which that converts direct current (DC) to alternating current (AC). The converted AC can be at any required voltage and frequency with the use of appropriate transformer, switching and control circuit.

6 Power Conditioning Unit

Power conditioning unit is used for improving the quality of the power that is delivered to electrical load equipment. Proper selection of the Power conditioning unit ensures that the system will operate in the optimum range and also extends the life-time of the various components.

System Design and Development:-

A block diagram of the system is shown in Fig. In this design the following factors have been taken into consideration.

_ Grid interfacing circuitry matching,

_ Effects of voltage fluctuation, harmonic distortion and stability

_ Over current, over voltage protection and power failure

_ Power conditioning and flickering

_ Safety, bi-directional metering for power tariff

_Centralized metering and energy tracking system

_Solar performance monitoring

Details of the Scheme

A distributed approach to solar energy is the smart next generation thinking that will drive the renewable industry forward. As more and more utilities-scale solar farms face delays and criticism over land use issues such as natural habitat infringement, rooftops are already there and just waiting for a solar panel upgrade. While maintenance of a vast network of solar rooftops spread out across entire cities may prove cumbersome, it will open up maintenance-related job opportunities, further spurring economic recovery. What's better is that the project is entirely funded by the private sector, which just goes to show that renewable energy doesn't need to rely on government subsidies to be viable.

It is proposed to install 1 Kw or 2 kw solar PV grid connected power generating system to be installed on roof tops in Gwalior city on a maximum of 5000 houses. The project developer is proposed to be GMC in association with a private/semi Government entity.

Financials

Total Investment: Rs.105 crores

Installed Capacity: 5 Mw

Table 29:Financials for 5 Mw rooftop solar SPV project

1	Assumed cost of 1 Wp as per MNRE guidelines	Rs	60
2	Cost of 1 Kw of Solar PV grid connnected system	Rs.	60000
3	System Capacity	Kw	1
4	Hours of sunlight per day	Hours	5.5
5	No. of sunny days	Days	330
6	Cost of Energy Paid per kwh to EB	Rs. Per Kwh	5

7	Annual Generation of energy by solar			Kwh pa	1815
8	Cost of Energy Paid per kwh by EB to project developer				
				Rs per kwh	15.49

First Phase: 10 years

9	Annual Generation of energy by solar	Kwh pa	1815
10	Amount per Kwh of generated energy paid by developer to	Rs per kwh	1
	house owner		
11	Net amount per unit of Kwh generated earned by developer	Rs per kwh	14.49
12	Amount earned by house owner in first 10 years	Rs	18150
13	Amount earned by developer	Rs	262993.5

Second Phase: 10 years

14	Annual Generation of energy by solar	Kwh pa	1633.5
15	Amount per Kwh of generated energy paid by developer to	Rs per kwh	5.49
	house owner		
16	Net amount per unit of Kwh generated earned by developer	Rs per kwh	10
17	Amount earned by house owner in second 10 years	Rs	89679.15
18	Amount earned by developer in second 10 years	Rs	163350

Third Phase: 5 years

19	Annual Generation of energy by solar	Kwh pa	1470.15
	Amount per Kwh of generated energy paid by developer to	Rs per kwh	7.745
20	house owner		
21	Net amount per unit of Kwh generated earned by developer	Rs per kwh	7.745
22	Amount earned by house owner in third 5 years	Rs	56931.55
23	Amount earned by developer in third 5 years	Rs	56931.55

Table 30 : Life Cycle earnings

Developer		
Phase 1	10 years	262993.5
Phase 2	10 years	163350
Phase 3	5 years	56931.55
Total		483275.05
Average monthly receipts		
	Rs.	**2685**

House Owner

Phase 1	10 years	18150
Phase 2	10 years	89679.15
Phase 3	5 years	56931.55
Total		164760.70

Average monthly receipts

Rs. ***915***

Energy Saved/Generated

Implementation Scheme

For implementing grid connected roof top solar PV system in a phased manner an implementation scheme has also been proposed. The main features of the proposed scheme for the initial period would be:

- A Special Purpose Vehicle Organization (SPVO) will be established for developing the projects as bundled project for project financial structuring and availing CDM benefits by the SPVO. SPVO will also undertake following activities:
    - Project technical and financial structuring
    - Obtaining various clearances, approvals etc
    - Identification and approval of vendors

- Establishing qualifying criteria for selection of implementing organization
- Development of bid documents
- Others activities required to prepare a detailed project report and structuring of the project

- The company can avail tax benefits related to accelerated depreciation. While individuals/Government may not be able to avail tax benefits related to interest on loans.
- Once the project is ready the SPVO will call for bids for lowest rates and select the bidder (company) with lowest bid for implementing project on Build-Own-Operate (BOO) basis.

9.3.3

RE-3

- SOLAR COOKER - BOX AND PARABOLA

a) Solar cooker

Solar cooker is a device which uses the energy of sunlight to heat food or drink to cook it or sterilize it. There is no cost for solar radiation. Using parabolic, box, or panel cookers means no gas or electricity costs. They are easy to maintain and just as easy to build. With a little planning and some basic mathematical calculations, anyone can own their own solar cooker. Besides the economic savings, solar cooking helps in the fight against global warming and deforestation. By using the sun’s rays to cook meals, firewood is saved and in many remote areas time is used more usefully than for gathering the necessary firewood needed for wood burning stoves

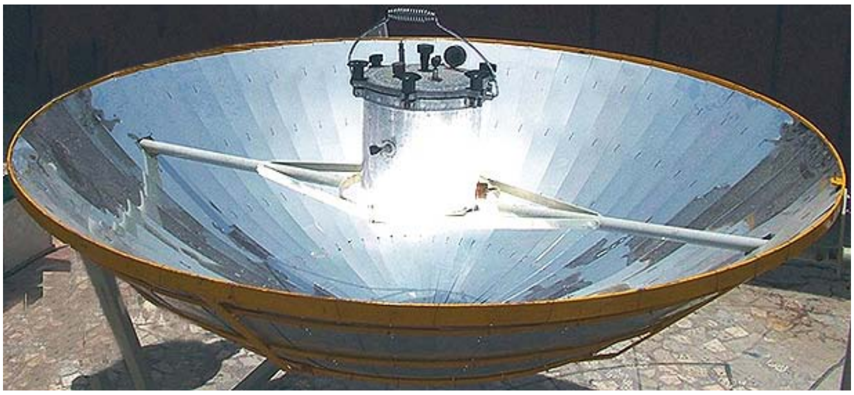
Box cookers

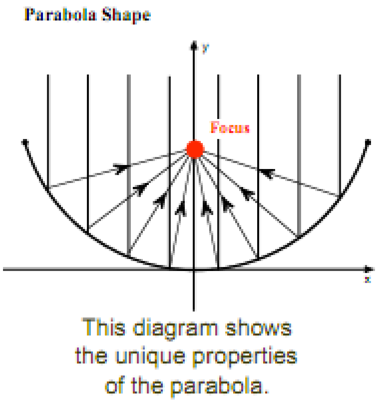
A box cooker has a transparent glass or plastic top, and it may have additional reflectors to concentrate sunlight into the box. The top can usually be removed to allow dark pots containing food to be placed inside. One or more reflectors of shiny metal or foil-lined material may be positioned to bounce extra light into the interior of the oven chamber. Cooking containers and the inside bottom of the cooker should be dark-colored or black. Inside walls should be reflective to reduce radiative heat loss and bounce the light towards the pots and the dark bottom, which is in contact with the pots.

Cookers with paraboloidal reflectors

When a three dimensional parabola (i.e. a paraboloid) is aimed at the sun, all the light that falls upon its mirrored surface is reflected to a point known as the focus. If a black cooking pot is placed at the focus it will absorb the light's energy and become very hot. A satellite dish is an example of a parabaloid that can be made into a cooker. Parabolic Solar cookers heat up quickly and are used like a standard stovetop range to sauté or fry foods, boil water, or even bake bread. They can also be used to generate steam, power sterling engines, crack water to produce H_2 gas,and even plasma matter.

Fig 30 : Cookers with paraboloidal reflectors





Benefits

- Solar cookers use no fuel, which means that their users do not need to fetch or pay for firewood, gas, electricity, or other fuels. Therefore, over time a solar cooker can pay for itself in reduced fuel costs. Since it reduces firewood use, the solar cooker reduces deforestation and habitat loss. Since there are about 2 billion people who are still cooking on open fires, widespread use of solar cookers could have large economic and environmental benefits
- Solar box cookers attain temperatures of up to about 165 deg. C (325 deg. F), so they can be used to sterilize water or prepare most foods that can be made in a conventional oven or stove, from baked bread to steamed vegetables to roasted meat. When solar ovens are placed outside, they do not contribute unwanted heat inside houses.
- Solar cookers do not produce any smoke as a product of combustion. The indoor concentration of health-damaging pollutants from a typical wood-fired cooking stove creates carbon monoxide and other

noxious fumes at anywhere between seven and 500 times over the allowable limits. Fire-based cooking also produces ashes and soot, which make the home dirtier. However, any type of cooking, including solar cooking, can evaporate grease, oil, etc., from the food into the air.

- Unlike cooking over an open fire, children cannot be burned by touching many types of solar cookers, which are made from cardboard or plastic and do not get hot. Unlike all fuel-based cooking arrangements, these solar cookers are not fire hazards. However, solar cookers that concentrate sunlight, e.g. with paraboloidal reflectors, do produce high temperatures which could cause injury or fire.

Solar cooking technologies have been considered as cheap and robust technologies for the developing countries for quite some time. Telkes(1959) through her experiments on solar ovens remarks on the cost effectiveness of solar box cookers and on their applicability in preparing a wide range of food practically all types of foods can be prepared. We conclude that all types of food can be prepared in solar ovens of the types described (triangular solar oven, pot stove, and the cylindrical oven carried out a study on food processing ability of 7 solar cookers. He established the principle requirements for successful adoption of solar cookers as:

(i) Unit must cook foods effectively. Unit must be capable of providing a sufficient energy rate, at desired temperature, and to desired quantity of food.

(ii) It must be sturdy to withstand rough handling and natural hazards.

(iii) It must be sociologically acceptable and fit in with the cooking and eating habits of the people.

(iv)It must be economically possible for the user to obtain the cooker at a cost that gives him gain by its use (ibid).

Proposed Project:

There are 505 827 households in Gwalior based on data of residential electricity connections as released by the DISCOM.

It is proposed to facilitate the sale of 10000 solar cookers in the city of Gwalior in the years upto 2018 in two phases.

Phase	Quantity of Solar Cookers sold
Phase –I	3000
Period: upto 2013	
Phase-II	7000
Period : 2013-2018	
Total	10000

Economics of Solar Box cookers

Electricity Substitution

Type of cooker	:	Solar Box Type
No. of hours used in a day	:	4 hrs
Total no. of sunshine day in one year	:	330
No. of hours of use in one year	:	330 × 4 = 1320 hrs
Total kW saving in one year	:	1320 hrs × 3.2 kW
	:	4224 kWh
Total no. of Cookers	:	10,000
Total no. of years	:	2011 -2018 = 7 years
Hence total Energy saving in kWh in 7 years	:	295680000 kWh
		=2957 Lakh kwh
Total Saving in Rs @ 5 Rs/kWh	:	1478400000 Rs/-
	:	14784 Lakhs INR
Total GHG reduction (tone carbon)	:	295680000 × 0.000963

= 284739.84 tonnes

LPG Substitution

No. of cylinders saved per year per cooker	:	4
Annual LPG saved in Kgs for 10000 cookers	:	4 X 14.4 kgs/cyl X 10 000 kgs
		= 5 76 000 kgs/year
Amount Saved annually @Rs.32 per kg	:	Rs. 184.32 lakhs
Investment for 10000 cookers @Rs.2000	:	Rs.200 lakhs
Simple Payback	:	1.8 years
Qty of LPG saved on 7 years	:	40 32 000 kgs in 7 years

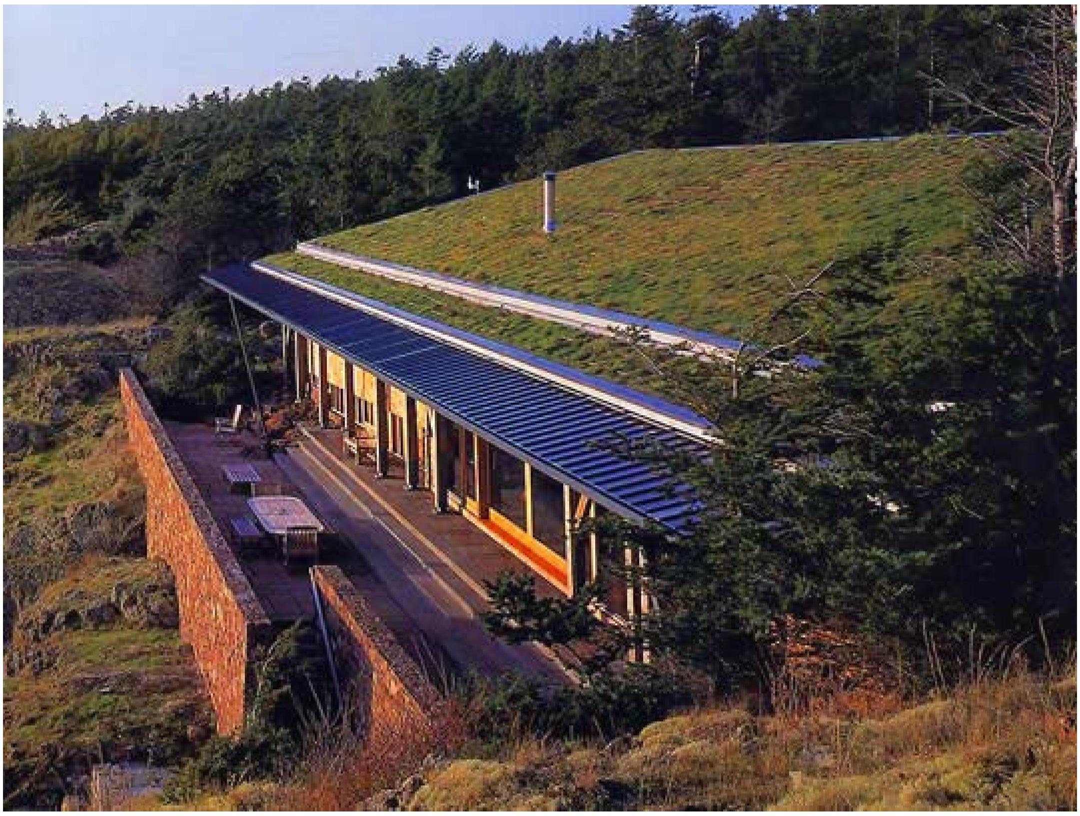
2.9 kg Co2 per Kg Lpg: 1.492 kgCo2 per liter of LPG Source: BEE documents

GHG saved in 7 years	:	1 16 92 800 kgs of Co2
	:	11 692.8 tonnes of Co2

9.3.4

RE-4

- PASSIVE BUILDING TECHNIQUES AND GREEN BUILDINGS



Model Building Byelaws For Construction Of Green Buildings to be introduced by Gwalior Municipal Corporation

Overview

India has rich traditions and history in holistic strategies for buildings and construction. Despite this, the sustainable buildings agenda currently receives limited attention. While there have been local initiatives for promoting sustainable buildings which include research, pilot or advocacy projects, there is no coordinated approach to address the wider sustainable buildings agenda. Commercial and residential sectors continue to be a major market for the construction industry. These sectors consume a lot of energy throughout the life cycle of buildings thus becoming a major contributor to greenhouse gas emissions.

Given the spiralling urban growth and the number of buildings, energy consumption and the resultant carbon emissions is on the rise in the country. The Background note of UNEP, Sustainable Buildings and Construction Initiative (SBCI) says that as per the 17th Electrical Power Survey (EPS) of the Central Electricity Authority, the electricity demand is likely to increase by 39.7% in 2011-12 as compared to 2006-07, by another 43.7% in 2016-17 as compared to 2011-12 and by yet another 37.5% in 2021-22 as compared to 2016-17. With a near consistent 8% rise in annual energy consumption in the residential and commercial sectors, building energy consumption has seen an increase from 14% in the 1970s to nearly 33% in 2004-05. Electricity use in both residential and commercial sectors is primarily for lighting, air conditioning, refrigeration, appliances and water heating. The urban sector depends heavily on commercial fuels for its energy needs. It is estimated that on an average in a typical commercial building in India, around 60% of the total electricity is consumed for lighting, 32% for air conditioning, and less than 8% for refrigeration. Whereas in a typical residential building, around 28% of the total electricity is consumed for lighting, 45% for air conditioning, 13 % for refrigeration, 4% for televisions and 10% for other appliances in the urban sector. The average electricity consumption for air conditioning and lighting in India is around 80 kWh/m^2/annum and 160 kWh/m^2/annum for residential and commercial buildings respectively. Under a Business As Usual (BAU) scenario and based on a 10% annual increase in new built-up areas, the projected annual increase in electricity demand in commercial and residential buildings would be of the order of 5.4 billion kWh.

Energy consumption in Indian buildings is expected to increase substantially due to economic growth, construction demand and other aspects of human development. The demand for energy to run appliances such as TVs, air conditioning and heating units, refrigerators and mobile phone chargers will increase substantially as living standards rise. Also the growth in commercial sector and the shift from rural to urban living will continue to take place. This will result in a substantial increase in resultant emissions from the buildings sector alone and need concerted efforts to bring down the energy consumption by buildings through various measures.

The necessity of taking appropriate efforts to bring down carbon emissions from the building sector is now imperative, as comparatively, the energy savings potential of the building sector with that of other economic sectors, has the greatest potential among all sectors, in all countries, and at all cost levels. This holds true, for India as well, given the high growth rate in construction industry.

The green building movement in India is a step to minimise the negative impact of construction activity on the environment. It has become extremely important today to look at buildings *per se* from the energy consumption point of view. Energy consumption and its reduction need to be seen as the key to a sustainable future. As far as green buildings are concerned, regulations alone are not sufficient to promote green buildings. Awareness and discretion among architects and planners will also play a pivotal role along with incentivising the whole process. For instance, the commercial space in India has grown by nine per cent in this decade whereas the commercial sector energy consumption increased by 13 per cent reflecting the fact that newer buildings consume more energy. Air circulation in buildings, narrower building construction, and green roofs, are some of the most viable means of green buildings.

2. Definitions

2.1 A standard definition of a green building is that it uses less water, optimises energy efficiency, conserves natural resources, generates less waste and provides healthier spaces for occupants, as compared to a conventional building. Green buildings use less energy, and initially cost 5% to 7% more because users are paying for new systems and research and development costs, but within five years, they can recover the costs and start saving.

2.2 **Baseline energy-performance and associated greenhouse gas emissions**

According to a report of UNEP 2007, baseline energy performance of a building type is defined as the typical energy consumption of a particular building type in a given geographical area using the prevalent technologies and construction method and building materials (energy performance tends to change drastically with change in climatic zone, nature and function of the building). An attempt needs to be made to develop baseline energy-performance and associated greenhouse gas emissions for the major building types in India.

2.3 **Zero net emissions in existing and new buildings:**

Zero net emissions are accounted for in Zero-energy buildings. Zero energy buildings are defined as buildings that produce as much energy as they consume over a full year. 'Zero energy' states that the energy produced on-site through renewable sources (such as wind, sun) is equal to the energy used by the building when annual accounting is done.

3. Key attributes of Sustainable buildings :

- Consideration of sustainability aspects in all phases of building design and planning
- Consideration of sustainability aspects during construction and production of building materials
- Use of healthy and environmentally friendly building materials and products
- Use of efficient systems
- Use of constructions and systems which are easy to maintain and service
- Safeguarding high functionality, flexibility and adaptability
- Safeguarding health and comfort of users, occupiers and visitors
- High aesthetic and urban design quality; high public acceptance
- Appropriate location with good access to public transportation services and networks

In a nutshell, sustainable buildings use less energy and water, generate less greenhouse gases, use materials more efficiently, and produce less waste than the conventional buildings over their entire life cycle.

4. Key initiatives

The country has a number of policy initiatives to mainstream energy efficiency and green buildings as control and regulatory instruments, including appliance standards, mandatory labelling and certification, energy efficiency obligations, and utility DSM(Demand side management) programs; economic and market-based instruments; fiscal instruments and incentives; support, information and voluntary action. Some of these are :

4.1 Energy Conservation Building Code 2007

The Energy Conservation Act 2001 provides for the establishment of state energy conservation agencies to plan and execute programs. The Act led to the formation of Bureau of Energy Efficiency (BEE) that formulated the Energy Conservation Building Code (ECBC). It targets building energy efficiency and was introduced in the year 2007. This is the nation's first building energy code and aims to have a major impact on energy-efficiency in buildings. It is a voluntary code for all buildings with a connected load of 500 kW and most likely to become mandatory. It covers minimum requirements for building envelope performance as well as for mechanical systems and equipment, including heating, ventilation and air conditioning (HVAC) system, interior and exterior lighting system, service hot water, electrical power and motors in order to achieve energy efficiency in different climatic zones of India.

4.2 The Ministry of Environment and Forests (MoEF), Environmental Impact Assessment (EIA) and Clearance is a mandatory requirement for all buildings with a built up area above 1.50 lakh m2 and such projects have to be apprised by the MoEF's Environmental Appraisal Committees (EACs) and the State Environmental Appraisal Committees (SEACs).

4.3 The Ministry of New and Renewable Energy has initiated several programs focusing on the utilisation of renewable energy sources in buildings.

4.4 Sustainable Habitat Mission under the National Action Plan on Climate Change. The National Action Plan on Climate change was launched by the Hon'ble Prime Minister, Dr. Manmohan Singh on June 30, 2008. It encompasses a broad and extensive range of measures, and focuses on eight missions, which will be pursued as key components of the strategy for sustainable development. These include missions on solar energy, enhanced energy efficiency, sustainable habitat, conserving water, sustaining the Himalayan ecosystem, creating a

"Green India," sustainable agriculture and, finally, establishing a strategic knowledge platform for climate change. For the Sustainable Habitat Mission, the strategies proposed aim at promoting efficiency in the residential and commercial sectors through various measures such as change in building bye laws, capacity building, research and development in new technologies, education and awareness, etc., management of municipal solid waste, and promotion of urban public transport.

4.5 Energy labelling of appliances.

BEE has several programs to set labels and energy efficient standards for refrigerators, air conditioners, motors and other appliances. Labelled products have been in the market since 2006. In a move to manage energy demands, BEE has made star rating for energy efficiency mandatory for a host of electrical appliances from September 20, 2008.

5. Rating systems

Building rating systems are a popular tool to bring momentum in achieving energy efficiency and sustainability in buildings. The country has currently two rating systems namely, LEED and GRIHA.

5.1 Leadership in Energy and Environmental Design (LEED) :

Leadership in Energy and Environmental Design (LEED) Green Building Rating System™, developed and managed by the USGreen Building Council(USGBC), is the most widely used rating system in North America. Buildings are given ratings of platinum, gold, silver, or "certified", based on green building attributes. LEED is evolving rapidly; in the United States, at least nine types of specific programs exist, including those for new commercial construction and major renovation projects, existing building operations and maintenance, commercial interiors, homes, schools, neighborhoods and retail.

The Indian Green Building Council (IGBC) founded by the collaboration between the Confederation of Indian Industry (CII) and Godrej, has taken steps to promote the green building concept in India. Currently, IGBC is facilitating the LEED rating of the U.S. Green Building Council in India. LEED-India was launched in 2001 and rates buildings on environmental performance and energy efficiency during the design, construction and operation stages.

5.2 Green Rating for Integrated Habitat Assessment (GRIHA): The Ministry of New and Renewable Energy have adopted a national rating system- GRIHA which was developed by The Energy and Resources Institute (TERI). It is an indigenously developed rating system completely tuned to climatic variations, architectural practices, existing practices of construction and attempts to revive passive architecture. The GRIHA rating system takes into account the provisions of the National Building Code 2005, the Energy Conservation Building Code 2007 announced by BEE and other IS codes. This was developed specifically aimed at non-air conditioned or partially air conditioned buildings. GRIHA has been developed to rate commercial, institutional and residential buildings in India emphasizing national environmental concerns, regional climatic conditions and indigenous solutions.

GRIHA stresses passive solar techniques for optimizing visual and thermal comfort indoors and encourages the use of refrigeration-based and energy-demanding air conditioning systems only in cases of extreme thermal discomfort.

There has been an upcoming trend especially in the commercial sector to look at sustainability aspects and of late, a number of such projects have gone in for either of the above prevalent building assessment system (rating system). As an indication, there are some 375 registered green building projects in India with LEED accounting for 260 million sq. ft. and 28 registered green building projects for GRIHA accounting to 1.3 million sq. ft.

5.3 Conservation of Energy And Buildings and Construction- "One of the best ways of achieving is to incorporate green initiatives in building bye laws, and one of these is to make rainwater harvesting and recharge mandatory for every construction. The other initiative would be to encourage use of solar energy in buildings for heating of water, which should be pursued strongly by State Governments. Further, "Architects can employ innovative techniques for building homes that are cooler without air conditioning while government can start by replacing all incandescent bulbs in its offices and quarters with CFL ones

6. Steps to Initiate Sustainable Green Buildings

6.1 Sustainable site planning
6.2 Sustainable site practices
6.3 Building design
6.4 Passive solar design
6.5 Building materials
6.6 Building systems
6.7 Renewable energy systems
6.8 Waste and water management
6.9 Green practices

The idea is to include comprehensive practices on energy efficiency that incorporate

6.10 lighting design
6.11 Low-cost, low-energy materials
6.12 Waste management and water conservation
6.13 Sustainability in the community

7. Byelaws

The bye-laws for construction of Green Buildings should include:

- setting annual carbon emission targets for all newly constructed buildings
- targets set to achieve a 20% reduction in emissions from dwellings and 23% from buildings other than dwellings
- new bye-laws to improve compliance by requiring sample air pressure testing for all buildings, including dwellings
- new requirement for householders to be provided with an energy rating for new homes that show estimated energy costs for space heating, water heating, ventilation and lighting together with the calculated annual CO2 emissions that will be emitted from the dwelling
- improved standards that will result in developers needing to make greater use of energy saving insulation, more efficient heating boilers and consider using low or zero carbon systems such a solar panels and geothermal technology to demonstrate compliance

Setting clear performance targets in the building bye-laws for all new buildings will not only make a significant contribution to reducing CO2 emissions but will offer householders reduced fuel bills too. This will result in improved building standards and a more sustainable built environment. A key component of this Eco-Active initiative should also inform and encourage people on how to make energy savings.

8. Non negotiable Byelaws Green Building Construction Techniques

8.1. Proper Ventilation

Green Buildings promote adequate ventilation of all habitable rooms including bath rooms, kitchens with high-efficiency in-duct filtration system to allow proper drainage of air-conditioning coils to control humidity including heating and cooling systems which ensure indoor air quality.

Over and above the provisions stipulated in NBC,2005, the minimum aggregate area of openings , excluding doors inclusive of frames shall not be less than

a)12.5% of the Floor area for dry hot climate

b) 20% of the Floor area for wet hot climate

c) 15% of the Floor area for intermediate climate

d) 10%of the Floor area for cold climate

8.2 Prevention of indoor microbial contamination

Under this technology, construction and finishing materials are selected with zero or low emissions to improve indoor air quality. Many building materials and cleaning / maintenance products emit toxic gases, such as volatile organic compounds (VOC) and formaldehyde gases which result in a detrimental impact on occupants' health and productivity. Such products are not to be used in building construction and their finishing.

8.3 Utilization of recycled material for minimizing the cost of building

Demolition and reconstruction of old buildings is a continuous phenomenon. Population and demand for buildings are increasing day by day whereas resources are depleting in the same proportion. Building construction activities consume one-sixth of the world's fresh water withdrawals, one-fourth of its wood harvest, and two-fifths of its material and energy flow. About 22 percent waste material (bricks, concrete, wood, steel, metals, steel pipes, plastic pipes, electric wires, sanitary material etc.) of demolished buildings can be reused or recycled thus prolonging our supply of natural resources and minimizing construction cost. In green buildings, about 25 % recycled material is used.

8.4 Installation of glass panels

Instead of wooden window, glass panels in aluminium framework shall be installed in green buildings to maximise flow of natural light inside the building during day time.

8.5 Installation of Rainwater Harvesting System

The green buildings shall be well equipped with rainwater harvesting system to preserve depleting water resource.

8.6 Maximizing the use of renewable natural resources

In order to maximize the use of renewable natural resources in green buildings, the energy efficient equipments such as Compact Fluorescent Lights (CFL) and Solar Water Heating Systems etc. based on non conventional energy resources shall be installed.

8.7 **Minimizing the Use of depleting resources**

Since, forest cover is depleting day by day in the world, therefore, use of fresh wood is minimized in green buildings. Wherever, use of wood is considered necessary, in such buildings, the wood of fast regenerated trees shall only be used so that utilization of such material may not effect the ecological balance of the earth.

8.8 **Minimizing energy use in green buildings**

The green buildings are fixed with energy sensors to minimize the use of power within the building. When there is no person within a room, the lights would automatically go off.

8.9 **Water conservation and efficiency measures in green buildings**

In green buildings, water is used in the most efficient way. The grey water from bath rooms shall be recycled to flush toilets.

8.10 **Proper disposal of garbage**

The garbage of green buildings shall be properly handled, placed and disposed off as per Building Bye Laws of respective Civic Bodies by segregating it into biodegradable and non-biodegradable wastes.

8.11 **Maintenance of greenery**

In green buildings, the open areas shall be well landscaped with maintenance of maximum greenery for building healthy environment.

- Solar water heating systems for bathing, washing, cleaning etc.
- Solar steam generating systems for community cooking, laundry, sterilization etc.
- Solar passive architecture for natural cooling and heating
- Solar photovoltaic for electricity generation. Various systems/ technologies useful in building could be solar home systems, solar generators, solar street/ garden lights, & building integrated

photovoltaics.

8.12 Solar Water Heating Systems

- A device to provide hot water at 60-80c using heat energy from the sun integrated with storage & back up facilities
- Vast potential in homes, hotels, hospitals, hostels, dairies, industries, institutions, govt. buildings etc.
- Large scale installations could save enormous amount of electricity besides having load shavings during peak hours & abating CO_2 emission
- 40 million sq. m. estimated as techno-economic potential

8.13 Energy

- A 100 lpd system can replace an electric geyser of 2kW capacity. On an average, it can save around 1200 units of electricity in homes or around 120 liters of diesel/ furnace oil in a year in industries & commercial establishments

- Assuming that 50% of the domestic systems are in use at a time, 1 lakh systems installed in a city can result in 100 MW of peak load saving

- 1 lakh systems can also lead to electricity saving of 120 million units/yr to the users for a period of 15-20 years
- 40 million sq. m. potential could lead to peak load shaving of 14,000 MW (70% systems in homes) apart from saving of enormous amount of electricity & fossil fuels in homes & other establishments besides abating CO_2 emissions in atmosphere

9. Measures to incentivize construction of Green Buildings

1. Government constructed and Government owned/maintained buildings should mandatorily be Green buildings across the board. This will set an example to other agencies/ private sector for taking up construction of green buildings. Certain demonstrative projects should be publicised by State

Governments spelling out the nature and quantum of savings in water, electricity consumption etc.

2. The private sector needs to be encouraged in promoting construction of Green Buildings by giving rebate in property tax. Where property tax has been dispensed with eg Haryana, Rajasthan etc, rebate in stamp duty, electricity tariff , and water tariff may be considered.
3. Certified Green Buildings maybe allowed additional rebate.
4. Certified Green Buildings covering various occupancies may also be allowed in incentive FAR.

Measures already in place and recommended for Gwalior Municipal corporation to initiate.

1. Support Measures

- Amendment in building bye-laws for mandatory use of solar water heaters in certain category of buildings
- Rebate in electricity tariff /property tax on use of solar water heating systems
- Incorporation of solar water heating systems in new building & housing complexes by builders & developers
- Rebate in income tax being persued with MoF

2. Measures taken by States/MC's as reported by MNRE

- GOs for amendment of building bye-laws issued (18)
  - Andhra Pradesh, Madhya Pradesh, Punjab, Himachal Pradesh Maharashtra, Tamilnadu, Rajasthan, Haryana, Uttar Pradesh, Uttranchal, Chandigarh, Chattisgarh, Nagaland, Delhi, W.B, Karnataka, Mizoram , Dadar & Nagar Haveli
- Bye-laws amended (22)- Karnataka (1), Gujarat (1), W.B.(1), Maharashtra (9), Andhra Pradesh (2), UP (7), Chatisgarh(1),
- Rebate in electricity tariff (6)
  - Rajsthan (15 paise/unit) , Karnataka (50 paise/uint) , West Bengal (40 paise to Max. of Rs. 80/-), Assam (Rs. 40/-), Haryana (Rs 100/ 100 lpd up to 300 lpd) & Uttranchal (Rs. 75/sq. m.)

- Rebate in property tax (4)
  - Thane, Amravati, Nagpur & Durgapur providing 6- 10% rebate

3. Initiatives by Delhi Government as reported by MNRE

- Use of systems in certain categories of buildings made mandatory. Rigorous monitoring & publicity by Delhi Govt. Penalty clause introduced
- Scheme for promotion of domestic systems launched
- Rs. 6,000 rebate on each system provided to users. Award scheme announced for other systems
- Group Housing Societies/ RWAs / Builders being persuaded to install systems in multi-storied flats. Design guidelines prepared by MNRE
- Provisions of installing solar water heaters included in Master Plan 2021
- Banks/ Suppliers/ Utilities being tied up for facilitating installation of systems at users places. Implementation in ESCO mode being explored

4. Actions proposed

- Architects & Engineers to involve themselves in practicing energy efficient building designs & convince people for adopting the same. They should even understand the concept of Green buildings & promote among people
- Builders & Developers to start constructing buildings & housing complexes integrated with solar water heating systems & passive architectural designs
- Municipal Corporations/ Municipalities to adopt & notify modifications in building bye laws. Plans for certain categories of buildings to be approved only if solar water heater & passive features are incorporated
- Banks/ FIs to join the MNRE soft loan scheme through IREDA. Housing loans to include the cost of solar water heaters. Provisions to be made mandatory/ attractive schemes to be developed
- Manufacturers to have tie ups with builders/ Architects & Financial Institutions

- Architects/ SNAs/ Manufacturers to publicize the concept of solar buildings & generate proposals for support from MNRE
- State Govts. to issue GOs on mandatory use of passive concepts in Govt./ public sector buildings & enforce implementation

5. <u>Promotional Measures to promote Solar Passive Architecture</u>

- Support for DPR up to Rs. 2 lakhs & for construction of Govt /Public buildings to a Max. of Rs. 50 lakhs.
- GOs by State Govts. on mandatory use of passive concepts in Govt./ public sector buildings. H. P. , Haryana, Punjab, Rajasthan & Nagaland issued such orders.
- Solar Passive design concepts incorporated in Energy Conservation Building Code by BEE & National Building Codes by BIS.
- A National Rating System for Green Buildings developed in association with TERI. It will be suitable for all kinds of buildings in different zones of the country. Proposed to be incentivized & in operation during 2008-09.

6. <u>Solar Buildings-National Rating System</u>

- Indigenous system suitable for all kinds of AC/ non-AC & intermittent cooling buildings
- Developed through interactions with all stakeholders including relevant Ministries & Departments. Takes into account NBC 2005 & ECBC 2007
- System will help new buildings in assessing their predicted performance over its entire life cycle.
- Will operate on 100 point marking basis. 43 points pertain to energy & waste management. Proposed to be incentivized by MNRE

A National Advisory Council constituted for advice and direction to the Rating System. A Technical Advisory Committee also formed for modification & up-gradation of the system, if any.

7. <u>Solar Cities by MNRE</u>

Objective : To promote the use of renewable energy & energy conservation devices/systems in cities & towns by providing support to Municipal Corporations for preparation and implementation of a Road Map to develop their cities as Solar Cities

Targets : 60 cities with at least one in each State to a maximum of 5 in a State. Each city to reduce their existing energy consumption by 10% in 5 years

Support : Up to Rs. 50 Lakhs per city/ town for preparing Master Plan, oversight of its implementation, setting up of a Solar city cell & organizing promotional activities.

8. **Criteria for selection**

- P

  olitical and administrative commitment towards adoption of sustainable energies (Resolution to be passed by the City Council/Administration)
- Regulatory measures taken on adoption of energy conservation and renewable energy
- Potential for adoption of energy conservation & RE
- Initiatives already taken by City Council/Administration in promoting energy conservation and renewable energy
- Urban Local Bodies' previous experience in involving public participation and working with all stakeholder
- Willingness to provide resources and sustenance of activities under the program.

9. 11th Plan Proposals for urban areas

- Solar water heating systems (5 million sq. m.)
- Solar steam/air heating systems (0.25 million sq.m.)

- Energy efficient solar buildings (5 million sq. m. covered area in 1000 buildings)
- Solar photovoltaic devices/systems for urban areas (100 MW capacity systems)
- Solar Cities (60 No.)

9.4 Energy Efficiency

9.4.1

EE-1

- USE OF CFL- BACHAT LAMP YOJANA

Background and Project Justification

Energy demand is increasing due to accelerated industrialisation, urbanisation and an emerging consumer society. The fossil energy supply use is expected to be three times the current consumption. Keeping the above factors in mind, the Government of India enacted the Energy Conservation Act in 2001 and created the Bureau of Energy Efficiency to spearhead the improvement of energy efficiency in the economy through regulatory and promotional instruments.

Energy Efficient technology: Lighting accounts for almost 20 percent of the total electricity demand in the country and it is due to ICLs which are highly energy consuming. Only about 5 percent is converted into light and rest is used as heat where as CFL uses only 1/5th of electricity and provides the same level of illumination. To overcome the challenge of over heating, CFLs are recommended by BEE to conserve Energy.

1. Decreases peak load: Lighting is one of the major contributors to peak load. If 400 million light points are replaced with CFLs; it would lead to a reduction of over 10,000 MW in electricity demand. It would not only reduce emissions but also result in the reduction of peak load in the country which currently faces a shortage of up to 15 percent.
2. Reduce Green House Gas emissions: Incandescent Lamps are harmful to the environment because they use so much energy to function. Most of the energy is emitted as heat and not as light. It leaves a larger carbon foot print. With BLY, the harmful effect on the environment will be reduced to a great extent.
3. Win-win situation for all stakeholders: This lamp savings programme reduces government and household expenditure. With reduction in energy consumption in every household, the country can conserve its limited power supply and on a household level, electricity bills are within control

Stake holders

CER issuance.

Distributing companies (DISCOM) has the responsibility to prepare the database of households (include names of users, their address and average electricity consumption) to install CFLs. They distribute CFL lamps in exchange of incandescent lamps and estimate technical distribution losses in the electricity grid. They also inspect replaced ICLs. ***CFL Suppliers'*/Investors** role is to collect fused CFLs through buy-back schemes and make sure they are disposed off in a safe manner. They provide CFL at the price comparable to GLS4 lamps. They prepare the CDM programme activity design documents (CPA-DDs) for CDM project and submit them to BEE. They operate and manage project on day to day basis. There is a tripartite agreement between BEE, DISCOM and CFL supplier. The manufacturers and investors of the scheme are: Bajaj Electricals Limited, Plaza Power and Infrastructure Company, Delta Electronics, Balaji Greentech Limited, Finite Energy Limited, B&G Power Limited, Nuvo Fertilizers & Resources private limited etc

The Ministry of Power is the nodal agency, promoting a company called *Energy Efficiency Services Limited (EESL)* for implementation of energy efficiency in India. The Company has promoted energy efficiency projects like Bachat Lamp Yojana, Agricultural Demand Side Management and Municipal Demand Side Management. It has also acted as a Resource Center for capacity building of State Development Agencies, Utilities, financial institutions, etc.

BLY was registered with UNFCCC in April 2010 under which it has been implemented In 14 states. It has empanelled a list of CFL suppliers, including CFL manufacturers, based on their respective capacities and understanding of their CDM approach. It is based on the Clean Development Mechanism (CDM), an arrangement under the Kyotol Protocol allowing industrialised countries with a greenhouse gas reduction commitment to invest in projects that reduce emissions in developing countries as an alternative to more expensive emission reductions in their own countries. The most important factor of a carbon project is that it establishes that it would not have occurred without the additional incentive provided by emission reductions credits. The CDM allows net global greenhouse gas emissions to be reduced at a much lower global cost by financing emissions reduction projects in developing countries where costs are lower than in industrialized countries.

The CDM is supervised by the CDM Executive Board (CDM EB) and is under the guidance of the Conference of the Parties (COP/MOP) of the United Nations Framework Convention on Climate Change (UNFCCC).

Objective

1. Replace inefficient incandescent bulbs with CFLs for households only.
2. To provide an inclusive and sustainable development strategy that is sensitive to climate change.
3. Reduce price of CFL from Rs 100 to Rs 15 per piece.
4. Use Clean Development Mechanism to recover balance cost.
5. Generate Certified Emission Reduction (CER) after monitoring, validation and oversight of CDM Executive Board sold in executive markets.

6. Revenue from sale of CERs to service investments; estimated revenue/CFL of Rs 25 per year-cost recovered in 2-3 years.

It is proposed to install 10000 CFLs under the BLY scheme in Gwalior in association with MPMVNL, MPUVN , GMC and the Ministry of Power.

Energy	**Electricity MWh**	**Total MWh**
Energy - base case	1,168	1,168
Energy - proposed case	409	409
Energy saved	759	759
Energy saved - %	65.0%	65.0%

Energy Saved upto 2013 : 1518 Mwhr

Emission Analysis

Base case electricity system (Baseline) **Country - region**	**Fuel type**	**GHG emission factor (excl. T&D)** **tCO2/MWh**	**T&D losses** **%**	**GHG emission factor** **tCO2/MWh**
India	All types	0.933	8.0%	1.014

GHG emission		
Base case	tCO2	1,184.3
Proposed case	tCO2	414.5
Gross annual GHG emission reduction	tCO2	769.8
GHG credits transaction fee	%	10.0%
Net annual GHG emission reduction	tCO2	692.8
GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	Yr	10
GHG reduction credit escalation rate	%	5.0%

Cost to be incurred by consumer@15 Rs per lamp: Rs.1 50 000.00

9.4.2

EE-2

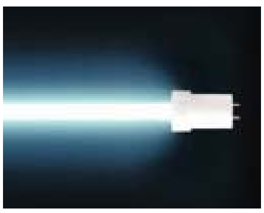
- IMPLEMENTATION OF T-5 INLINE BALLAST

General Description

T-5 Inline Electronic ballast is an innovative Electronic Ballast for Fluorescent Tube Lamps (FTL). It is invented to retrofit standard FTL systems that are operated with Conventional Electromagnetic Ballast (c-Ballast), into energy saving Electronic Operation in a simple, fast and cost effective manner.

The Plug & Save concept of the Inline ballast allows such retrofitting process to be carried out by end users without employing highly qualified expensive electricians. It only takes a minute.

As such, without the complications of wiring, no installation or recurrent maintenance costs are incurred. The T-5 inline Ballast with the T5 tube is probably the most commercially viable e-Ballast in the market.



INLINE T5 SERIES

Fits T5 FTL into common T8/T12 fixtures, and provide High Frequency Energy Saving operation.

It is proposed to replace 10000 nos T-12 FTL with the T-5 Inline Ballast in Hotels , Hospitals, Office Buildings, Educational institutions, hostels ,etc by the year 2013

Footprint Savings

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.933	8.0%	1.014

GHG emission				
Base case	tCO2	7,727.2		
Proposed case	tCO2	6,108.5		
Gross annual GHG emission reduction	tCO2	1,618.7		
GHG credits transaction fee	%	10.0%		
Net annual GHG emission reduction	tCO2	1,456.9	is equivalent to	267
GHG reduction income				
GHG reduction credit rate	INR/tCO2	500.00		
GHG reduction credit duration	Yr	10		
GHG reduction credit escalation rate	%	5.0%		

Cost Savings

Fuel saved	Electricity MWh	Incremental initial costs INR	Fuel cost savings INR	Incremental O&M savings INR	Simple payback Yr
Replacement of T-12 with T-5 inline Electronic ballast	1,597	93,50,000	1,05,36,966	10,00,000	0.8

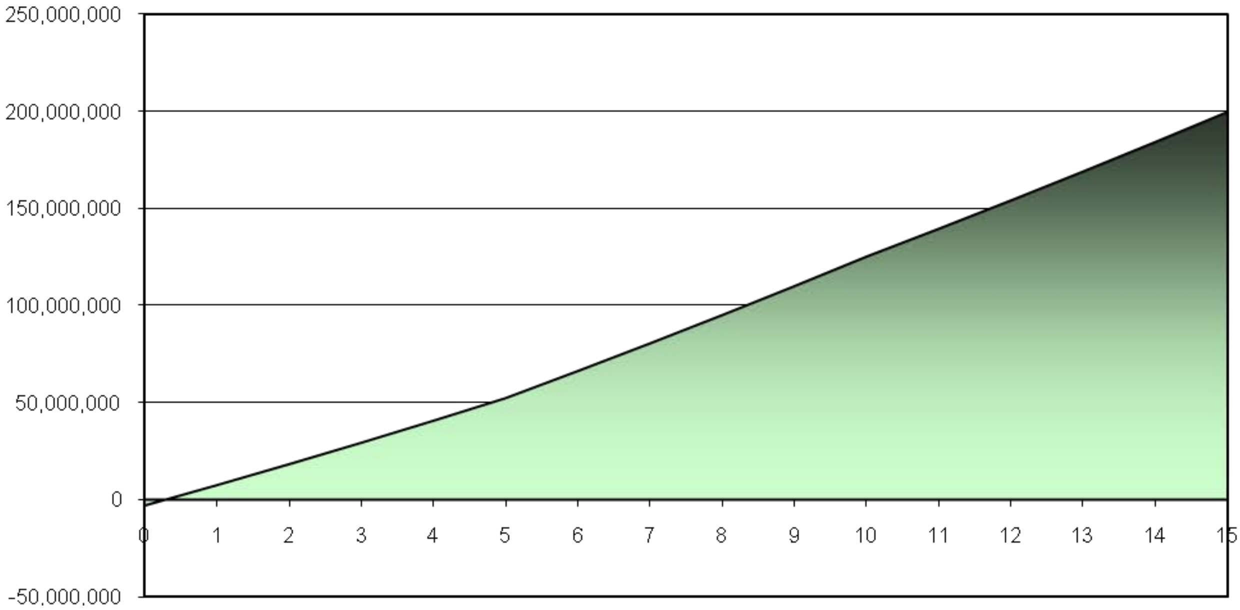
Resource Savings

Replacing with the T-5 inline ballast will save 15 97 000 kWh or 'units of electricity per year.

Base case	Proposed case	Fuel cost savings

Fuel consumption Mwhr	Fuel cost	Fuel consumption Mwhr	Fuel cost	Fuel saved Mwhr	Fuel cost savings
7,621.2	INR 5,02,99,920	6,024.7	INR 3,97,62,954	1,596.5	INR 1,05,36,966

Cumulative cash flows graph



Year

Financial Analysis

Financial parameters		
Inflation rate	%	2.0%
Project life	yr	15
Debt ratio	%	70%
Debt interest rate	%	12.00%
Debt term	yr	5
Initial costs		
Energy efficiency measures	INR	93,50,000
Other	INR	10,00,000
Total initial costs	INR	1,03,50,000
Incentives and grants	INR	
Annual costs and debt payments		
O&M (savings) costs	INR	-10,00,000

Fuel cost - proposed case	INR	3,97,62,954
Debt payments - 5 yrs	INR	20,09,834
Other	INR	
Total annual costs	INR	4,07,72,788
Annual savings and income		
Fuel cost - base case	INR	5,02,99,920
GHG reduction income - 10 yrs	INR	7,28,425
Other	INR	
Total annual savings and income	INR	5,10,28,345
Financial viability		
Pre-tax IRR - equity	%	341.5%
Pre-tax IRR - assets	%	104.8%
Simple payback	yr	0.8
Equity payback	yr	0.3

9.4.3

EE-3

- IMPLEMENTATION OF 5-STAR RATED AIR CONDITONERS

General Description

An average non-energy star rated 1.5 Ton Window AC consumes in the vicinity of 2100 Watts on average (calculated across on-off cycles). By comparison, a modern 5-Star rated split unit AC of the same cooling capacity consumes on average 1700 Watts - an energy savings of approximately 20%. Always shade your AC from direct sun. It reduces the efficiency by 5%.

It is proposed to replace 2000 air conditioners with 5 star rated Air conditioners in residences and small offices etc

Footprint Savings

Emission Analysis

Base case electricity system (Baseline) Country – region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.933	8.0%	1.014

GHG emission		
Base case	tCO2	24,514.0
Proposed case	tCO2	21,316.5
Gross annual GHG emission reduction	tCO2	3,197.5
GHG credits transaction fee	%	10.0%
Net annual GHG emission reduction	tCO2	2,877.7

GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	yr	10
GHG reduction credit escalation rate	%	5.0%

Cost Savings

Note: savings are approximately doubled in cities with higher electricity rates such as Mumbai.

Note: Window AC's are not as energy efficient as Split Units and therefore do not achieve better than 3-star Energy Ratings.

Facility Characteristics	Electricity	Incremental initial costs	Fuel cost savings	Incremental O&M savings	Simple payback
Fuel saved	**MWh**	**INR**	**INR**	**INR**	**Yr**
Replacement with 5 Star rated AC	3,154	5,00,00,000	2,08,13,760	10,00,000	2.3

Resource Savings

	Electricity	Total
Energy	**MWh**	**MWh**
Energy - base case	24,178	24,178
Energy - proposed case	21,024	21,024
Energy saved	3,154	3,154
Energy saved - %	13.0%	13.0%

9.4.4

EE-4

- IMPLEMENTATION OF DUCTED AIR COOLERS

General Description

Evaporative coolers are useful in low-humidity areas or regions. The outdoor air will pass over water saturated pads and cause the water to evaporate into it. The 15 to 45 degree F (depends upon humidity) cooler air is then directed into the space to be cooled and pushes warmer air out through windows that are opened. Evaporative coolers cost about one-half as much to install as air conditioners and use about one-quarter as much energy. The windows can be opened in this type of air cooling system so it keeps fresh air always inside the space to be cooled. The evaporative air cooler can be installed in two ways: Central-location installation for small spaces and ducted system for larger spaces. This cooling system can be installed for domestic, commercial and industrial spaces.

Footprint Savings

Replacing a Two ton Split AC which is a 2 star rated with an Evaporative Air Cooler equivalent can reduce carbon footprint by 6 tonnes CO2e for 273.75 days (Approximately 9 months).

Cost Savings

Replacing an Two ton Split AC which is a 2 star rated with an Evaporative Air Cooler equivalent can save you at least Rs. 16170.08 for 273.75 days per year

(Approximately 9 months) on your electricity bill (based on all-India average electricity rates) and savings are approximately doubled in cities with higher electricity rates such as Mumbai.

Resource Savings

Replacing an Two ton Split AC which is a 2 star rated with an Evaporative Air Cooler equivalent can save 3850.02 kWh or 'units of electricity for 273.75 days per year (Approximately 9 months).

Proposed Implementation: 2000 ACs to be replaced with ductable evaporative coolers with investment is Rs.10 00 00 000 @ Rs.50 000 per unit

For ACs to be replaced with ductable evaporative coolers	Per year/AC	Upto year 2013
Electricity	3859 kwh	1 54 36 000 kwh
GHG	3.8 t CO2e	15 200 tCO2e
Money savings@5.5 Rs/kwh	21 224 Rs.	8 48 96 000 Rs.

Simple Payback: **2.4 years**

The investment to be made is **Rs.50000 /unit**.

The savings per Unit/year is **Rs.21224.**

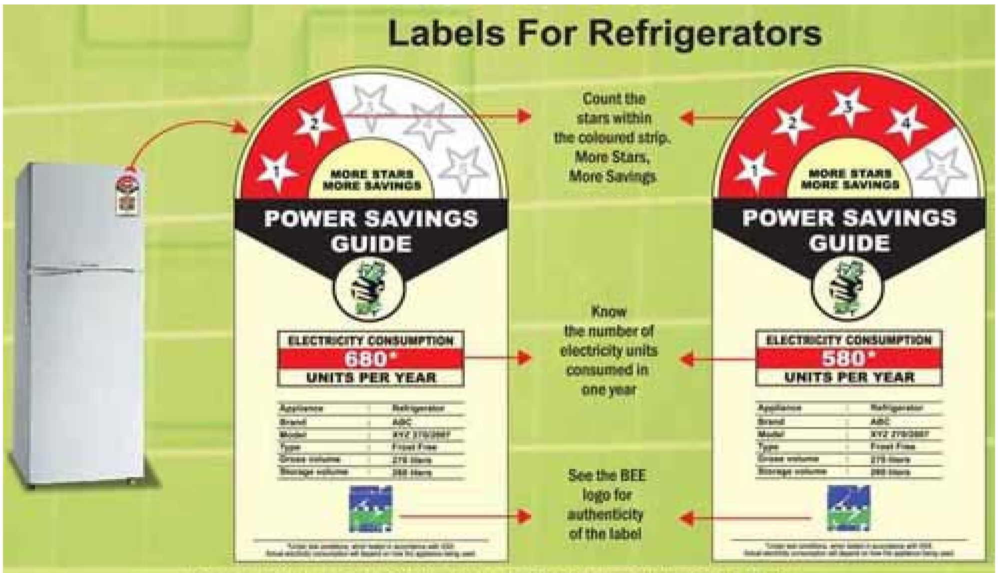
Hence the Simple pay back = **50000/21224**

= 2.4 years

9.4.5

EE-5

- **ENERGY STAR RATED REFRIGERATORS**



Energy and Cost saving for 250 Litres Frost Free Refrigerator at different Star Rating

Star Rating	Energy Consumption Per Year (Approx.)	Per Unit Charge Rs. (approx.)	Electricity Cost/Year in Rs.	Total Saving (w.r.t No star) Every year (Rs.)	Refrigerator Cost in Rs. (Approx.)	Cost Difference Rs.	Pay Back Period in Years
NO STAR	1100	2.50	2750	0	14000	0	0
1 (One)	977	2.50	2443	308	15000	1000	3.25
2 (Two)	782	2.50	1955	795	15500	1500	1.89
3 (Three)	626	2.50	1565	1185	16500	2500	2.11
4 (Four)	501	2.50	1253	1498	17500	3500	2.34
5 (Five)	400	2.50	1000	1750	18500	4500	2.57

General Description

An average 10 to 15 year old 2-door, 300 Liter, Frost-Free Refrigerator consumes in the vicinity of 120 Watts on average (calculated across on-off cycles). By comparison, a modern 5-Star rated refrigerator with identical characteristics consumes on average 50 Watts - an energy savings of approximately 60%.

Footprint Savings

Replacing a 10-15 year old refrigerator with a 5-star rated equivalent can reduce carbon footprint by 0.57 tonnes CO2e annually

Cost Savings

It would save you at least Rs. 2600 per year on your electric bill (based on all-India average electricity rates).

Note: savings are approximately doubled in cities with higher electricity rates such as Mumbai.

Resource Savings

Replacing a 10-15 year old refrigerator with a 5-star rated equivalent can save 613 kWh or "units of electricity per year

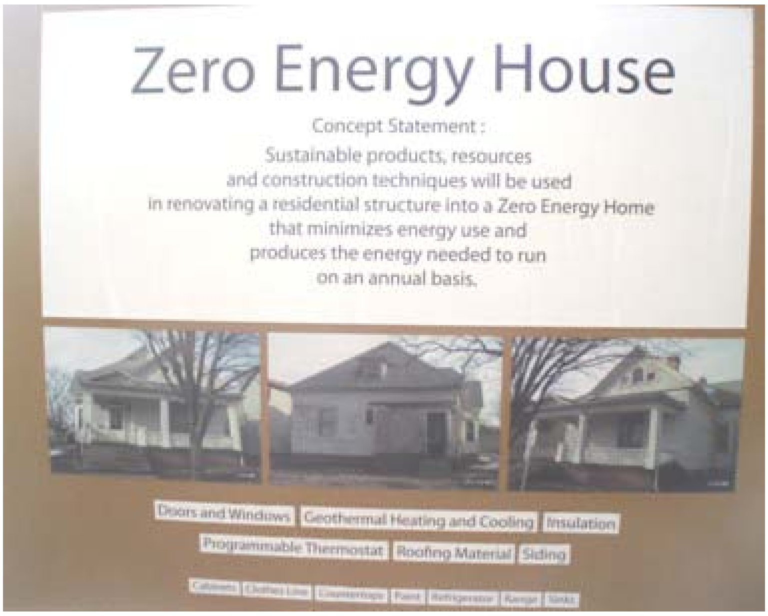
Proposed Implementation: 10 000 refrigerators among 50 000 households to be replaced with energy efficient refrigerators @ 20000 per unit with a total investment of Rs.10 00 00 000

For one refreigerator	Per year/home-office	Upto year 2013
Electricity	613 kwh	1 22 60 000 kwh
GHG	0.57 t CO2e	5 700 tCO2e
Money savings@5.5 Rs/kwh	3371.5 Rs.	6 74 30 000 Rs.

Simple Payback:3 years

9.4.6

EE-6 • DEVELOPMENT OF A ZERO ENERGY HOME/OFFICE



A net zero-energy building (ZEB) is a residential or commercial building with greatly reduced energy needs through efficiency gains such that the balance of energy needs can be supplied with renewable technologies.

Buildings have a significant impact on energy use and the environment. Commercial and residential buildings use almost 40% of the primary energy and approximately 70% of the electricity in the United States (EIA 2005). The energy used by the building sector continues to increase, primarily because new buildings are constructed faster than old ones are retired. Electricity consumption in the commercial building sector doubled between 1980 and 2000, and is expected to increase another 50% by 2025 (EIA 2005). Energy consumption in the commercial building sector will continue to increase until buildings can be designed to produce enough energy to offset the growing energy demand of these buildings. Toward this end, the U.S. Department of Energy (DOE) has established an aggressive goal to create the technology and knowledge base for cost-effective zero-energy commercial buildings (ZEBs) by 2025.

In concept, a net ZEB is a building with greatly reduced energy needs through efficiency gains such that the balance of the energy needs can be supplied by renewable technologies.

A ZEB typically uses traditional energy sources such as the electric and natural gas utilities when on-site generation does not meet the loads. When the on-site generation is greater than the building's loads, excess electricity is exported to the utility grid. By using the grid to account for the energy balance, excess production can offset later energy use. Achieving a ZEB without the grid would be very difficult, as the current generation of storage technologies is limited. Despite the electric energy independence of off-grid buildings, they usually rely on outside energy sources such as propane (and other fuels) for cooking, space heating, water heating, and backup generators. Off-grid buildings cannot feed their excess energy production back onto the grid to offset other energy uses. As a result, the energy production from renewable resources must be oversized. In many cases (especially during the summer), excess generated energy cannot be used.
We assume that excess on-site generation can always be sent to the grid. However, in high market penetration scenarios, the grid may not always need the excess energy. In this scenario, on-site energy storage would become necessary.

Prioritize Supply-Side Technologies to Those Available On Site and within the Footprint

Various supply-side renewable energy technologies are available for ZEBs. Typical examples of technologies available today include PV, solar hot water, wind, hydroelectric, and biofuels. All these renewable sources are favorable over conventional energy sources such as coal and natural gas; however, we have developed a ranking of renewable energy sources in the ZEB context. Table 1 shows this ranking in order of preferred application. The principles we have applied to develop this ranking are based on technologies that:

- Minimize overall environmental impact by encouraging energy-efficient building designs and reducing transportation and conversion losses.

• Will be available over the lifetime of the building.

• Are widely available and have high replication potential for future ZEBs.

This hierarchy is weighted toward renewable technologies that are available within the building footprint and at the site. Rooftop PV and solar water heating are the most applicable supply-side technologies for widespread application of ZEBs. Other supply-side technologies such as parking lot-based wind or PV systems may be available for limited applications. Renewable energy resources from outside the boundary of the building site could arguably also be used to achieve a ZEB. This approach may achieve a building with net zero energy consumption, but it is not the same as one that generates the energy on site and should be classified as such. We will use the term “off-site ZEB” for buildings that use renewable energy from sources outside the boundaries of the building site.

Table 31 : ZEB Renewable Energy Supply Option Hierarchy

Option Number	ZEB Supply-Side Options	Examples
0	Reduce site energy use through low-energy building technologies	Daylighting, high-efficiency HVAC equipment, natural ventilation, evaporative cooling, etc.
On-Site Supply Options		
1	Use renewable energy sources available within the building’s footprint	PV, solar hot water, and wind located on the building.
2	Use renewable energy sources available at the site	PV, solar hot water, low-impact hydro, and wind located on-site, but not on the building.
Off-Site Supply Options		
3	Use renewable energy sources available off site to generate energy on site	Biomass, wood pellets, ethanol, or biodiesel that can be imported from off site, or waste streams from on-site processes that can be used on-site to generate electricity and heat.
4	Purchase off-site renewable energy sources	Utility-based wind, PV, emissions credits, or other “green” purchasing options. Hydroelectric is sometimes considered.

Proposal for implementing a 10 000 Sq feet ZEB office building for Gwalior Municipal Corporation

	Area (Sq. Feet)	Base Case	Proposed Case
Cost (Rs.) -estimated	10 000	3 00 00 000	10 00 00 000

A good ZEB definition should first encourage energy efficiency, and then use renewable energy sources available on site. A building that buys all its energy from a wind farm or other central location has little incentive to reduce building loads, which is why we refer to this as an off-site ZEB. Efficiency measures or energy conversion devices such as daylighting or combined heat and power devices cannot be considered on-site production in the ZEB context. Fuel cells and microturbines do not generate energy; rather they typically transform purchased fossil fuels into heat and electricity. Passive solar heating and daylighting are demand-side technologies and are considered efficiency measures. Energy efficiency is usually available for the life of the building; however, efficiency measures must have good persistence and should be “checked” to make sure they continue to save energy. It is almost always easier to save energy than to produce energy.

9.4.7

EE-7

• ESTABLISHMENT OF ENERGY CENTRE FOR SERVICE AND DEMONSTRATION

It is proposed to establish an energy centre to promote energy efficiency and renewable energy activities in Gwalior with the following mandate.

- The Energy Efficiency & Renewal Energy Management Centre of GMC seeks to create partnerships between industry, consumers, manufactures and institutions to give a new direction to this movement.
- It will create awareness about Energy Efficiency & Renewable Energy Resources and how they can be harnessed in various applications in the home, business, industry, trade and buildings.
- It will do so by organising trainings of all groups of people who would become torch bearers for Energy Efficiency and Renewable Energy.
- It will advise on regulatory measures.
- It will create a panel of experts who will work with various sectors to help in promoting this as a business model and creation of value for the customers.
- It will change student ideas in this area by organising Awareness Camps, Debates, Essay Competitions, Exhibitions & Experiments to carry the message through the youths of Gwalior.
- Set up an Energy Conservation Fund and collaborate with financing institutions to find Energy Conservation Activities including Research Projects having demonstration capability with reputed institutions in Gwalior.
- Work with architects and planners for promotion Green Building Concepts in Gwalior to conserve Energy, Water, Air Quality, and promote Gwalior Solar City Campaign of GMC.
- Promote projects which further energy conservation and renewable energy technologically and financially.

- Arrange for demonstration of energy efficiency and renewable energy products and technologies.
- Act as a service centre for the above products.

Table 32 : Project Financials

Sl.No	Budget Head	Amount (Rs. In lakhs)
1	Land and Building(to be provided by GMC)	0
2	Interiors	15
3	Display equipment	25
4	Service centre set up (Tools and Tackles)	10
5	Out reach Activities(1st year)	20
6	Publicity and Awareness	25
7	Salary and Admin Expenses(1st Year)	40
	Total	**135**

9.5 Publicity and awareness

In every country, there are opportunities for more efficient energy management. Improving efficiency at all levels of government can result in lower energy costs, reduced demand on capacity-constrained electric utility systems, increased energy system reliability, and reduced emissions of greenhouse gases and local air pollutants.

In addition, the government sector’s buying power and visible leadership offer a powerful, non-regulatory means to stimulate market demand for energy-efficient products and services.

Increased buyer demand can trigger a positive response from domestic suppliers, encouraging them to know more about energy efficiency.

Despite these benefits of government sector leadership in energy efficieny, many countries—particularly developing and transition economies—have only recently begun to focus on energy efficiency policies in this sector.

Institutional barriers that historically have constrained public on energy-efficiency efforts include a lack of awareness and technical expertise, bias toward buying lowest-first-cost products .The barrier can be outcome by creation of publicity and awareness. These can be done by organizing work shops, exhibitions ,rallies and contest. These all can be done in joint ventures and sponsors from interested private firms.

The workshops training can be conducted in industries, government offices etc to give effectiveness on energy awareness. Exhibitions can be conducted to public and live demo on energy efficient things can be shown to them.

Similarly mass rallies can also be conducted to public to teach the usefulness in energy management.

As our Ex Prime Minister Jawaharlal Nehru said "Children are our builders for our nation". Creating awareness in school level is made by 'contests- debate, painting,etc and these are conducted at school level for motivating them in their young age itself so they can build up our nation with bright future.

Table 33: Expenditure for publicity and awareness creation

No	Details	No of events	Budgeted Amount/event (Rs. in lakhs)	Total (Rs. in lakhs)
1	Workshops	4	5	20
2	Exhibitions	2	10	20
3	Rallies	4	2	8
4	Contest	5	2	10
			Total	**58.00**

10.0 Commercial and Institutional Sector

10.1 Background and description

An area consisting of non-housing units such as non-manufacturing business establishments (e.g., wholesale and retail businesses), health and educational institutions, and semi government and private offices.

Commercial sector as defined economically, consists of business establishments that are not engaged in transportation or in manufacturing or other types of industrial activity (agriculture, mining, or construction). Commercial establishments include hotels, motels, restaurants, wholesale businesses, retail stores, laundries, and other service enterprises; religious and nonprofit organizations; health, social, and educational institutions. Street lights, pumps, bridges, and public services are also included if the establishment operating them is considered commercial.

Buildings typically cover residential and commercial buildings; where commercial buildings are typically all buildings that are not residential, industrial, or agricultural. Sometimes this broader grouping of commercial buildings is separated further into institutional and commercial.

A **commercial building** is a building that is used for commercial use. Types can include office, warehouses, or retail (i.e. convenience stores, stores, shopping mall, etc.). In urban locations, a commercial building often combines functions, such as an office on levels 2-10, with retail on floor 1. Local authorities commonly maintain strict regulations on commercial zoning, and have the authority to designate any zoned area as such. A business must be located in a commercial area or area zoned at least partially for commerce.

Commercial buildings utilize nearly seven percent of the total electricity consumption in India. Electricity used in commercial buildings is primarily generated by fossil fuels contributing to greenhouse gas emissions in the country.

It is estimated that buildings can reduce energy consumption to 140 units from 200 kilowatt hour per square metre (kWh/sq.m.) of floor area per year, effectively reducing 30-40 percent energy consumption. This can be achieved by incorporating appropriate design interventions in the lighting, heating, ventilation and air-conditioning systems. The major area of energy use in the commercial and institutional building are-

- HVAC
- Lighting
- Water heating
- Other electrical appliances

10.2 Summary of Recommendations- Commercial and Institutional Sector

RENEWABLE ENERGY INITIATIVES

No	Project Details	Investment (Rs. In Lakhs)	Energy Generated in lakh kWh PA	Annual GHG t Co2	Energy Generated/ Saved upto 2013
	COMMERCIAL & INSTITUTIONAL SECTOR				0
5	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOTELS	93.6	4.849	497.1	9.698
6	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOSPITALS	106	4.58	469.9	9.16
7	250 KWP SOLAR PV AND 30,000 LPD SOLAR WATER HEATER AT BORDER SECURITY FORCE(BSF) ACADEMY GWALIOR	717	5.91	496.5	11.82
	Commercial Sector Sub Total	916.6	15.339	1463.5	30.678

ENERGY EFFICIENCY MEASURES

No	Project details	Investment (Rs. lakhs)	Savings(Rs lakhs p.a.)	Savings(lakh kWh p.a.)	Savings(Tonnes of carbon/year)	Savings kwh upto 2013
	COMMERCIAL & INSTITUTIONAL SECTOR					
8	IMPLEMENTATION OF T-5 INLINE BALLAST IN COMMERCIAL BUILDINGS	93.5	105	15.96	1456.9	31.92
9	IMPLEMENTATION OF CFLs IN PLACE OF ICLS IN COMMERCIAL BUIDINGS	10	25.05	3.8	346.4	7.6
10	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS IN COMMERCIAL BUILDINGS	500	208.13	3.154	2877.7	6.308
11	SOLAR HEAT-REFLECTING CLEAR WINDOW FILMS	480	139	21.12	3263	42.24
12	LED BULBS	900	636.24	96.4	9000	192.8
13	UPVC WINDOWS COMMERCIAL BUILDINGS	750	288.35	43.69	4.3	87.38
	Commercial Sector Sub Total	2733.5	1401.77	184.124	16948.3	368.248

10.3 Renewable Energy Potential in Commercial and Institutional Buildings

This section covers two important types of commercial and institutional buildings.

These are:

• Hotels

• Hospitals

10.3.1

RE-5

• IMPLEMENTATION OF SOLAR WATER HEATERS IN HOTELS

A. Existing Stock of Hotel/Guesthouse Rooms in Gwalior

A comprehensive list of Hotels and the rooms is not available in any official Records. A preliminary survey and details obtained from MP tourism Department – regional office Gwalior has helped to prepare a list of top hotels in Gwalior.

Table 34: Overview of Hotels/Guesthouses Rooms in Gwalior

Sl. No.	Name	Address	No. OF Rooms	No of beds	Sanctiond load	Electricity bill in Lakhs
1	Usha Kiran Palace	Nadi GATE, Jayendraganj, Lashkar Ho, Gwalior - 474001	25	50	25	70-80
2	Central Park Hotel	2/A, City Centre, Madhav Rao Scindia Marg, Gwalior Ho Gwalior	40	80	30-40	1.5-2
3	Hotel Gwalior Regency	Bus Stand, Link Road, Gwalior Ho Gwalior	40	80	35	1
4	Tansen Residency	6a, Gandhi RD, Gwalior Ho Gwalior	30	60		2-2.5
5	Hotel Landmark	47, Manik Vilas Colony, Infront Of Hanuman Mandir, Station Chouraha	40	80		1.5-2
6	Sita Manor Hotel	Opp Akashvani Bhawan, Gandhi Road	43	86	20	1.5
7	Surbhi Hotel	Naya Bazar, Lashkar Ho, Gwalior	22	44		0.40-0.45
8	City Palace Hotel	Sanjay Complex, Jayendraganj, Lashkar City, Gwalior	26	52	25	0.300.-50
9	Grace Hotel	40, Manik Vilas, Gwalior Ho Gwalior,	18	36	15	0.2
10	Safari Hotel	Railway Station Market, Station Road	20	40		
11	Ambassador Hotel	Zinsi Road No 1, Lashkar Ho, Gwalior	30	60	25	2.5
12	D M Hotel	New Bus Stand & Railway Station, Gwalior Ho Gwalior	16	32	20	20-30
13	Hotel Habitat Inn	Opposite Post Office, Mlb Road, Shinde KI Chhawani,	40	80	30	0.75-1.5
14	Hotel Shiv Shakti Palace	NAI Sadak, Lashkar City, Gwalior	14	28		0.25
15	Maan Mandir Hotel	Gwalior Ho Gwalior, Gwalior	20	40		

16	Maharaja Hotel	Kampoo Road, Roxy Road, Lashkar Ho, Gwalior	18	36		0.7
17	Mahima Hotel	Behind Railway Platform No 4, Tansen Road, Gwalior Ho Gwalior	15	30		
18	**TOTAL**		**457**	**914**		

b. Development of Hot Water Requirement Norms

The Green Tech-MNRE report on SWH potential in India has led to the development of following norms of hot water consumption

Classification for the purpose of calculation of consumption norms

- Low-End= 1 Star and 2 Star
- Mid-End= 3 Star
- High-End = 4 Star + 4 Star Apartment + 5 Star + 5 Star Apartment + 5 Star

Deluxe+ Heritage+ Heritage Grand

The hot water purpose and position with reference to hotel standard is explained in the below table. The above mentioned study has led to the development of following norms of hot water consumption (table 6.5).

Table 35 : Hotel areas for hot water consumption and industry practice

	Heritage	**5 Star And Deluxe**	**4 Star**	**3 Star**	**2 Star**	**1 Star**	**Approved**	**Other**
Guest room								
• Tub-bath	√	√	√	√	×	×	■	■
• Shower	√	√	√	√	√	√	√	√
• Bucket bath alone	×	×	×	×	×	×	×	√
Kitchen	√	√	√	√	√	√	■	■
Locker-room	■	√	√	■	×	×	■	■

showers								
Swimming pool	×	×	×	×	×	×	×	×
Common restroom	×.	√	√	×	√	×	×	×
Janitorial Work	×	■	×	×	×	×	×	×
Laundry	√	√	√	√	√	√	■	■
Gym/Spa	■	√	√	■	√	√	■	■

Table 36 : Hot water consumption norm for hotels/guesthouses (lpd/room)

Hotel Category / Purpose	Govt of India Approved / Classified		Low - end	Other SWH relevant hotels/ guest house
	High and Mid-end			
	Business Destination	Tourist		
Guestroom	50	75	30	25
Laundry	50	50	X	X
Kitchen	40	20	20	5
Locker showers	5	10	X	X
Common rest room/gym/spa	5	10	X	X
Total	150	165	50	30

Table :

High-end : 150 lpd/room

Mid-end : 125 lpd/room

Low-end : 50 lpd/room

Other : 30 lpd/room

Source: Green Tech-MNRE report

C. Projection of Hotel Rooms

A study of the actual growth over a period in the number of establishments/rooms covered under GOI approval/classification is partial; it highlights a CAGR of 3.68%. The record, on the demand side, in terms of growth in domestic tourist visits and foreign tourist visits over 1996-2007 is also available; the respective CAGR is 11.6%

and 9.55. Based on our consultation with the hotel industry owners and historic demand growth record, the report has adopted the following CAGR in respect of rooms across hotel standards/regions.

2008 to 2013 : 10% pa

2014 to 2017 : 7.5% pa

2018 to 2022 : 5% pa

Thus the above growth figures are taken to estimate the growth of hotel rooms in Gwalior city. The preliminary survey acts as a basis for the 2008 scenario.

A C Neilson estimate, under a study carried out for Government of India in 2006, for alternative scenarios, of average hotel room requirement for 2015 is 1.384 million rooms. However, the hotel room providers factor in occupancy (60% to 65%) and thus plan a supply @ 1.5 times the average requirement. In other words, A C Neilson study leads to the need for 2 million rooms in 2015.

Table 37 : Hotel Room Projection in Madhya Pradesh

Region	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Madhya Pradesh	18742	20617	22678	24946	27441	30185	32449	34882	37499	39373	41342

Table 38 :Projection of Hotel rooms in Gwalior with associated Hot water requirements

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Hotel rooms	457	503	553	608	669	736	791	851	914	983	1057
Hot water requirements-LPD	22850	25135	27649	30413	33455	36800	39560	42527	45717	49145	52831

Techno Economic analysis

	Unit	Base case	Proposed case
Load type		Hotel/Motel	
Number of units	Unit	736	
Occupancy rate	%	66%	
Daily hot water use - estimated	L/d	36,821	
Daily hot water use	L/d	36,800	36,800
Temperature	°C	70	65
Operating days per week	d	7	7

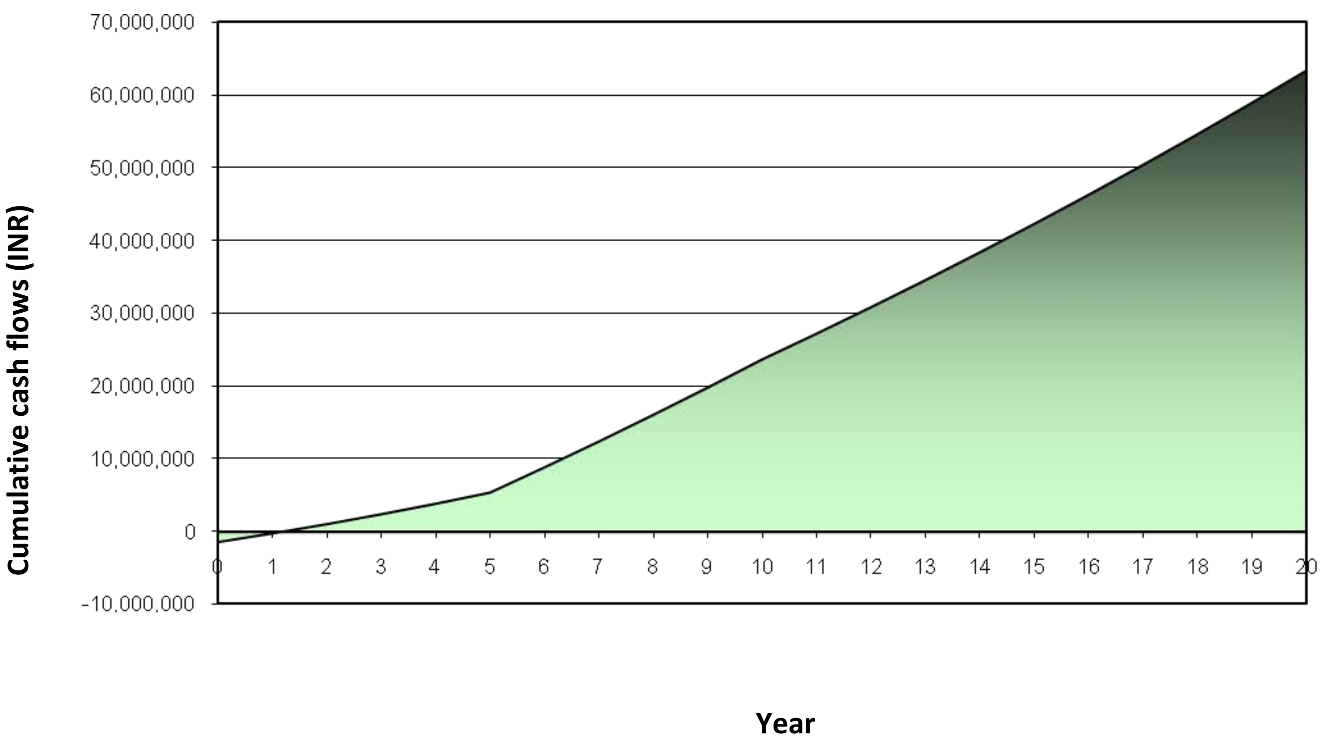
Financial Analysis

Financial parameters		
Inflation rate	%	2.5%
Project life	yr	20
Debt ratio	%	85%
Debt interest rate	%	5.00%
Debt term	yr	5
Initial costs		
Heating system	INR	73,60,000
Other	INR	20,00,000
Total initial costs	INR	93,60,000
Incentives and grants	INR	
Annual costs and debt payments		
O&M (savings) costs	INR	5,00,000
Fuel cost - proposed case	INR	14,01,470
Debt payments - 5 yrs	INR	18,37,635
Other	INR	0
Total annual costs	INR	37,39,106
Annual savings and income		
Fuel cost - base case	INR	46,01,817
GHG reduction income - 10 yrs	INR	2,48,565
Other	INR	
Total annual savings and	INR	48,50,382

income

Financial viability		
Pre-tax IRR - equity	%	95.7%
Pre-tax IRR - assets	%	22.6%
Simple payback	yr	3.2
Equity payback	yr	1.2

Cumulative cash flows graph



Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.943	8.0%	1.025

GHG emission				
Base case	tCO2	714.8		
Proposed case	tCO2	217.7		
Gross annual GHG emission reduction	tCO2	497.1		
GHG credits transaction fee	%	0.0%		
Net annual GHG emission reduction	tCO2	497.1	is equivalent	91.0

to

GHG reduction income

GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	yr	10
GHG reduction credit escalation rate	%	5.0%

Project verification		Base case	Proposed case
Fuel type		Electricity	Electricity
Seasonal efficiency		100%	100%
Fuel consumption - annual	MWh	697.2	212.3

Energy Saved per annum:484.9 Mwh

F. Important Measures and Major Observations

Promoting Energy Service Company (ESCO) based models

For setting-up large SWH installations in commercial buildings, industries and large residential developments, ESCO approach has the potential to become the most preferred implementation arrangement. GMC in association with consultants should develop an action plan to develop feasible ESCO models and create conducive environment for development of sustainable SWH ESCO businesses

Poor Radiation Days in a Year

Unlike households, hotel/guesthouses are not discouraged by cloud cover or low radiation for a few days or weeks in the year. Thus, monsoon or fog in winter in itself is not the reason for hotel/guesthouses to stay away from SWH.

Roof Availability

The roof-availability for SWH is an issue mainly for hotels/guesthouses which do not own the roof. The roof-ownership, in turn, is linked to the hotel-size. Based on consultation with hotel managers/civil engineers, a premise is made that hotels/guesthouses having 15 room upward capacity own the roof.

There is the trend, among centrally air-conditioned hotels, of setting up cooling towers, hydro equipment, satellite dish antennas on the roof. Despite this trend, there remains adequate space to install SWH to meet the hot water requirement in most of such hotels.

Present Fuel Use

The hotels having a room capacity upward of 30 rooms largely utilize liquid fuel for water-heating. The small hotels- room capacity up to 30 rooms-rely on electricity or wood. It is attractive, from a payback period perspective, for electricity and liquid fuel dependent hotels/guestSWH Market Assessment houses to adopt SWH. It is, only small wood-using hotels/guest-houses, existing on a limited scale, for which SWH is less attractive. Hotels located in areas especially Gwalior facing severe power shortage and long hours of power cut often opt for SWH.

Policy Environment: SWH for Hotels/Guesthouses

The highlights of the present policy environment are as follows.

• A municipal corporation order making it compulsory for new hotels to install SWH is in force in many cities. It is advisable for GMC to initiate bye laws making it compulsory for hotels having rooms upwards for 15 to compulsorily install solar water heaters.

• A scheme of loans at the concessional interest rate of 5% pa for SWH is being implemented by IREDA which should be adequately publicized.

• There is accelerated depreciation provision for commercial hotels/guesthouses. The awareness of the accelerated depreciation provision among owners of modest hotels/guesthouses is low.

Other Issues

The hotel/guesthouse industry expressed the following wish-list

• Lowering of SWH capital cost

• Technical solution of the problem of somewhat-staggered-through-the-day demand for hot water

• SWH delivering hot water round the year

10.3.2

RE-6

- IMPLEMENTATION OF SOLAR WATER HEATERS IN HOSPITALS

A. Hospital Beds in Gwalior

A city wise estimate of number of Hospitals and the beds therein is indicated in the table below which is sourced from the Gwalior National Urban Database and a preliminary survey.

A recent report commissioned by the Ministry of New and Renewawable Energy and Greentech also offers the national rates of increase in beds yearwise based on the National CAGR which is used to compute the increase in hot water requirements for the hospitals in Gwalior.

Development of Hot water norms

Table 39 : Utilisation of hotwater in hospitals category wise

	Bathroom		**Kitchen**		**Laundry**	
	Govt	**Pvt**	**Govt**	**Pvt**	**Govt**	**Pvt**
Hospital up to 15 beds	√	√	**x**	**X**	**x**	**X**
Hospital from to 16 to 50 beds	√	√	**Limited**	**Limited**	**X**	**X**
Hospital with over 50 beds	√	√	√	√	**Limited**	√

The laundry and kitchen are features of large corporate or public hospitals and these hospitals contribute a tiny percentage of total hospital beds in India. The kitchen requirement is for cleaning and works out under 5 litres per bed. For practical purpose, patient room or bathing constitutes the hot water requirement of hospitals. The arrangement, typically, is shower and/or bucket bath. There are patients who, for medical reasons, are required to abstain from bathing. The care-takers accompanying the patient, in many instances, do not bathe in the hospitals. These practices bring down the hot water consumption in a hospital.

The hospital owners/managers interviewed by us estimated hot water consumption per bed around 25 lpd/bed for patients who are permitted to bathe. The hospital covered under the survey reported SWH provisioning at rates varying from 15 to 60 lpd/bed, the popular provisioning norm, though, is in the vicinity of 30 lpd/bed. We have, therefore, followed the norm of SWH provisioning @ 30 lpd/bed for government and private hospitals, except for modern multi-specialty private hospitals.

Table 40 : Number of hospitals, dispensaries, etc., doctors, nurses, paramedical staff and total number of beds available therein as on 2008

Type of Hospital	**No. of Units**		**No. of Beds**	
Hospital	Govt.	Private	Govt.	Private
Allopathic	7	302	470	712
Ayurvedic	1	NIL	4	NIL
Homeopathic	NIL	NIL	NIL	NIL
Unani	NIL	NIL	NIL	NIL
Family welfare & maternity center	1	1	NIL	NIL
Others	NIL	NIL	NIL	NIL
Dispensary				
Allopathic	17	NIL	NIL	NIL
Ayurvedic	11	NIL	NIL	NIL
Unani	NIL	NIL	NIL	NIL
Homeopathic	5	NIL	NIL	NIL

Others	NIL	NIL	NIL	NIL
Primary Health Centres	124		NIL	
Nursing Home	616		-	

Source:Ministry of Urban Development,GOI

Table 41 : Data collected during primary survey as on 2011 of selected hospitals in Gwalior

Sl. No.	Name of hospital	Address	No. of beds	Sanctioned load (KVA)	Electricity bill (Rs) in Lakhs per month	Hot water requirement Lits	Capacity of solar Water heater	Price in (lakh Rs)	Initial water temp.°C	Final water temp.°C	Thermal energy required to heat the water, KJ	Electrical conversion of the require heat to heat the water, kWh	Yearlly Electricity saving (kWh)	Total cost saving in (lakh Rs)
1	Birla Hospital	Surya mandir road,Gwalior	250	400	6	7500	7500	15	30	60	945000	263	433125	19
2	Gwalior Cancer hospital	A	256	300	6_7	7680	7680	15	30	60	967680	269	443520	20
3	Civil hospital	Civil dispensary, fort road Gwalior.	35	25	0.25-0.30	1050	1050	2	30	60	132300	37	60638	3
4	Dr. Kaul hospital & research institute	Naya Bazar, Gwalior	38	35 kVA	0.30-0.40	1140	1140	2	30	60	143640	40	65835	3
5	Grover Hospital	Baradari Chauraha, Morar ho. Gwalior	22	30 kVA	0.20-0.25	660	660	1	30	60	83160	23	38115	2
6	Maheshwari Nursing home	Mlb colony, laxmi bai colony padav, Gwalior	92	45kVA	0.8 - 1	2760	2760	6	30	60	347760	97	159390	7
7	Gwalior Casualty Hospital	Gwalior Ho, Gwalior.	250	200kVA	5_6	7500	7500	15	30	60	945000	263	433125	19
8	Ratan jyoti Netralaya	18, Near Sai Baba Mandir, Vikas Nagar, Gwalior	20	25 kVA	0.2-0.3	600	600	1	30	60	75600	21	34650	2

9	ESI	Tansesn Road, Gwalior Ho, Gwalior	100	95 kVA	4_5	3000	3000	6	30	60	378000	105	173250	8
10	Olyai hospital	Hospital road Ho, Gwalior MP	15	23kV A	0	450	450	1	30	60		16	25988	1
11	Ashirva d Hospital	Near Ravi shanka Hostel, Gwalior Ho Gwalior	30	40 KVA	0.30-0.35	900	900	2	30	60	56700	16	25988	1
12	JA Hospital	Thatipur Gwalior	22	20 KVA	0.15-0.20	660	660	1	30	60	113400	32	51975	2
13	Kamla Raja Hospital	Gwalior Ho, Gwalior.	15	20 KVA	0.15-0.17	450	450	1	30	60	83160	23	38115	2
15	**Total**					**3435 0**	**34350**	**65**					**1983713**	**89**

C. Projected Hospital Beds and Hot Water Requirement

The growth of beds in Government hospitals is expected to be 2% and we expect private hospital growth @7% pa till 2013 and to taper to 5% over 2014-18 period and 3% pa thereafter. The number of hospital beds as in 2008 viz 712 in Private and 470 in Government is expected to increase to 1275 and 573 in 2018.

Table 42 : Projection of estimated hospital beds in Gwalior

Category/year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Private	712	762	815	872	933	999	1049	1101	1156	1214	1275
Government	470	479	489	499	509	519	529	540	551	562	573

D. Hot Water Requirement

It is assumed that the hot water requirement is taken on an average of 30 litres per day per bed considering that there are not many super speciality hospitals I Gwalior where the water requirement goes as high as 190 litres per day

The total hot water requirement will increase from 35 460 lpd in 2008 to 45540lpd in 2013 and 55440 lpd in 2018.

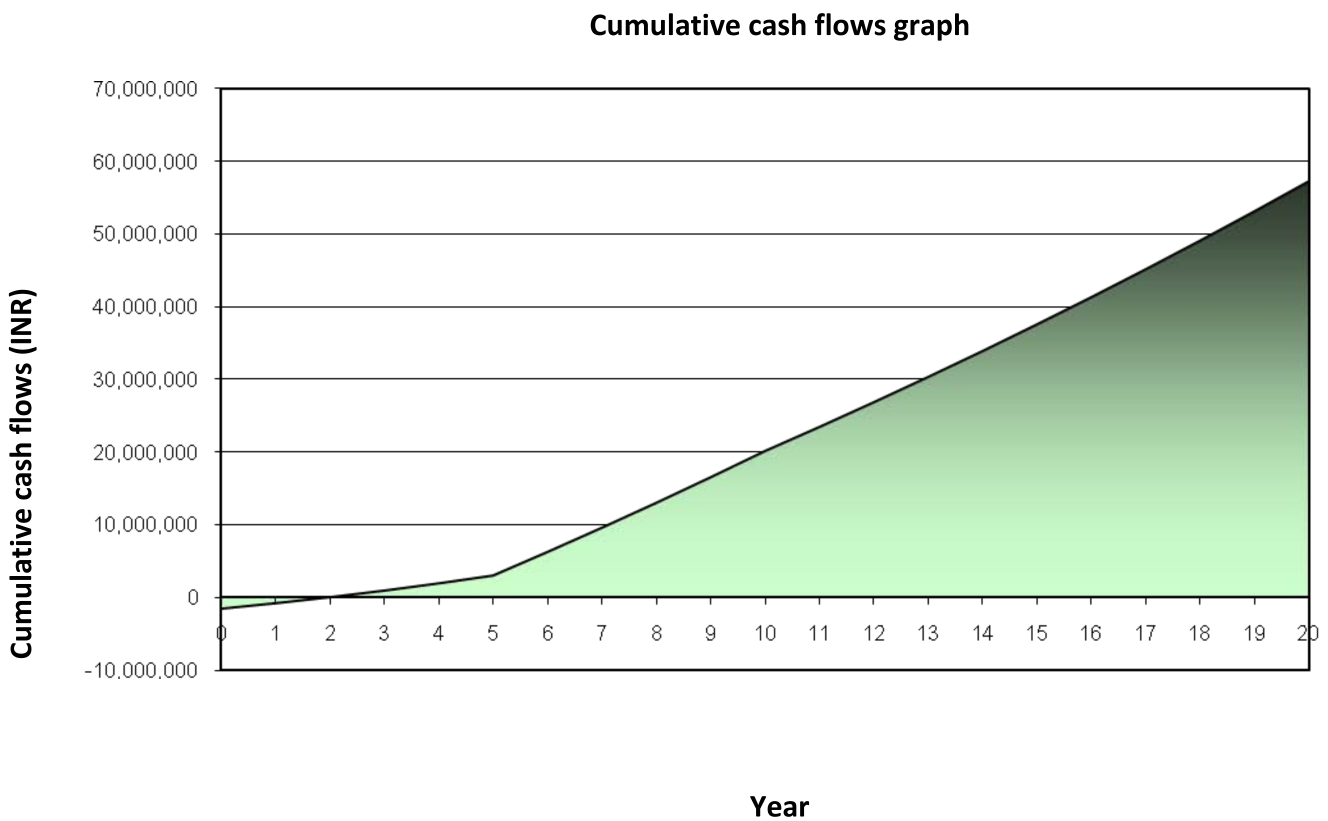
Table43 : Projections for 2013

Sl. No.	Category of hospital	No. of beds	Hot water requirement Lits	Capacity of solar Water heater	Price in (lakh Rs)
1	Private	999	29970	29970	60
2	Government	519	15570	15570	31
	Total	1518	45540	45540	91

E.Techno Economic Analysis

Financial Analysis		
Financial parameters		
Inflation rate	%	2.5%
Project life	yr	20
Debt ratio	%	85%
Debt interest rate	%	5.00%
Debt term	yr	5
Initial costs		
Heating system	INR	91,00,000
Other	INR	15,00,000
Total initial costs	INR	1,06,00,000
Annual costs and debt payments		
O&M (savings) costs	INR	5,00,000
Fuel cost - proposed case	INR	26,69,578
Debt payments - 5 yrs	INR	20,81,083
Other	INR	
Total annual costs	INR	52,50,660
Annual savings and income		
Fuel cost - base case	INR	56,94,749
GHG reduction income - 10 yrs	INR	2,34,959
Other	INR	
Total annual savings and income	INR	59,29,708
Financial viability		
Pre-tax IRR - equity	%	65.5%
Pre-tax IRR - assets	%	17.9%

Simple payback	yr	3.8
Equity payback	yr	2.0



Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.943	8.0%	1.025

GHG emission		
Base case	tCO2	884.6
Proposed case	tCO2	414.7

Gross annual GHG emission reduction	tCO2	469.9		
GHG credits transaction fee	%	0.0%		
Net annual GHG emission reduction	tCO2	469.9	is equivalent to	86.1cars/trucks

GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	yr	10
GHG reduction credit escalation rate	%	5.0%

Project verification		**Base case**	**Proposed case**
Fuel type		Electricity	Electricity
Seasonal efficiency		100%	100%
Fuel consumption - annual	MWh	862.8	404.5

Energy saved per year: 458.3 mwh

F. Important Measures to be taken and major observations

Hospitals

The major observations are as follows:

SWH Awareness and Exposure

The awareness on SWH, among private hospital owners, is mixed across hospital standards/size. The knowledge of owners of small private hospitals is less-favourable for- SWH climatic zones, in most instances, the knowledge is limited to existence of SWH product.

Poor Radiation Days in a Year

Unlike households, hospitals are not discouraged by cloud cover or low radiation for a few days or weeks in the year. Thus, monsoon or fog in winter in itself is not the reason for private hospitals to stay away from SWH.

Roof Availability

For government hospitals, roof is clearly available for SWH installation. The roof in respect of private hospitals appears substantially available but the precise position is Not clear. Most private hospitals having 15 patient bed upward are assumed to possess roof for SWH installation. In respect of up to 15 bed hospitals, roof availability is mixed because many of these hospitals are independent buildings with own roof. We estimate that 10% to 15% of private hospital beds cannot be serviced by SWH because of roof availability. The new private hospitals, regardless of size and ownership of roof, can be mandated to install SWH through working out access to the common roof, since a policy of compulsory SWH for hospital is already in vogue in principle.

Present Fuel Use

The hospitals, barring large private hospitals- use electricity for water-heating. The cost of water-heating, therefore, is high. The large hospitals generally have liquid or gaseous fuel (Furnace oil/LPG/LDO/Gas) based boilers and hot water generation systems.

Policy Environment: SWH for Hospital

This is identical to one for hotels- compulsory SWH for new hospitals, concessional interest loan and accelerated depreciation.

Other Issues

Unlike hotels, it is not too difficult, barring luxury hospitals, to regulate hot water timing, a positive for SWH installation. We came across an SWH- dependent hospital where the system is turned off in summer.

Many owners of small/medium hospitals analyze the techno-economics of SWH at great length; the SWH suppliers find it difficult to cope with the demands they raise in terms of time and effort. In several of the large hospitals which are spread over a large area, extensive piping is required for supplying hot water from a central facility and hence the cost involved in piping through a centarlised SWH emerges as a major issue.

10.3.3

RE-7

- **250 KWP SOLAR PV AND 30,000 LPD SOLAR WATER HEATER AT BORDER SECURITY FORCE (BSF) ACADEMY GWALIOR**

Introduction

Border Security Force Academy, one of the largest Para-Military forces in the World, is a versatile force, which is responsible for guarding round the clock vast and volatile borders not only against trans-border criminals but also against heavily armed trans-border terrorism as well. Though guarding the borders is the prime commitment, security forces remain heavily and decisively involved in the interior as well in combating insurgency and militancy in various parts of the country. Because of its friendly and human face, BSF remains the much sough after Force for combating and containing serious law and order situations in the trouble prone

States. And in case of hot War, BSF works as a force multiplier and contributes substantially towards over all War efforts of the nation as a credible front line Force.

Location

Border Security force Academy is located 32 km away from the land of legendary music maestro-Tansen, Gwalior.

Current Situation:

Border Security force Academy is spread over an area of 2923 acres, which includes many wings of academy, different units like Tear Smokes unit, Central Workshop and stores, CSMT (Central School of Motors transport), NTCD (National Training Center for Dogs, Composite Hospital, Central Printing Press, BIDP (BSF Institute of Disaster Response) and Education School.

Presently Electricity demand for the Academy is more than 500 kW which is being drawn by State Electricity board.

Proposed Project

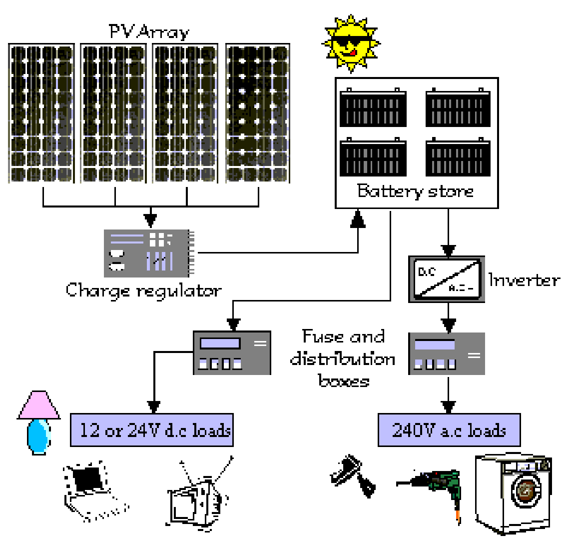
a) **250 kWp Solar PV Power Plant:** It is being proposed with this project to generate 250 kW power with the help of Solar PV off grid system. The system will be equipped with battery backup for 6 hours period. System will be capable of delivering the power for minimum 6 hours in day. The generated power will be mainly used for Lighting and small and medium power equipment in Academy.
b) **Solar Water Heater** it is also being proposed to install 30,000 LPD capacities on roof different unit of the academy as per requirement.

Solar PV power Generating System

Solar power is the conversion of sunlight to electricity. Sunlight can be converted directly into electricity using photovoltaic (PV). Solar PV system is an arrangement of photovoltaic array, solar charge controller PCU, Battery bank and protection devices in **which solar energy is converted into direct current electricity via Photovoltaic effect.**

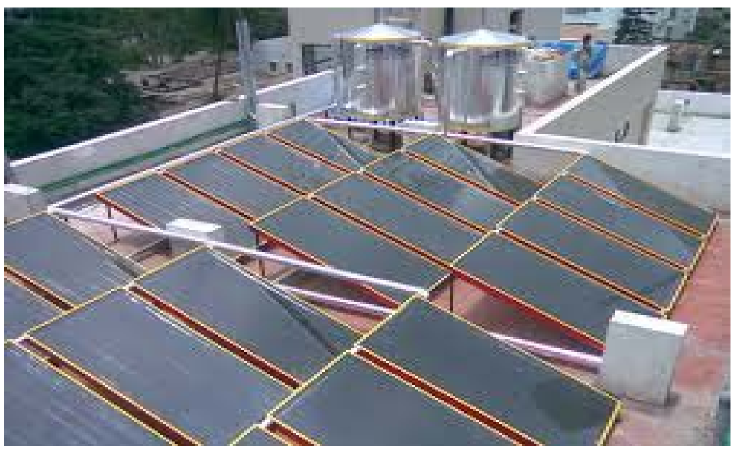
Photovoltaic is the most direct way to convert solar radiation into electricity and is based on the photovoltaic effect. It is quite generally defined as the emergence of an electric voltage between two electrodes attached on a solid or liquid system upon shining light on to this system. Practically all photovoltaic devices incorporate a pn junction in a semiconductor across which the photovoltage is developed. These devices are also known as solar cell.

Fig 31 : Solar PV power Generating System



Solar Water Heater

One of the popular devices that harness the solar energy is solar hot water system. A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. The solar energy incident on the absorber panel coated with selected coating transfers the hat to the riser pipes underneath the absorber panel. The water passing through the risers get heated up and are delivered the storage tank. The re-circulation of the same water through absorber panel in the collector raises the temperature to 80 °C (Maximum) in a good sunny day. The total system with solar collector, storage tank and pipelines is called solar hot water system.



Estimated Cost

a) Estimated Cost for Solar PV Power System = Rs 1.50 Crore
b) Estimated Cost for Solar Water Heater System = Rs 42 Lakhs
c) Total Cost = Rs 7.17 Crore.

Table 44 : Solar Water Heater – Cost estimate

Sl. No.	Type of Technology	Capacity	Unit Price (Rs)	Total Cost (in Lakhs Rs)	MNRE Subsidy (Rs)	Total Subsidy(Lakh Rs)
1	Solar PV	250 kWp	60/W	150	18/w	45

2	Solar Water Heater	30,000 LPD	140/ LPD	42	1750 /sq.m of collector area	10.5
3	**Total**			**192**		**55.5**

Savings

a) Solar PV System

Table 45 :Solar PV system – System cost& savings and Power Generation & GHG Reductions

i) System Cost and Saving

Sl. No.	Capacity (kWp)	Generation Per Year (kW/year)	Unit Cost (Rs/kWh)	Total saving Per year
1	250	66000	4.5	297000

ii) Power Generation and GHG Reduction

Sl. No.	Type of Technology	Power Generation (kW) from 2011		GHG Reduction (tons of Carbon) from 2011	
		Up to 2013	Up to 2018	Up to 2013	Up to 2018
1	Solar PV 250 kWp	132000	462000	111	388

b) Solar Water Heater System

Table 46 : Solar water Heater system – Electricity & money saving and electricity savings & GHG Reductions

i) Electricity and Money Saving:

Sl. No.	Capacity (LPD)	Quantity No.	Total Capacity (LPD)	kW saving /day	kW saving/yr @ 300 days/yr	Saving per day (Rs)	Saving per Year (Rs) @300 days/yr
1	2000	15	30000	1750	525000	2362500	708750000

ii) Electricity Saving and GHG Reduction

Sl. No.	Type of Technology	kW of Saving from 2011		GHG Reduction (tons of Carbon) from 2011	
		Up to 2013	Up to 2018	Up to 2013	Up to 2018
1	Solar Water heater	1050000	3675000	882	3087

10.4 Energy efficiency in Commercial Sector

EE-8

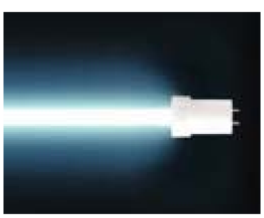
- IMPLEMENTATION OF T-5 INLINE BALLAST IN COMMERCIAL BUILDINGS

10.4.1 General Description

T-5 Inline Electronic ballast is an innovative Electronic Ballast for Fluorescent Tube Lamps (FTL). It is invented to retrofit standard FTL systems that are operated with Conventional Electromagnetic Ballast (c-Ballast), into energy saving Electronic Operation in a simple, fast and cost effective manner.

The Plug & Save concept of the Inline ballast .allows such retrofitting process to be carried out by end users without employing highly qualified expensive electricians. It only takes a minute.

As such, without the complications of wiring, no installation or recurrent maintenance costs are incurred. The T-5 inline Ballast with the T5 tube is probably the most commercially viable e-Ballast in the market.



INLINE T5 SERIES

Fits T5 FTL into common T8/T12 fixtures, and provide High Frequency Energy Saving operation.

It is proposed to replace 10000 nos T-12 FTL with the T-5 Inline Ballast in Hotels , Hospitals, Office Buildings, Educational institutions, hostels ,etc by the year 2013

Footprint Savings

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.933	8.0%	1.014

GHG emission				
Base case	tCO2	7,727.2		
Proposed case	tCO2	6,108.5		
Gross annual GHG emission reduction	tCO2	1,618.7		
GHG credits transaction fee	%	10.0%		
Net annual GHG emission reduction	tCO2	1,456.9	is equivalent to	267

GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	Yr	10
GHG reduction credit escalation rate	%	5.0%

Cost Savings

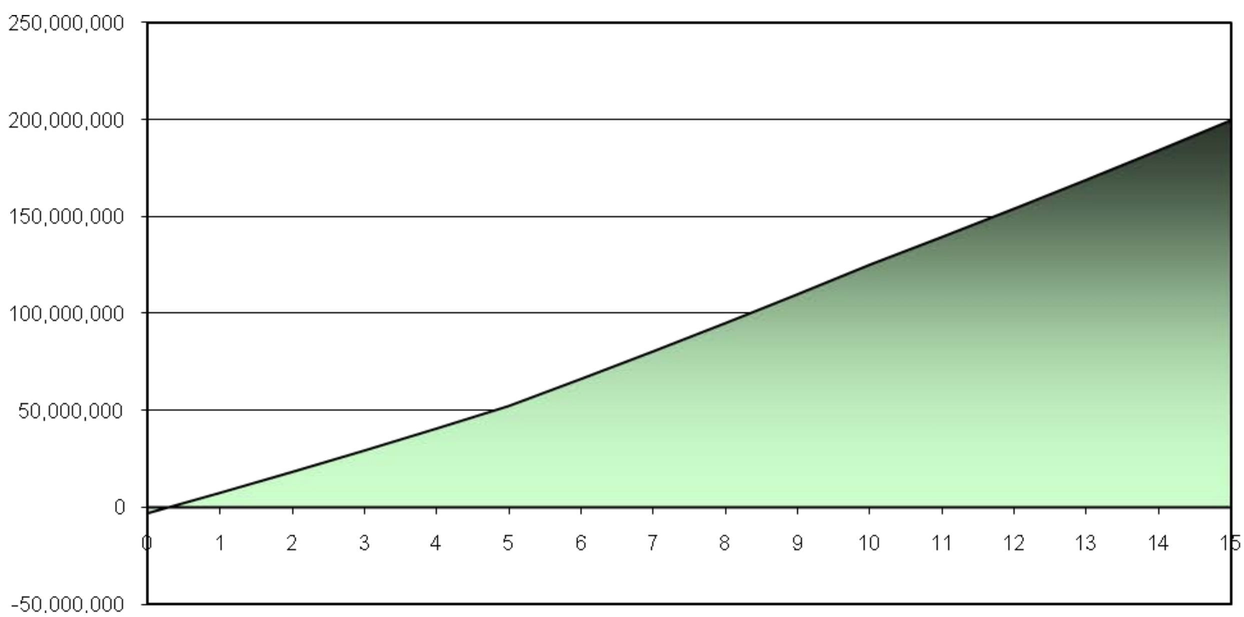
Fuel saved	Electricity MWh	Incremental initial costs INR	Fuel cost savings INR	Incremental O&M savings INR	Simple payback Yr
Replacement of T-12 with T-5 inline Electronic ballast	1,597	93,50,000	1,05,36,966	10,00,000	0.8

Resource Savings

Replacing with the T-5 inline ballast will save 15 97 000 kWh or 'units of electricity per year.

Base case		Proposed case		Fuel cost savings	
Fuel consumption Mwhr	Fuel cost	Fuel consumption Mwhr	Fuel cost	Fuel saved Mwhr	Fuel cost savings
7,621.2	INR 5,02,99,920	6,024.7	INR 3,97,62,954	1,596.5	INR 1,05,36,966

Cumulative cash flows graph



Year

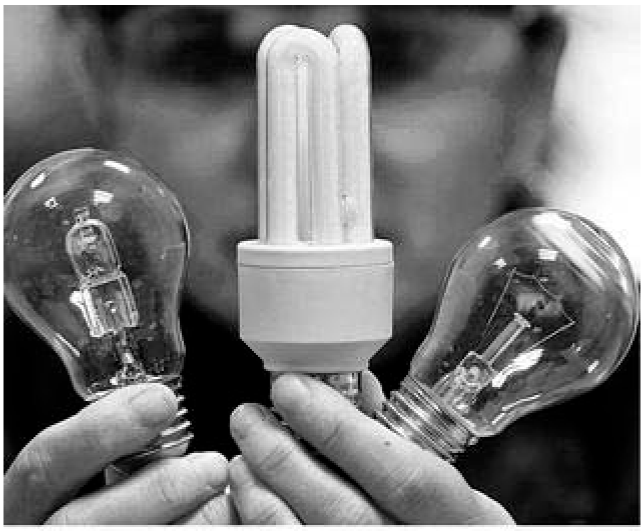
Financial Analysis

Financial parameters		
Inflation rate	%	2.0%
Project life	yr	15
Debt ratio	%	70%
Debt interest rate	%	12.00%
Debt term	yr	5
Initial costs		
Energy efficiency measures	INR	93,50,000
Other	INR	10,00,000
Total initial costs	INR	1,03,50,000
Incentives and grants	INR	
Annual costs and debt payments		
O&M (savings) costs	INR	-10,00,000
Fuel cost - proposed case	INR	3,97,62,954
Debt payments - 5 yrs	INR	20,09,834
Other	INR	
Total annual costs	INR	4,07,72,788
Annual savings and income		
Fuel cost - base case	INR	5,02,99,920
GHG reduction income - 10 yrs	INR	7,28,425
Other	INR	
Total annual savings and income	INR	5,10,28,345
Financial viability		
Pre-tax IRR - equity	%	341.5%
Pre-tax IRR - assets	%	104.8%
Simple payback	yr	0.8
Equity payback	yr	0.3

10.4.2

EE-9

• IMPLEMENTATION OF CFLS IN PLACE OF ICLS IN COMMERCIAL BUILDINGS



General Description

Lighting accounts for almost 20 percent of the total electricity demand in the country and it is due to ICLs which are highly energy consuming. Only about 5 percent is converted into light and rest is used as heat where as CFL uses only 1/5th of electricity and provides the same level of illumination. To overcome the challenge of over heating, CFLs are recommended by BEE to conserve Energy.

1. Decreases peak load: Lighting is one of the major contributors to peak load. If 400 million light points are replaced with CFLs; it would lead to a reduction of over 10,000 MW in electricity demand. It would not only reduce emissions but also result in the reduction of peak load in the country which currently faces a shortage of up to 15 percent.
2. Reduce Green House Gas emissions: Incandescent Lamps are harmful to the environment because they use so much energy to function.

3. Win-win situation for all stakeholders: This lamp savings programme reduces government and household expenditure. With reduction in energy consumption in every commercial building, the country can conserve its limited power supply and on a building level, electricity bills are within control

It is proposed to install 5000 CFls of 14 watts capacity instead of Incandescent lamps of 60W.

Cost savings

Show:	Electricity	Incremental initial costs	Fuel cost savings	Incremental O&M savings	Simple payback
Fuel saved	**MWh**	**INR**	**INR**	**INR**	**yr**
Use of 14watt CFLs instead of 40watt ICLs	380	10,00,000	25,05,360	0	0.4

Carbon Foot print

Emission Analysis

Base case electricity system (Baseline) Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.933	8.0%	1.014

GHG emission		
Base case	tCO2	592.1
Proposed case	tCO2	207.2
Gross annual GHG emission reduction	tCO2	384.9
GHG credits transaction fee	%	10.0%
Net annual GHG emission reduction	tCO2	346.4
GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00

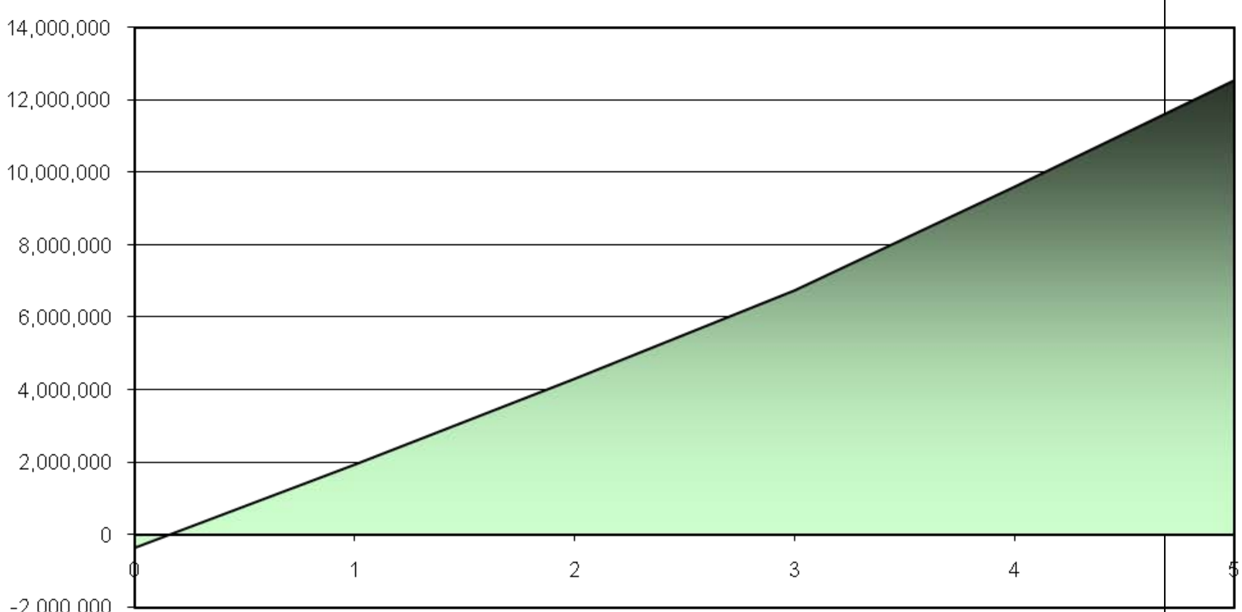
GHG reduction credit duration	yr	10
GHG reduction credit escalation rate	%	5.0%

Resource Savings

Energy	**Electricity MWh**	**Total MWh**
Energy - base case	584	584
Energy - proposed case	204	204
Energy saved	380	380
Energy saved - %	65.0%	65.0%

Benchmark Energy	**Electricity MWh/lamp**	**Total MWh/lamp**
Energy - base case	0.1168	0.1168
Energy - proposed case	0.0409	0.0409
Energy saved	0.0759	0.0759

Cumulative cash flows graph



Year

Financial Analysis

Financial parameters		
Inflation rate	%	2.5%
Project life	yr	5
Debt ratio	%	70%
Debt interest rate	%	11.50%
Debt term	yr	3
Initial costs		
Energy efficiency measures	INR	10,00,000
Other	INR	2,00,000
Total initial costs	INR	12,00,000
Incentives and grants	INR	
Annual costs and debt payments		
O&M (savings) costs	INR	0
Fuel cost - proposed case	INR	13,49,040
Debt payments - 3 yrs	INR	3,46,732
Other	INR	1,00,000
Total annual costs	INR	17,95,772
Annual savings and income		
Fuel cost - base case	INR	38,54,400
GHG reduction income - 10 yrs	INR	1,73,197
Other	INR	
Total annual savings and income	INR	40,27,597
Financial viability		
Pre-tax IRR - equity	%	642.3%
Pre-tax IRR - assets	%	194.8%
Simple payback	yr	0.5
Equity payback	yr	0.2

EE-10

• IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS IN COMMERCIAL BUILDINGS

General Description

An average non-energy star rated 1.5 Ton Window AC consumes in the vicinity of 2100 Watts on average (calculated across on-off cycles). By comparison, a modern 5-Star rated split unit AC of the same cooling capacity consumes on average 1700 Watts - an energy savings of approximately 20%. Always shade your AC from direct sun. It reduces the efficiency by 5%.

It is proposed to replace 2000 air conditioners with 5 star rated Air conditioners in Hotels, Hospitals, Educational Institutions, offices etc

Footprint Savings

Emission Analysis

Base case electricity system (Baseline) Country – region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	All types	0.933	8.0%	1.014

GHG emission		
Base case	tCO2	24,514.0
Proposed case	tCO2	21,316.5
Gross annual GHG emission reduction	tCO2	3,197.5
GHG credits transaction fee	%	10.0%
Net annual GHG emission reduction	tCO2	2,877.7
GHG reduction income		
GHG reduction credit rate	INR/tCO2	500.00
GHG reduction credit duration	yr	10

GHG reduction credit escalation rate	%	5.0%

Cost Savings

Note: savings are approximately doubled in cities with higher electricity rates such as Mumbai.

Note: Window AC's are not as energy efficient as Split Units and therefore do not achieve better than 3-star Energy Ratings.

Facility Characteristics	Electricity	Incremental initial costs	Fuel cost savings	Incremental O&M savings	Simple payback
Fuel saved	**MWh**	**INR**	**INR**	**INR**	**yr**
Replacement with 5 Star rated AC	3,154	5,00,00,000	2,08,13,760	10,00,000	2.3

Resource Savings

Energy	**Electricity MWh**	**Total MWh**
Energy - base case	24,178	24,178
Energy - proposed case	21,024	21,024
Energy saved	3,154	3,154
Energy saved - %	13.0%	13.0%

10.4.4

EE-11

- SOLAR HEAT-REFLECTING CLEAR WINDOW FILMS

General Description

Most of the carbon footprint from air-conditioned residences and offices is the consequence of electricity consumption by cooling appliances. While installing more energy efficient air conditioners is an effective way to reduce this footprint, the footprint reduction can be greatly enhanced by reducing the quantity of incoming heat energy that the device has to 'fight'. The commonly used dark-tinted films applied on automobile windows, is an example of a relatively outmoded method of reducing incoming heat energy to Minimise air-conditioning load. Reflective 'mirror-like' surfaces that reject solar energy also perform the same function. These solutions, while reducing heat load, do however have an adverse effect on the lighting requirements of the indoor areas they shield – they block visible light as much as they block heat energy from the sun. Recent innovations have resulted in the creation of films that reject upwards of 90% of infrared and UV rays (the primary agents of conveying solar heat into interiors of building) while permitting 70% of visible light to pass through. Such films are known as spectrally selective films. By comparison, heavy silver window films permit just 15 to 20% of visible light to pass through. As an added benefit, the UV-blocking property of these films leads to dramatic reduction in fading of upholstery, carpets and other soft-furnishing. Prolonging the life of these resource intensive and high cost products has notable indirect but tangible footprint benefits as well. The lower cost of incorporating this solution relative to the cost of replacing existing cooling devices elevates this alternative in the priority list of interventions; it ought to be implemented as a pre-requisite prior to any other capital intensive solutions.

Footprint Savings

Placing a solar reflective window film (Spectrally selective films) onto on a window we can save carbon footprint by 10.2 kg CO_2e per year per Square foot of a window film. For a typical home of 2 bedrooms which has 2 windows in each room and measuring a total of 64 Sq ft (4*4 Sq ft of each window) of windows, can reduce carbon footprint by 652.8 kg CO_2e per year.

Cost Savings

Placing a solar reflective window film (Spectrally selective films) onto on a conventional window, can save you at least Rs. 27.6 per year per Square foot of a window film on your electricity bill (based on all-India average electricity rates) and savings are approximately doubled in cities with higher electricity rates such as Mumbai. For a typical home of 2 bedrooms which has 2 windows in each room and measuring a total of 64 Sq ft (4*4 Sq ft of each window) of windows, can save you at least Rs. 1766.4 per year on your electricity bill (based on all-India average electricity rates) and savings are approximately doubled in cities with higher electricity rates such as Mumbai.

Resource Savings

Placing a solar reflective window film (Spectrally selective films) onto on a conventional window, can save 6.6 kWh or 'units of electricity' per year per Square foot of a window film. For a typical home of 2 bedrooms which has 2 windows in each room and measuring a total of 64 Sq ft (4*4 Sq ft of each window) of windows, can save 422.4 kWh or 'units of electricity' per year.

Estimated Savings for 5000 homes/offices with Investment of Rs.4 80 00 000

For a 2 room house /office	Per year per 64 sq ft	Upto year 2013
Electricity	422.4 kwh	42 24 000 kwh
GHG	652.6 kg CO2e	65 26 000 kg CO2e
Money savings	2789 Rs.	2 78 90 000 Rs.

Simple payback : **3.4 years**

EE-12 • LED BULBS

General Description

CFL Bulbs represent the most popular energy saving lighting device used to dramatically cut carbon footprint. They belong to new age technology. But there is a technology, fast approaching and no longer just on the horizon, called Light Emitting Diode (LED) lighting that provides even greater energy savings compared to CFL Bulbs. An LED Bulb consuming merely 6 Watts of power can emit the same light as a 11 Watt (+3 Watt Choke) CFL Bulb or a 60 Watt Regular Incandescent Bulb. Additionally, since these bulbs last approximately 40 times longer than regular bulbs and 6 times longer than CFL bulbs, their higher initial cost is recovered through fewer bulb purchases. And this is the least known, but very crucial, advantage of LED and other energy saving lighting technologies – they reduce the heat load that air conditioners must 'fight'. This is because more than 98% of the energy output of an Incandescent Bulb is wasted as heat energy, which warms the air in a room. By reducing the power supplied by 90% (by using LED bulbs), the quantity of heat generated in the room is also reduced proportionally. The end result is a significant savings in energy costs and carbon footprint from Air Conditioner use.

Cost Savings

Replacing 6 regular light bulbs, used 8 hours per day, save you at least Rs. 4000 per year on your electric bill (based on all-India average electricity rates).

Footprint Savings

Replacing 6 regular light bulbs, used 8 hours per day, can reduce carbon footprint by 1.4 tonnes CO2e annually.

Resource Savings

Replacing 6 regular light bulbs, used 8 hours per day, can save 964 kWh or "units of electricity per year

Table 47 : Energy Savings Calculator for Replacing Light Bulbs

	Incandescent Light Bulbs	CFL (Compact Fluorescent Bulbs)	LED (Light-Emitting Diode Light Bulbs)
Life Span (in hours)	1,500	10,000	60,000
Watts	60	14	6
Cost	Rs.15	Rs.150	Rs.1500
KWh of electricity used over 6000 hours	3,600	840	360

Electricity Cost (@ Rs.9 per KWh)	Rs.32,400	Rs.7560	Rs.3240
Bulbs needed for 6000 hours of usage	40	6	1
Equivalent 6000 hour bulb expense	Rs.600	Rs.900	Rs.1500
Total 60,000 Hour Lighting Spend	**Rs. 33,000**	**Rs.8460**	**Rs.4740**

Calculate Your Energy Savings

# of household light bulbs	30	30	30
Your estimated daily usage (hours)	5	5	5
Days in month	30	30	30

Household/office savings over 60,000 hours

(energy + replacement)

Household cost	Rs.9,90,000	Rs.2,53,800	Rs.1,56,700
Savings by switching from Incandescent	Rs.00	Rs.7,37,000	Rs.8,33,300

Monthly household/office energy savings

KWh used per month	279		27

		63	
Electricity Cost (@ Rs. 9 per KWh)	Rs.2511	Rs.567	Rs. 243
Savings by switching from Incandescent	Rs,00	Rs.1944	Rs.2268
Yearly household/office energy savings			
KWh used per year	3285	767	329
Electricity Cost (@ Rs. 9 per KWh)	Rs.29565	Rs.6903	Rs.2961
Savings by switching from Incandescent	Rs.00	Rs. 22,662	Rs. 26,604

Note: the below projections are calculated for Rs.6.6 per unit

Replacing 6 light bulbs with LED lamps per household/office for 10,000 homes

For a 2 room house /office for 6 lamps	Per year/home-office	Upto year 2013
Electricity	964 kwh	1 92 80 000 kwh
GHG	0.9 t CO2e	18 000 tCO2e
Money savings@6.6 Rs/kwh	6362 Rs.	12 72 48 000 Rs.

Simple Payback:2.8 years

10.4.6

EE-13 • UPVC WINDOWS

General Description

uPVC is an ideal replacement of conventional (wooden, aluminium, steel etc) windows in the sense that it can reduce deforestation, provide better insulation that reduce heat losses (20% of a home's heat is lost through its windows and energy saving double glazing uPVC windows can cut the heat lost out of windows by 50%), prevent noise from entering the household and do not require any maintenance or painting. UPVC is an environment friendly recyclable material, which is widely used in

Green buildings for residential, commercial and industrial applications. Manufacturing cost of uPVC is 30% lesser in compared to steel and aluminium.

Footprint Savings

It can reduce 6816 kg of CO2e emissions a year.

Cost Savings

Cost savings from Installation of uPVC Windows can be obtained due to better insulation of the household from outside environment. Thereby it prevents heat losses, which leads to reduction in usage of the HVAC. The cost savings obtained from optimum usage of HVAC in a floor area of 1000 sq ft and 300 sq ft window area is Rs. 18350 per annum on your electricity bills.

Resource Savings

For a floor area of 1000 sq. ft and window area 300 sq.ft the power saving / annum due to HVAC optimisation is 4369 kWh or units.

Proposed Implementation: 1000 blocks of 1000 sq feet and 300 sq ft window area with investment is Rs.7 50 00 000

For a 1000 sq ft/300 sq window area house /office block	Per year/home-office	Upto year 2013
Electricity	4369 kwh	87 38 000 kwh
GHG	4.3 t CO2e	8 600 tCO2e
Money savings@6.6Rs/kwh	29 013 Rs.	5 76 70 800 Rs.

Simple Payback:2.5 years

10.5 Other measures for energy conservation in Commercial Buildings

Energy Conservation

Many criteria can be used in decisions whether to install energy-saving equipment or implement new procedures. The most frequently considered are total costs, rate of return, ease of implementation, and certainty of the desired outcome. The following four categories are examples of how a commercial facility can make changes to achieve energy conservation.

HVAC

A big category for light industrial operations is HVAC. Waste heat from processes, lighting, air compressors, etc. can contribute in winter but may not be well distributed. Waste heat at some facilities can create additional cooling loads not only in summer, but to a lesser degree in the other seasons as well. Consider the viability of combined heat and power for your facility.

• Waste heat from compressors can frequently be captured for space heating or other uses.

• Supply air for the compressors and boilers should be from the outside, not indoor air.

• Seal leaks and increase insulation, at least up to recommended R-values.

• Add economizers to the A/C system (a useful technique except on hot, humid days).

• Identify and correct unwanted drafts and unwanted air movement from one area to another.

• Use ceiling fans where appropriate.

• Adjacent rooms that are maintained at different temperatures should be separated by doors or flexible transparent barriers.

• Heating and cooling ducts should be insulated.

• Use automatic controls such as programmable thermostats, time clocks, bypass timers, weather sensors, and activity sensors, where appropriate.

• Areas of building prone to solar heat gain should be shaded in summer and exposed in winter.

• Thermostats should be set cooler in winter and warmer in summer.

Hot Water

Hot water, depending on the business, may or may not be a large percentage of facility energy use.

• Do not overheat hot water beyond your needs or local codes.

• Insulate hot water lines, especially those nearest the tank.

• Install low flow sprayers at point-of-use.

• Install heat recovery systems where practical.

• If using an electric water heater, consider using natural gas instead.

• To keep sediment from building on heat transfer surfaces, drain and flush the tank every 6 months.

• Consider using a solar heater for the bulk of your hot water requirements.

Lighting Design

Energy efficient lighting starts with efficient lighting design. Often people work in older spaces that were designed for different tasks or a different layout.

• Evaluate the design of the general and task lighting for the work being done in the area.

• Consider lighting that could be turned off in overlit areas or occupancy sensors for areas of infrequent use.

• Replace mercury vapor lamps with super T8 or high output T-5 fluorescents, or other more efficient lighting.

• Have fixtures and lamps cleaned annually or as necessary to maintain light output.

• Upgrade lighting efficiency with retrofit kits or total replacement.

• Consider controls to turn off lights near outside walls that get natural daylighting.

• Use energy efficient lighting design and equipment for outside (e.g. Solar switches with Energy Savers).

• Disconnect ballasts from delamped fixtures.

• Use electronic, not magnetic ballasts.

Other electrical appliances

Another important category of use is often referred to as “plug loads” or equipment such as computers, printers, desk lamps, portable fans, etc. that can plug into outlets and can be turned on and off at the user’s discretion.

• Educate employees on energy conservation and seek their ideas and actions in conservation goals.

• Utilize automatic features of computers and networks for sleep modes and power down modes.

• Make use of clock controls to de-activate copiers, and other equipment overnight and on weekends.

• Use equipment that is energy efficient and offers energy saving features (e.g., Energy Star).

• Monitor use of personal plug loads (e.g., heaters, refrigerators, coffee makers, etc.)

11.0 Industrial Sector

Coal, Electricity, Petrol, Diesel, LDO, Furnace Oil are some major source of the energy in the industries. We have collected data of all the major industries of the Gwalior City and collected data of all forms of energy being used in the sector

11.1 Back ground and Description

Gwalior is based on the industries housed in the territory. Gwalior is known to be the industrial base that is largely supporting the economy at Gwalior.

In fact, the industries of Gwalior are recognized as the counter magnet to the industries of National Capital Region. It is noteworthy that the industries of Gwalior are emerging as integrated industrial estates. These industrial estates of Gwalior are run by the development corporations that are large working towards the proliferation of these industries. The independent industrial development corporations are thus contributing towards the expansion of the economy of Gwalior.

Moreover, it is noteworthy that the industrial estates of Gwalior possess all the facilities that are required for the development of the industries of Gwalior. In fact, these existing industrial areas are said to be instrumental in the development of the industries in Gwalior. Some of the industries that form an integral part of **Gwalior economy** are:

Textile mills

- Artificial silk manufacturing plants
- Handicraft and hand loom industry
- Tanning industry
- Chemical industry

Gwalior Chemical Industries Limited is one of the principle industries that caters to the needs of a number of industries. To name a few:

- Agrochemical industries
- Flavors and fragrance industries
- Pharmaceuticals and dyes industries

Besides, Gwalior Chemical Industries Limited is the largest producer of Chlorotoluene products in India.

Besides, trade and commerce in Gwalior also form a major constituent of its economy. In Gwalior, Morar is the center of trade and commerce. In fact, Morar is known for its tanning industry. The pottery and carpets by the artisans of Gwalior also contribute towards the economy.

Gwalior Chemical industries, Gwalior specializes in chemical products. It is one of the leading industries in Gwalior that is known to operate seven large chemical plants. There are three main industrial estates namely Birlanagar, Maharajpura and Baraghata. In the Birlanagar area most of the insutries have closed down including the biggest Mill namely J.C.Mill.According to the dostrict Industries cell most of the industrial land in the Gospura industrial area has been returned back. The Baraghata industrial area due to pollution problems is proposed to be established in the western region now.

Oil and dal mills and other agriculture based units, wood industries are proposed to be located outside the city area. Ready made garments, hosiery and other non polluting industries will be allowed to work in the city.

Source:Gwalior GMC CDP

Table 48 :List of Industries listed with the MPMKVVCL

City Circle

Sl.No.	**Cate-gory**	**Purpose**	**Name / address of consumer**	**Sanctioned / contrect demand in KW/HP/KVA**	**Consum-ption during month in units**
CITY CIRCLE GWALIOR					
			CITY CIRCL GWALIOR		
1	HV 3.1	Industrial	Sr. DEE(CR) Laxmanpura	500	156853
2	HV 3.1	Industrial	Hindustan Vidhyut Products	200	14700
3	HV 3.1	Industrial	Cold Storage & General Mills	250	108150
16	HV 3.1	Textile	Harshit Textile	700	188364
17	HV 3.1	Industrial	Romy Oil Industries	100	22550
18	HV 3.1	Industrial	R.R. Wire & Cable	118	25985
19	HV 3.1	Industrial	Apex Industries	200	23673
20	HV 3.1	Industrial	Surya Roshni Ltd.	150	37170
21	HV 3.1	Industrial	Diksha Packing	100	51615
22	HV 3.1	Industrial	Akash Industries	125	27215
23	HV 3.1	Industrial	Quality Food Products	100	15518
24	HV 3.1	Industrial	Deeksha Contener	200	3033
25	HV3.1	Industrial	The D E E.(CR) Rly Sation	450	203650
28	HV 3.1	Industrial	Unipetch Rubber	260	58226
29	HV 3.1	Industrial	J.B. Mangharam	400	237240
30	HV 3.1	Industrial	Gupta Refrectories	180	21355
31	HV 3.1	Industrial	M.P. Industries.	200	40920
32	HV 3.1	Industrial	B.P. Food	425	220100
33	HV 3.1	Industrial	C.P. Industries	800	185080
34	HV 3.1	Textile	Takshashila Textile	300	78055
60	HV 3.1	Industrial	Kapoor Strips	250	24970
61	HV 3.1	Industrial	Brijlal/Daulatram	195	37388
62	HV 3.1	Industrial	Acme Plast	380	62983
63	HV 3.1	Industrial	Kailash Industries	200	60420
64	HV 3.1	Industrial	Sheetal Industries	150	65690
65	HV 3.1	Industrial	Paras White Gold Indu.	154	54122

66	HV 3.1	Industrial	Pawan Kumar /Budhamal	167	38500
67	HV 3.1	Industrial	Moolchand / Madhav Das	120	25340
68	HV 3.1	Industrial	Shiv Shakti Till Mills	100	22544
70	HV 3.1	Industrial	D.E.(F.R.S.) Telephone Exc.	340	155483
71	HV3.1	Industrial	Ramanand Enterprises	300	107280
72	HV 3.1	Industrial	S.A. Trading Co.	200	43650
73	HV 3.1	Industrial	Parinamitra Electricals	160	10737
79	HV 3.1	Industrial	Gangwal Industries	250	71520
85	HV 3.1	Industrial	R.R. Floor Mills	370	56290
86	HV 3.1	Industrial	Cadbury India Ltd.	2500	1619900
87	HV 3.1	Industrial	S.R.F. Ltd.	4000	459600
88	HV 3.1	Industrial	A.V.N. Tubes	600	52400
89	HV 3.1	Industrial	Lapinous Rock Wools	630	216360
90	HV 3.1	Industrial	Punchsheel Rubber	595	165760
91	HV 3.1	Industrial	Pee Cee Cosma	180	27432
92	HV 3.1	Industrial	Jai Maruti Gas Cyl.	176	16210
93	HV 3.1	Industrial	Crompton Greaves	1000	572389
94	HV 3.1	Industrial	Godrej consumer Products	3320	1444000
95	HV 3.1	Industrial	Super -Sack	600	0
96	HV 3.1	Industrial	Jamuna Auto Ltd	1500	793680
97	HV 3.1	Industrial	Supreem Industries	1200	420240
98	HV 3.1	Industrial	Supreem Industries (PVC Film)	150	11600
99	HV 3.1	Industrial	S.K. Industries	275	108320
100	HV 3.1	Industrial	Vikram Woolens	1500	701040
101	HV 3.1	Industrial	Atlas Cycle	650	169280
102	HV 3.1	Industrial	M.P. Telilinks	700	61480
103	HV 3.1	Industrial	Ranbaxy Laboratories	650	307867
104	HV 3.1	Industrial	Asha Oil Industries	550	82620
105	HV 3.1	Industrial	G.K.B. Opticals	200	24890
106	HV 3.1	Industrial	Eminnence India	500	38200
107	HV 3.1	Industrial	Gwalior Tank & Veesuals	150	30180
108	HV 3.1	Industrial	Kodak India	150	19930
109	HV 3.1	Industrial	Hemco Engineers	315	57020
110	HV 3.1	Industrial	Malanpur Rubber	200	9010
111	HV 3.1	Industrial	Starling Agro	2000	890340
112	HV 3.1	Industrial	Marval Vinayal	850	336840
113	HV 3.1	Industrial	Shriniwas Cable	200	29040
114	HV 3.1	Industrial	S.M. Milkose	750	174016
115	HV 3.1	Industrial	Vishal Air Products	180	112000

116	HV 3.1	Industrial	Badri Narayan Rubber	460	162400
117	HV 3.1	Industrial	Venkat Raman Food	350	70310
118	HV 3.1	Industrial	V.R.S. Food	2500	988800
119	HV 3.1	Industrial	Essel Plast	125	42777
120	HV 3.1	Industrial	Kurlon Limited	325	71040
121	HV 3.1	Industrial	Surya Roshni Limited	3000	687900
122	HV 3.1	Industrial	Tewa API	1750	639825
123	HV 3.1	Industrial	Kashish Rubber	200	43560
124	HV 3.1	Industrial	Surya Roshni (Component)	1100	546640
125	HV 3.1	Industrial	season Rotogravre	250	16480
126	HV 3.1	Industrial	Surya Roshni Ltd.	1500	136200
		LT CONSUMER			
1	LV 4	IP	M.S. Gwalior Tools Mahraj pura	117 KW	18545
2	LV-3.2	Office	M.s. R.P.G. Coll center city center	87 KW	38794
3	LV-3.2	Hotal	M.S. Mataly halas Thatipur	111 KW	17067
4	LV 3.2	Hospital	Dr. Ajai Tiwari	85 KW	16871
5	LV 3.2	Tower	M/S Reliance communication Ltd	45 KW	13269
6	LV-3.2	Tele Exch	The A.E. (G.M.) Bada	65 KW	11946
7	LV 3.2	Hospital	Smt. Rashmi Parihar Basant Bihar	49 KW	20841
8	LV 4	Blade Factory	M/S Kapoor Strips	145 HP	18302
9	LV 4	IP	M/S Sushant Udyog	100 HP	31238

O and M circle

l.No.	**Cate-gory**	**Purpose**	**Name / address of consumer**	**Sanctioned / contrect demand in KW/HP/KVA**	**Consum-ption during month in units**
(O&M)CIRCLE GWALIOR					

1	HV-3.1	Industrial	M/s Bharat Petrolium Rairoo	150	14430
2	HV-3.1	Industrial	M/s Gwalior Distillers Rairoo	1170	357040
3	HV-3.1	Industrial	M/s Hindustan Petrolium Rairoo	150	10030
4	HV-3.1	Industrial	M/S Rail Spring Karkhana Sitholi	1200	226010
5	HV-3.1	Industrial	M/s Indian Oil Corpn.Rairoo	200	43938
9	HV-3.2	Cold Storage	M/S Prakash cold storage	105	15650
10	HV-3.2	Cold Storage	M/S Parikshit cold storage	110	17800
11	HT-3.1	Industrial	M/S Jain stone	250	21330
12	HT-3.1	Industrial	M/S Naiduniya news	200	18135
14	HT-3.1	Industrial	M/S Balaji gangsaw Industries	125	20100
15	HT-3.2	Cold Storage	M/S Agrasen cold storage	105	13480
16	HT-3.1	Industrial	M/S Stone India	140	17765
18	HT-3.1	Industrial	M/S Mathura Stones Export	120	14745
19	HT-3.1	Industrial	M/s Jindal Oil Industries	250	102805
20	HT-3.2	Cold Storage	M/s RVS Cold Storage	146	27320
21	HT-3.2	Cold Storage	M/s Jai Mahakal Cold Storage	125	17870
22	HT-3.1	Industrial	M/s G.D.P. Agro Industries Gwl.	137	56900
23	HT_3.1	Industrial	M/s Jai Baba Industreis. Vill Birawali	167	26300
24	HT-3.2	Cold Storage	M/s Bansal Cold Storage, Gwl	155	41735
26	HT_3.1	Industrial	M/s Shree Jee Biofuels, Purani Chawani, Gwalior	130	22670
27	HT_3.1	Industrial	M/s Bihariji Oils Pvt.Ltd.	250	140120
31	HT-3.1	Industrial	M/s Gwalior Sugar Co Dabra	500	80040
34	HT-3.1	Industrial	M/S Econ Antari	180	32840
35	HT-3.1	Industrial	M/s Savitri Foods Product,	140	14809

			Dabra		
36	HT-3.1	Industrial	M/s G.M. (TSU) BSF,Tekenpur	376	49770
39	HT-3.1	Industrial	M/s Agro Solvent Product Datia	1500	579780
42	HV-3.1	Industrial	M/s Kachhawah Minerals, Datia	117	4748

We have segregated and summary of the above HV industrial customers is as below.

Sl.No	**Caategory**	**Total Connected load-KVA**	**Total Units consumed in a month Kwh**	**Total units consumed in a year Mwh**
1	**Industrial**	55643	16547845	198574.14

11.2 Summary of recommendations – Industrial Sector

RENEWABLE ENERGY INITIATIVES

No	Project Details	Investment (Rs. In Lakhs)	Energy Generated in lakh kWh PA	Annual GHG t Co2	Energy Generated/Saved upto 2013
	INDUSTRIAL SECTOR				0
8	IMPLEMENTATION OF PILOT BIOGAS PLANT IN TANNING INDUSTRY	375	2.54	236	5.08
9	USE OF SOLAR PRE HEATED WATER FOR BOILERS	TBA			0
10	USE OF SOLAR PV LED STREET LIGHTING	250	5.47	508.71	10.94
11	USE OF PARABOLIC STEAM GENERATORS	TBA			0
12	IMPLEMENTATION OF BIOMASS COGENERATION IN COLD STORAGES FOR PRODUCING POWER AND CHILLING	TBA			0
	Industrial Sector Sub Total	625	8	745	16

ENERGY EFFICIENCY MEASURES

No	Project details	Investment (Rs. lakhs)	Savings(Rs lakhs p.a.)	Savings(lakh kWh p.a.)	Savings (Tonnes of carbon/year)	Savings kwh upto 2013
	INDUSTRIAL SECTOR					
14	ENERGY EFFICIENCY AUDITS AND IMPLEMENTATION*	2184.27	1092.13	198.57	19850	397.14
	Industrial Sector Sub Total	2184.27	1092.13	198.57	19850	397.14

Calculations and Analysis

Energy savings anticipated : @10% savings = 19857.51 Mega watt hours per year

Annual Cost Savings : Rs.10 92 15 777 per year

GHG emissions savings : 19850 tCo2e

Energy savings expected till 2013 : 39714 Mega watt hours

Cost Savings @5.5 Rs per unit till 2013 in the next two years

:Rs.21 84 31 554

Estimated Investment considering a 2 year payback=Rs.2184 lakhs .Its is assumed that a minimum 10% nergy savings is possible in any industry after a detailed comprehensive energy audit.

11.3 Renewable Energy Initiatives

11.3.1

RE-8

- **IMPLEMENTATION OF PILOT BIO GAS IN TANNING INDUSTRY**

In India, there are about 3000 tanneries processing around 600 million kg of raw skin and hide per annum generating around 50 MLD of liquid waste and 305 million kg of solid waste. The pollution load in wastewater from tanneries is of the order of 30 – 120 kg of BOD5 and 75– 320 kg of COD per tonne of raw hide or skin processed. The environmental problems in the tanning industry have become more challenging after the Supreme Court verdict leading to the closure of polluting tanneries during 1995.

A although the liquid waste could be managed satisfactorily through the Common Effluent Treatment Plants / Effluent Treatment Plants (CETPs/ETPs), the solid waste from tanneries causes a major environmental problem through contamination of the soil , and groundwater apart from emission of huge quantities of green house gases to the atmosphere. Fleshing and sludge are the two major solid wastes emanating from tanning and treatment of tannery wastewater. It is reported that about 140-200 kg of fleshing, which are putrescible by nature, are generated for every tonne of leather processed. It contains about 80-90% moisture, 6-12% dry volatile matter and 4-8% ash and minerals. Large-scale leather processing activity in the country employing mechanical removal of fleshing has led to the generation of large quantity of fleshing which poses serious disposal problem. Similarly large quantity of sludge is produced when wastewater from tanneries is treated.

These solid wastes were managed through open dumping, land filling, thermal incineration, etc, triggering to secondary and tertiary environmental impacts. In view of this, demonstration project on high rate biomethanation technology have been installed for recovery of bioenergy from the biodegradable solid wastes of tanneries. This has not only helped in solving a major environmental problem of the tannery industry but also at the same time, led to production of green energy in the form of methane gas and improvement in viability of the treatment process.

DESCRIPTION OF THE PILOT PLANT

The solid wastes are collected in a dissolution tank, which is equipped with a mixer to completely mix the wastes. The homogenized wastes pass through a macerator to reduce the particle size for effective biodegradation

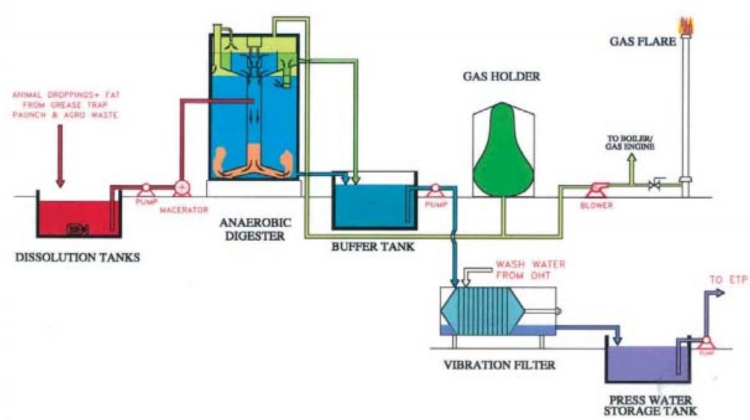
The homogenized waste is pumped into high-rate biomethanation digesters in which the homogenized wastes are treated under anaerobic conditions and the organic material is degraded into biogas. The produced biogas is stored in a gasholder, from where it is used for thermal energy application in the abattoir. The digested substrate is collected in a buffer tank from where it is pumped to a filter press to dewater the residue. The dewatered solids are used as bio –manure whereas the press water is collected in a storage tank and pumped to the ETP for further treatment and disposal.

The entire process consists of following five sections:

- Waste handling and slurry preparation section
- Anaerobic digestion section
- Biogas collection and scrubbing system
- Manure processing section
- Power generation section

TECHNOLOGY INVOLVED

Fig 32 : Bio gas in tanning plant



COST ECONOMICS Total cost of the project is Rs.3.75 crore,

BENEFITS ACHIEVED

1. **Employment Generation :**

   Waste to energy conversion plant is providing employment to about 10 persons for the collection of waste and operation and maintenance of the plant.

2. **Fuel Savings / Revenue Earned :**

   Revenue generated from biogas through thermal energy recovery is about Rs.14.0 lakhs per annum and through recovery of basic chromium sulphate from the solid wastes about Rs.5.0 lakhs per annum.

3. **Waste Management/ Cleanliness**

The project has demonstrated an eco-friendly process for the management of chrome leather shaving wastes from leather finishing unit. The process implemented is a total solution for the management of hazardous wastes in an environment friendly manner. It has improved the environment in and around the TIL complex

11.3.2

RE-9

- **USE OF SOLAR PRE HEATED WATER FOR BOILERS**

Preheating of boiler feed water

Solar thermal technology can be profitably employed to heat boiler feed water upto 90 deg Celsius and the pre-heated water can then be fed into the steam boilers. This application reduces the energy requirement substantially.

The Compound Parabolic Collector (CPC) is an improvised evacuated tube technology to increase heating efficiency of the tubes by 15%. Designed in Germany and delivered in India , this product has the following key benefits:

- Short installation times due to complete pre-assembled collectors
- Integrated return pipe and highly efficient thermal insulation

- Quick and easy exchange of the evacuated tubes without using any tools
- Hailstone test DIN EN 12975-2
- Low pressure loss allows several modules to be connected in series
- High energy yield in the transitional period and winter
- Extremely low heat loss due to the high vacuum

Advantages of CPC application are:

- Extremely modular
- Low structural cost
- Best ROI for Low Temperature Applications
- International Certifications: DIN , EN and ITW

11.3.3

RE-10

- USE OF SOLAR PV LED STREET LIGHTING

It is recommended to install Solar Led street lights in the main industries in Gwalior to save energy and also to provide light during the frequent power outages occurring in Gwalior.

High-performance LED Solar Street Lighting Systems.

These street lights combine high- performance LEDs along with high-efficiency electronics to deliver more light lumens to customers at lesser cost. Designed with battery back-up of 36 hours, our LED Solar Street Lights are highly reliable and can be used across the country under various climatic conditions.

Some of the key features of our LED Solar Street Lights are as below –

- Aluminum housing
- LEDs for light source
- Optics
- High efficiency driver & MPPT charge controller
- Polycrystalline solar cells

- Strong and safe
- Excellent heat dissipation IP65 protection
- High brightness and high efficacy
- Individual peanut optical lenses for uniform light distribution
- Low power consumption
- Mature technology, Improving Efficiency
- More Rugged
- Ease of availability
- Low discharge rate
- Ideal for Tropical conditions
- Low Maintenance & Long Life
- Long Life
- Back-up Ideal for cloudy conditions
- Rigid and safe
- Corrosion free
- Tubular construction
- 75% Depth of Discharge
- 1.5 days autonomy
- Octagonal Galvanized Pole
- Integrated approach for system design extracting best performance from each part
- Top Quality Optics

All the components are optimized for Optimum thermal management and maximum energy efficiency with lowest heat sink design cost

Microprocessor based charge controller (MPPT) and LED driver maximizes the performance of panel & battery

21W LED Solar Street Light

Luminaire

Light Output (after accounting driver loss & charge controller loss)

: **1800 lume**n

LED Efficacy : **100 lumens / watt**

LED Life	:> 50,000 hours
Housing	:IP 65 Aluminium die-cast housing
Total Harmonic Distortion	:0
LM80 report	:To be submitted
Driver efficiency	: >92%
Driver Life	
Luminaire Arm	
Charge Controller	

Type	:MPPT (microprocessor based)
Efficiency	:94%
No load current	:Less than 10 mA
Enclosure	:IP65
Solar Panel	:Multi crystalline silicon
Solar cells	

Voltage	:12V
Solar cell efficiency	:Min 14%
Solar panel efficiency	:12%
Junction box	:IP65
Mounting Arrangement Powder Coated	
Battery and Battery Box maintenance	:Lead-acid tubular battery of low
Type	:Poly Propylene
Container	:Ip 65
Permitted depth of discharge	:75%

Mounting position :Approx 5m from ground (anti-theft feature) / bottom

Battery box material and protection :Pre-coated galvanized sheet of 0.6mm thickness

Battery box protection thickness :Powder coating of 60 micron

Pole

Type :Octagonal Galvanized Pole

Height :5 m

Duty Cycle operation :Automatic dusk to dawn

Wind speed resistance of system :180 Km/hr

System Autonomy :36 hrs

Inbuilt Protections :Overcharge protection for batteryDeep discharge protection for battery Reverse polarity

i. Cost estimates

Cost of 1 Street Light : Rs.50,000.00

Implementation of 500 streetlights=Rs.250 lakhs

Energy Saved Per annum in Kwh replacing a 250Watt light: 5.47 lakh kwh per annum

Energy Saved per annum in Rs.lakhs=Rs.30 lakh

GHG saved:508.71 tonnes co2

RE-11 • USE OF PARABOLIC STEAM GENERATORS

Steam Generation

Solar parabolic dish concentrator consists of a concentrator which uses solar grade mirrors as reflectors and a receiver. The sunlight is concentrated onto the receiver and the medium which flows through the receiver gets heated up.

Solar parabolic concentrators can be effectively retrofitted/ integrated with steam boilers/ hot water boilers/ absorption cooling etc., so that solar can be used as a substitute to energy source to reduce utilization of conventional energy sources like LPG/ Diesel fired boilers.

Application Areas:

- Industrial Steam Generation
- **Solar Cooking**

  Steam is used at low pressures to cook food in large quantities, as it reduces the cooking time considerably. Solar thermal technology which produces heat can be profitably deployed to generate steam at desired pressure in eco-friendly manner.

Suitable for:

- Educational Institutions
- Canteens in industries/ commercial organizations
- Hotels
- Asrhams/ Temples

11.3.4

RE-12

- IMPLEMENTATION OF BIOMASS COGENERATION IN COLD STORAGES FOR PRODUCING POWER AND CHILLING

There are many cold storages in and around Gwalior as indicated by the list of industries detailed above. The following is a case study of a successful implementation of bio mass co generation in cold storages. There are many lessons to be learned from the following.

Case study;

DG SET COMBINED HEAT & POWER (CHP) GENERATION - A SUCCESSFUL CASE STUDY OF A COLD STORAGE

Courtesy :G.Subramanyam

Sr.Dy.Director (Energy Management)

National Productivity Council

The following is a successful case study of Cold Storage unit situated at outskirts of Hyderabad. The Unit started its operations way back in 1987. The company is one of the first and commercial De-Humidification Cold Storage unit in the state of Andhra

Pradesh, exclusively designed for high value hybrid seeds, tamarind , chillies etc. The company has state-of-art pre-cooling facility for export of quick perishables like fruits, vegetables and eggs. The unit needs both power and steam. The electrical power consumption is towards running refrigeration compressor and associated equipment like condensor pumps, chilled water pumps, cooling tower and lighting etc. The steam is used for de-humidification. In cold storage units. The temperature and RH control are most critical in cold storage units, and the moisture is absorbed by in adsorber using silicagel as deccicant. After absorption, the silica gel needs to be regenerated, and steam is used for ***Bry Air*** regeneration purpose. In ***Bry Air*** dehumidification in one cycle - adsorption of moisture takes place and in other cycle - re-activation of silica gel is carried out using hot air. Hot air is generated using steam in the radiator coils.

Initially, the unit went for 75HP LT connection with the SEB, which is meant for lighting only. For balance power requirements, 2 x 320 KVA DG sets were installed. For steam generation, 600 kg/hr capacity HSD fired boiler was installed. The unit requires around 185 Kw of power and 300-350 Kg/hr of steam. Initially the unit used to consume about 55-60 lit/hr Diesel in the DG sets and another 22-25 lit/hr Diesel in the boiler. The DG sets were used to operate for 12Hrs/day and the boiler was needed to operated about 10-12 Hrs/day. With this combination, the daily energy cost used to be around Rs.31,416/day, and the annual bill of the order of Rs.115 Lakhs/year. (All the costs are compared at the present rate).

When the cost of Diesel went up exorbitantly, the unit has gone for a gassifier, using rice husk as fuel, by investing Rs.15 Lakhs. The gassifier was supplied by M/s Ankur Scientific Energy Systems, Baroda. The rice husk is partially oxidized, and bio-gas is generated. The other by-products of the gassifier are ash & tar. The ash has very good market value and is being used by brick manufacturers and tar is sold as a lubricant. One problem with the gassifier is , the DG set cann’t run on completely on

100% bio-gas. A minimum of 30% Diesel and 70% gas is needed. But this unit decided to use 40% Diesel and 60% bio-gas for running the DG sets. By installing this Gassifier, the Unit has reduced their total energy bill to Rs. 79 Lakhs from the initial Rs. 115 Lakhs a savings of by Rs.36 lakhs, a significant reduction of more than 31%.

When these people decided to go for a gassifier, the cost of Rice husk used to be in the range of Rs.700-800/ton. But over a period, when every body started using rice husk, the cost of rice husk also gone up and is now available in the range of Rs1500-1600/Ton, and almost doubled. At this stage, they approached National Productivity Council, to help them to reduce their energy bill further by carrying out Energy Audit in the year 2000.

After preliminary visits and taking some trails on DG sets, Boiler and refrigeration system, we thought Vapour Absorption Refrigeration (VAR) system would be best bet to replace the existing load of 100 TR , which is running on vapour compression Ammonia refrigeration system. Since steam is available and in case, if we want more steam, we thought we can generate from bio-gas. At this stage, two alternatives worked out. First one is to generate steam by installing Waste Heat Boiler(WHB), another alternative was to generate hot air directly from the Flue gas by installing simple air heater. First of all, why to generate steam and then produce hot air, if we are able to generate directly hot air, so that we can avoid one more inefficiency. But after working out various alternatives, our suggestion of heat recovery from DG sets exhaust gases and generating hot air was well appreciated. Since the DG sets are run continuously we felt this is an ideal case for Combined Heat & Power (CHP) generation.

The exhaust temperature of the DG sets used to be in the range of 390-400 ^{0}C. After detailed measurement of F.Gas flow, the potential heat available assessed to be around 1,00,000 Kcal/hr, which is more than sufficient to generate 1500 CFM hot air at 120 ^{0}C. This perfectly matched the plant requirements. After giving this idea, the unit has implemented the Waste Heat Recovery (WHR) system for their DG sets, in a record time of one month. Interesting part is, based on the heat duty, we have given them a rough estimate of heat transfer area required and the line diagram of the modification. The unit has fabricated the shell & tube heat exchanger on their own inside the factory itself at a cost of only Rs.3.5 lakhs(year 2000 cost) & present cost Rs.6 Lakhs. One single heat exchanger, with blower can cater to both the DG sets, with by-pass arrangement. When we gave them, the heat exchanger design, in fact, we ourselves were not confident of our own design. But after seeing the working model, which was giving hot air at 140-150 ^{o}C, at the exit of the Waste heat recovery system, we are proud that, we can do even designing.

By implementation of the WHR, the existing steam boiler was completely stopped and has become a stand-by boiler. By this the annual bill of the plant has further reduced to Rs.46 Lakhs from the initial Rs. 115 Lakhs. In another words, additional savings of Rs.33 Lakhs, by stopping the boiler alone. This amounts to reduction of another 42%. The following table-1 presents the cost comparison of three different combinations, i.e.1) DG set & Boiler, 2) DG set with Gassifier & Boiler and 3) DG set with Gassifier & WHR system.

Table 49 : Cost Benefit Analysis of DG set Cogeneration with Gasifier

Sl.no.	**Parameter**	**Unit**	**Case -1 Only DG set**	**Case-II DG set with Gasifier**	**Case-III DG set with Gasifier & WHR**
1.	DG set Rating	KVA	2 x 320	2 x 320	2 x 320
2.	Normal operation		320	320	320
3.	Avg.Power Generation	Kw	180	180	180
4.	Diesel Consumption in DG set	Lit/hr	55	22	22
5.	Rice husk consumption in Gassifier	kg/hr	0	200	200
6.	DG set F.Gas Exit Temp.	^{0}C	400	400	400
7.	Steam requirement	kg/hr	300	300	0
8.	Diesel consumption in the Boiler	Lit/hr	22	22	0
9.	Total Energy	Rs./day	31416	21552	12576

	Cost				
10.	Annual Energy Bill	Rs. Lakhs	115	79	46
11.	Annual Energy Savings	Rs. Lakhs	36		69
12.	Investment towards Gassifier	Rs. Lakhs	15		15
13.	Investment towards Waste Heat Recovery	Rs. Lakhs	0		6

	Case -1	**Case 2**	**Case 3**
Total Investment(Rs.Lakhs)	**-**	**15**	**21**
Payback(months)	**-**	**5**	**4**

This is a successful case study of a small cold storage unit, which experimented, by installing a gassifier and also the waste heat recovery system, there by reducing their energy bill from the initial Rs.115 Lakhs to Rs.46 Lakhs, a savings of Rs.69 Lakhs equivalent to 60% over a period. The simple payback period was hardly less than 4 months, really unbelievable. This savings are based on only 12hrs/day of operation. Imagine the savings, if the plant operates for 24 hrs and all the 3 shifts. This technology can be replicated not only in the similar cold storage units but also for other units, who needs combined heat & power (CHP) simultaneously and urge to reduce their energy bills.

11.4 Energy efficiency Measures IN INDUSTRIES

EE-14

- ENERGY EFFICIENCY AUDITS AND IMPLEMENTATION

About one-third of the energy used in Gwalior went to industry. That's not so surprising when you consider everything that falls under this economic sector.

The use of energy in industry affects every single citizen personally through the cost of goods and services, the quality of manufactured products, the strength of the economy, and the availability of jobs.

The industrial sector uses energy in many ways. Often energy is needed directly to raise the temperature of components in the manufacturing process, which is called process heating. Refining crude oil, where heat is used to separate various products, is an example of this. Another common use of energy in industry is to heat a boiler that generates steam or hot water.

Electricity and oil are heavily relied upon in industry and manufacturing. While a broad range of activities is included in this sector, a few stand out as the biggest energy users. The chemical, agro products, oil mills, and tanning, textiles industries draw a large amount of energy, as do pharma,etc in Gwalior. In fact, those industries consume about 75% of the energy used by this sector. For this reason, many efforts to improve the Gwalior's energy efficiency should focus on industry and manufacturing.

The first step in improving energy efficiency in small and medium scale industries is to perform a comprehensive energy audit. The comprehensive energy audit is subsidized by the Electricity Board and the Madhya Pradesh urja Vikas Nigam has also empanelled consultants to conduct the energy audits. It is seen by experience that an average minimum of 10% energy saving potential exists in case the industries implement recommendations mentioned in an energy audit report.

There are many funding and financing opportunities also available for implementing the recommendations often without any upfront capital investment costs.

Some recommendations for textile companies are enumerated below for reference.

Textile Industries

Introduction

Conservation of energy is an essential step to overcome the mounting problems of the worldwide energy crisis and environmental degradation. In particular, developing countries are interested to increase their awareness on the inefficient power generation and energy usage in their countries. However, usually only limited information sources on the rational use of energy are available.

The know-how on modern energy-saving and conservation technologies should, therefore, be disseminated to governments and industrial managers, as well as to engineers and operators at the plant level.

In energy intensive industries, savings of around 20% could generally be achieved through basic housekeeping improvements, with further savings from more detailed measures such as auditing and energy management programs. The rational use of energy calls for a broad application of energy conservation technologies in the various industrial sectors where energy is wasted. One of these energy intensive industrial sectors to be considered to improve efficiency through the introduction of modern energy conservation technologies is the textile industry.

In textile plants, appreciable amounts of energy could be saved or conserved at the energy supply side by appropriate steam distribution management, adjusting the air/fuel ratio in the boilers, installing cogeneration system, improvement power system and etc. However, due to maintenance, operation mode, and policy of a textile company could be different from plant to plant, the precise amount of energy saving only come once demand side measures have been considered.

Furthermore, since textile plants in developing countries is labor intensive industries, any improvement in supply or demand side energy efficiency would result in energy cost reductions and hence increase the income of the factory and the employees.

1. **Characteristics of Energy Consumption**

1.1Types of energy used in the textile industry

In general, energy in the textile industry is mostly used in the forms of: electricity, as a common power source for machinery, cooling and temperature control systems, lighting, office equipment, etc.; oil as a fuel for boilers which generate steam; liquefied petroleum gas; coal; and city gas.

Table 50 : Average energy requirement in textile Industries

Sl.No.	Branch	Thermal Energy	Electrical energy
1.	Fiber Manufacturing	70	30
2	Textile manufacturing	44	56
3	Clothing manufacturing	62	38
4	Finishing manufacturing	85	15

2. Promotion of Energy Conservation Technologies

While the significance of energy conservation awareness is relatively easily understood at home, when a program is introduced into a factory to promote it, its thorough implementation tends to be delayed at an early stage. Therefore, for its actual course of implementation, it is desired to devise company-wide coordinated measures similar to QC activities at factories. Also, in order to promote energy saving measures efficiently, it is found to be effective to separately consider general management techniques for “rational use of energy” and process-specific techniques to be developed in each specialized technical field.

2.1 Energy conservation management technologies

2.1.1 Organizational rationalization

Since energy management is relevant to a wide range of departments within a company, it is necessary to enhance the awareness, improve the knowledge and obtain the participation and cooperation of everybody involved in the production process. Therefore, while it is necessary for engineers and technicians with specialized technical knowledge to play a central role in energy conservation efforts, the implementation of an energy conservation program itself should not be left to a handful of specialists or specialized sections. Rather, it is desirable to address the task company-wide, for example by setting up an ‘Energy Management Committee’.

2.1.2 Improving efficiency of electricity use

(1) Lighting

Due to its nature of operations, the share of lighting in electricity use is relatively high. After the switch from tungsten bulbs to fluorescent lamps achieved considerable electricity savings, electricity-saving fluorescent lamps have been developed and marketed for further improvements, including those capable of reducing electricity use by several percent for the same level of illumination. In general, the effectiveness of illumination is influenced by various factors, such as the intensity of light source, the reflection coefficient and shape of the reflective fitting (lamp shade), the layout of the room to be illuminated, interior finish, color and the distance from the light source. Therefore, it is important to re-examine whether the light source is utilized in the most efficient way and take electricity saving measures, if necessary, such as reducing the number of lamps in use by switching from global lighting to local lighting as much as possible.

(2) Electric motors

The textile industry uses a vast number of relatively small electric motors. Notably, while a conventional machine was driven by a single motor with the generated mechanical power transmitted to various parts of the machine in a collective manner, many modern machines utilize multiple motors with a control board controlling the movement of each motor, which is directly coupled to a machine part to drive it independently from others. This is also a rationalized feature in terms of energy saving. However, regarding the selection of each motor, emphasis has been placed on mechanical performance, resulting in a motor with an excessive capacity. This leaves considerable room for reexamination from an energy conservation point of view.

(3) Electric heating

In the textile industry, electric heating has largely been replaced by other methods (steam, gas heating, or direct or indirect fired heating) for some time in order to achieve cost reductions. However, since electric heating only requires a small initial investment as a result of convenience and simplicity in equipment construction, it is still used for small capacity local heating purposes. Therefore, it is desirable to conduct a comparative investigation into alternative heating methods, such as far-infrared radiation heating, high frequency dielectric heating and microwave heating

2.1.3 Improvements in efficient fuel use

(1) Selection of fuel

Fuels utilized in the textile industry are in the form of coal and oil. More recently, efficient energy use is under investigation, including the revival of coal on the way to a further move from oil to liquefied and city gases, while reflecting various fuel prices. In selecting fuels, those with good flue gas characteristics in addition to high calorific value and ease of combustion are desired, so that air pollution can be prevented as much as possible

(2) Selection of boiler

By and large, boilers used in the textile industry have experienced a change from Lancastrian- or Scotch-type tubular or smoke tube to water-tube boilers (natural circulation and forced circulation water-tube boilers and once through boilers). As a result, boiler efficiency has improved from the conventional 60’s to 70’s of percentage points to as high as the 90’s. Since high performance boilers are prone to a rapid growth of scales inside their water tubes, feed water management becomes important. Furthermore, these boilers have small amounts of retained water and high evaporation speeds so that many aspects of their operation are automated, including feed water and combustion management.

2.1.4 Improvement in efficient use of steam

(1) Piping

The noted feature of steam use in the textile industry is that the amount of steam involved is not so large but the locations where steam is required are widespread so that steam losses due to heat radiation from steam transportation pipes and pressure drops are considerable.

Therefore, for steam transportation over long distances, high pressure and small diameter rather than low pressure and large-diameter piping is desired, with pressure reducing valves placed as necessary to regulate the steam pressure at the point of use, thereby curbing heat losses. Also, as pressure losses around bends are great, it is desirable to make their radii large. In order to prevent steam leaks from joints due to the thermal expansion of the pipe, expansion joints should be placed where required. Furthermore, in order to maintain the temperature inside the valve, tank and treatment tank as well as the piping, it is necessary to install them heat-insulated, using appropriate heat insulating materials, so as to efficiently use steam while preventing heat losses.

(2) Steam accumulator

Since live steam is often used in dyeing factories, fluctuations in steam use during working hours are large. On the other hand, since high performance water tube boilers and once-through boilers are designed such that water retained inside the boiler is very little, the boiler cannot react to momentary and sudden load changes, while responding to automatically controlled slow load changes is not a problem. In such a case, a steam accumulator can be installed midway through the heat transporting pipe, between the boiler and the heat consuming load, in order to store excess steam when the load is light by transforming it to heated water. This then transforms the heated water back to steam when the load is heavy in order to reinforce supply to the load. This allows the boiler to continuously operate with the average load and is quite advantageous in view of energy saving.

(3) Recycling of drain

So far, after its heat energy is consumed, steam has been drained off. However, in view of energy saving, it is necessary to collect and recycle the heat energy carried by the drain water.

2.1.5 Utilization of heat exchanger

In each production process of the textile industry, the heating and cooling of gases and liquids as media of heat are frequently required. This is done through heat exchange between different fluids, and in order to avoid contamination or chemical reaction due to their direct contact, heat exchangers are used to carry out indirect heating and cooling. It is important to use the right heat exchanger for the intended purpose

2.1.6 Measuring instruments and automatic control

Energy saving is an operation to grasp the actual situation of energy use in a factory precisely and quantitatively and to carry out improvement measures in order to rationalize and economize on it. While measuring instruments are needed to obtain quantitative data, it will become more and more important to investigate the use of sophisticated measuring instruments based on recent developments in mechanical and electronic engineering, combined with automatic control systems.

2.2 **Energy use and rational use of energy in process-specific technologies**

Progress in production rationalization is achieved through the implementation of a comprehensive set of measures, including energy conservation technologies as the centerpiece measure, along with time management, labor saving, natural resources saving and space saving. It has been frequently pointed out that, along with management techniques described earlier, the improvement and development of process-specific techniques on energy conservation greatly contribute to the rationalization of production. Here, process-specific techniques relating to energy saving are summarized for each specialized technical field.

2.2.1 **Fiber production**

In particular, the following techniques relate to energy saving

(1) Raw material production process

Implementation of energy saving through **improvements in the process and reaction conditions**

(2) Polymerization process

Promotion of energy saving through combining the POY (Pre-oriented Yarn: Yarn with some stability with its molecules partially having gone through orientation) and DTY (Draw Textured Yam: **false twisted yarn produced while drawing POY yarn) methods** and **an expanded use in multi-folded spinning yarn.**

2.2.2 **Spinning**

(1) Ring spinning operation

For the fine spinning operation, electricity is consumed in driving the spindles, packaging, and spinning, drafting, and operating the lifting and cleaning mechanisms. It is desired to curb the increase of electricity consumption as much as possible by setting an optimal condition for each of these electricity usages

(2)Air-conditioning

Although as an ideal working environment a room temperature less than 30°C is desirable, in cases where the working environment has been drastically improved in most other aspects with work load also reduced, a slightly increased room temperature may be permitted. there are many instances of seasonal switch-over from a damper to a pulley as a means of readjusting the blown air volume; this is in order to recycle the air sucked from the processing machine for each operation through a filter back to the same room, and it is therefore necessary to recheck the locations of fans for suction and returning

2.2.3 **Textured-yarn production**

While synthetic-fiber textured-yam is mostly produced with false twisting machines. As their operating speeds increased, driving and heat-curing motors and other peripheral equipment became larger, accompanied by an inevitable increase in electricity consumption.

Although this may be acceptable as long as the production improvement resulting from a high speed operation covers the increase in electricity costs, reductions in energy cost would surface as an avoidable urgent task, should a sharp increase in electricity charge occur. It can reasonably be said that the major form of energy consumed in the production of synthetic finished-yarn is electricity

Although the amount of electricity consumed in each piece of equipment varies with factory scale and the type of false twist machine, and therefore cannot be treated in a standardized manner, generally accepted average values may be taken as

3.5 kWh/kg for a single heater system and 5.0 kWh/kg for a double heater system as one report suggests.

60% of all energy consumption by a false twist machine occurs in the heater. Therefore, **improvements in the heat insulation of the heater** and **the lowering of heater temperature** may be considered as energy saving measures. Since the latter has implications in the characteristics of the finished-yam, whether or not it is adopted should be examined on such occasions as in the development of a new product.

Since air-conditioning plants are designed based on the conditions applicable at the time of installation, it is desirable that they be re-examined against the present conditions.

2.2.4 Weaving

As is shown in Figure 24, rationalization in fabric production is such that while various improvements in machinery aimed at high speed operation and labor saving have been carried out, the amount of energy use per unit of the product has gradually increased. Regarding loom design, high productivity shuttle less looms such as water jet, rapier and gripper types have successfully been introduced, with air jet models put in practice in the production area of industrial fabric material. The amount of energy consumed by each loom during its weaving operation can be estimated from the motor capacity and weaving speed. Conventional shuttle looms are based on the weft-insertion method, incorporating a shuttle zooming to and fro with a large inertia mass (approx. 400) and mounted with extra weft, and they also use energy consuming pins as an integral part of the machine. For this reason, the shuttle less looms' contribution to energy saving cannot be regarded as too high.

On the other hand, as a large amount of energy is consumed in sizing, as one of the preparatory operations for weaving, **the introduction of foam and solvent sizing operations are being investigated.** Furthermore, **long fiber fabrics using non sizing filaments have been developed,** eliminating the sizing process altogether. In a reported example, **the introduction of a new heat exchanger into a sizing machine with a very poor sealing capability achieved more than 40% of energy saving.**

2.2.5 Knitting

As is shown in Table 13, the share of energy cost in the total cost of production is not necessarily high for the knitting process. However, of the main production facilities for this process, knitting machines have also been undergoing a shift towards high speed and large capacity and fine gauge features; the current industry trend is for high added-value goods and multi-line, small-volume production based on advanced systems such as computer-controlled pattern making mechanisms. Therefore, a potential tendency for increased energy consumption should be taken into account. As a result, **it is desirable to conduct a comprehensive re-examination of the production schedule along with the implementation of actual energy conservation measures in order to reduce or restrain the share of energy cost in the total production cost.**

12 Municipal Sector

12.1 Background and description

The global trend towards increased urbanisation requires municipal bodies to provide services such as streetlights, solid waste management, sewage treatment & disposal, etc. All these activities consume significant amount of electricity, usually in an inefficient manner. The cost of energy sometimes constitutes more than 50% of the municipality's budget and implementing efficiency measures could reduce it by at least 25%. There is a potential to save around 10 billion rupees by implementing energy efficiency measures. Almost all municipal bodies depend on government support to meet their development and operating expenses. Government of India, through the Bureau of Energy Efficiency has initiated a programme to cover 175 municipalities in the country by conducting investment grade energy audits and preparation of detailed project reports. Energy Service Companies are being encouraged to take up the implementation of the programme with the help of financial institutions. Utilities must encourage implementation of DSM measures to relieve their network of such inefficient load. Municipal sector includes water pumping, waste water treatment, and street lighting .Electricity play the major role of source of energy.

The official buildings, activities of the Municipality wherein the Municipality is paying energy bills have been studied for implementation of energy efficiency and conservation measures under Municipal sectors The Situational Survey and detailed energy audit has been carried out by Elpro Energy Dimensions for the Bureau of Energy Efficiency in Gwalior.

12.2 Summary of Recommendations-Municipal Sector

RENEWABLE ENERGY INITIATIVES

No	Project Details	Investment (Rs. In Lakhs)	Energy Generated in lakh kWh PA	Annual GHG t Co2	Energy Generated /Saved upto 2013
	MUNICIPAL SECTOR				0
13	MUNICIPAL SOLID WASTE (MSW) TO ENERGY	7160	518	190859	1036
14	SEWAGE TO ENERGY	2185	32.93	17495	65.86
15	SOLAR PV POWER GENERATING SYSTEM	8450	74.1	5928	148.2
16	SOLAR STREET LIGHTING	260	5.689	529.06	11.38
17	SPECIAL AREA DEMONSTRATION PROJECTS				0
	GWALIOR FORT	55	0.55		1.1
	LAKSHMI BAI STATUE	5	0.06		0.11
	ITALIAN GARDEN	40	0.44		0.88
	SCINDIA SCHOOL	25	0.28		0.55
	Municipal Sector Sub Total	18180	632	214811	1264

ENERGY EFFICIENCY MEASURES

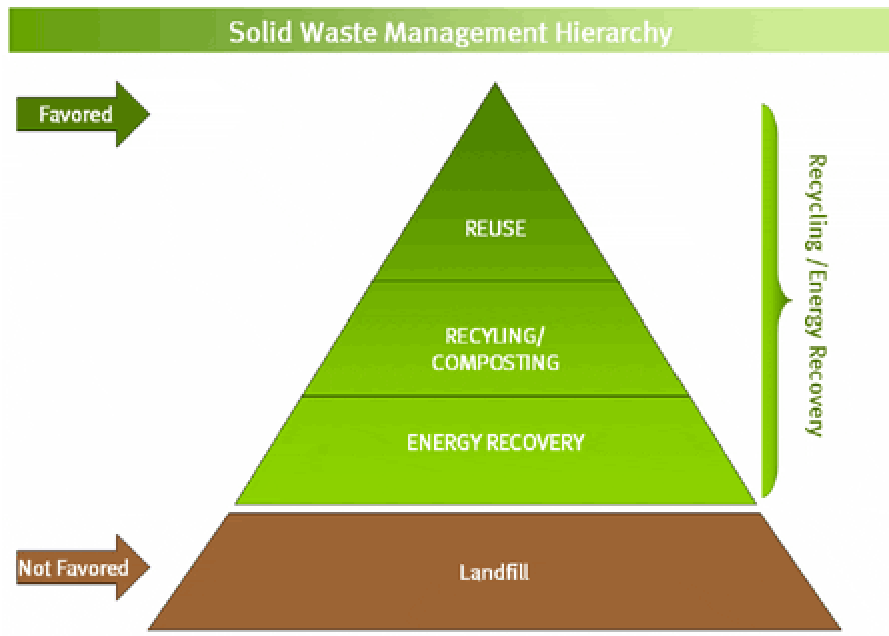
No	Project details	Investment (Rs. lakhs)	Savings(Rs lakhs p.a.)	Savings(lakh kWh p.a.)	Savings(Tonnes of carbon/ year)	Savings kwh upto 2013
	MUNICIPAL SECTOR					0
15	STREET LIGHTING ENERGY CONSERVATION	371.25	188.32	50.63	4050	101.26
16	WATER TREATMENT AND PUMPING SYSTEMS	85	43.92	14.63	1360	29.26
	Municipal Sector Sub Total	456.25	232.24	65.26	5410	130.52

12.3.1

RE-13

- MUNICIPAL SOLID WASTE(MSW) TO ENERGY

Municipal Solid Waste (MSW) to energy



The waste production rate of the Gwalior is estimated to be 735 tones per day from waste stream, primary households, business and commercial waste, collectively termed as Municipal Solid Waste, MSW. A huge potential of the power generation from this waste is estimated to be 110250 MW per year. If it will be utilized fully then it can meet up to 33 % of annual energy required. Net calorific value off the MSW is 11508 Kcal/kg.the composition of the solid waste is as follow:

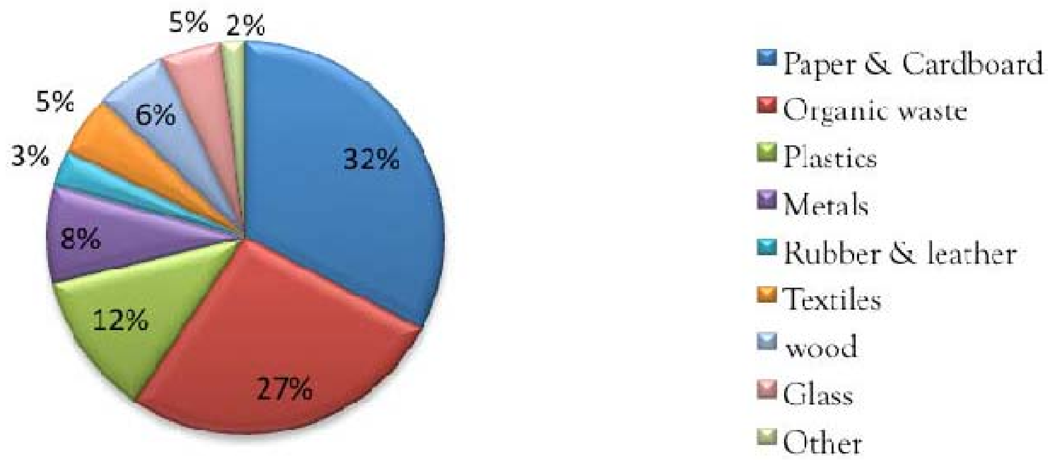


Fig 33 Composition chart of MSW

i. Technology to produce energy from MSW

Power generation from the MSW is the technology to convert organic fraction in MSW into combustible gases. The conversion shall be conducted in two ways:

1. Biological conversion for converting easily degradable wastes into energy rich gas (methane, CH_4)
2. Gasification of other organics to become synthetic gases (syn-gas) at a limited amount of oxygen.

Energy containing gases will eventually be used in the power generation process. The major advantages are:

- Reduction of MSW;
- Reduction of environmental and social problems at the disposal site;
- Utilization of MSW to generate energy; and
- Improvement of MSW management services.

ii. Energy generation Aspects

Daily production of the MSW is 785 Tones. It is expected that up to 75% of the total generated MSW will be collected successfully. On this basis we can say around

600 tones will be collected. It is shown from the below calculation that 8 MW power plant can be installed

Quantity of MSW - 600 tones

Net calorific value - 11508 Kcal/kg

Energy Recovery Potential (kWh) - NCV x W x 1000/860 = NCV x W x 1.16

Power Generation Potential (in kW) = 1.16 x NCV X W/24 = 0.048 X NCV x W

Conversion Efficiency (in percentage) = 25%

Net Power Generation Potential (kW) = 0.012 x NCV x W

The Power Generation Potential in the above case shall be = 82857.6 kW

= 8.3 MW

In all the above cases, for computation purpose we have taken conversion efficiency as 25% only in order to validate power potential conservatively.

CDM benefit

GHG reduction due to CH_4

Total CH_4 reduction = 6745.2 tone per year

1 tone CH_4 = 21 tone CO_2

Total CH4 reduction = 6745.2 × 21 =141649.2 tone / year

Total CER = 141649.2

1 CER = 10 $ = 50 Rs

Total benefit = 7082460 lakh Rs/ year

CO_2 Emission reduction

1 kWh = 0.95 kg CO_2

Total electricity generated = 518 lakh kWh/ year

CO_2 generated = 49210000 kg =49210 tone

Total CER = 49210

1 CER = 10$

Total benefit = 2460500 lakh Rs

Total CDM benefit = 9542960 lakh Rs / year

Cost estimates

Table 51 : Cost estimates of MSW to energy

Capital cost	Rs Lakh	7160.00
Income	Rs Lakh/annum	1754.165
Simple pay back	**Year**	**4**

Energy can be generated through Food waste:

In order to decrease food waste and mitigate climate change, East Bay Municipal Utility District (EBMUD) is pioneering an innovative method of reducing the amount of food waste reaching landfills while simultaneously producing renewable energy.

The kithen waste from the hotels in Gwalior is calculated approximately 16.200 tonnes annually and kitchen waste from houses, hospitals, hostels are put into about approximately 200 tonnes annually.

Hence total of about 216 tonnes of kitchen waste will contribute to the production of electricity

Net calorific value - 11508 Kcal/kg

Energy Recovery Potential (kWh) - NCV x W x 1000/860 = NCV x W x 1.16

Power Generation Potential (in kW) = 1.16 x NCV X W/24 = 0.048 X NCV x W

Conversion Efficiency (in percentage) = 25%

Net Power Generation Potential (kW) = 0.012 x NCV x W

The Power Generation Potential in the above case shall be 29828.7

i.e., 2.2828MW can be produced.

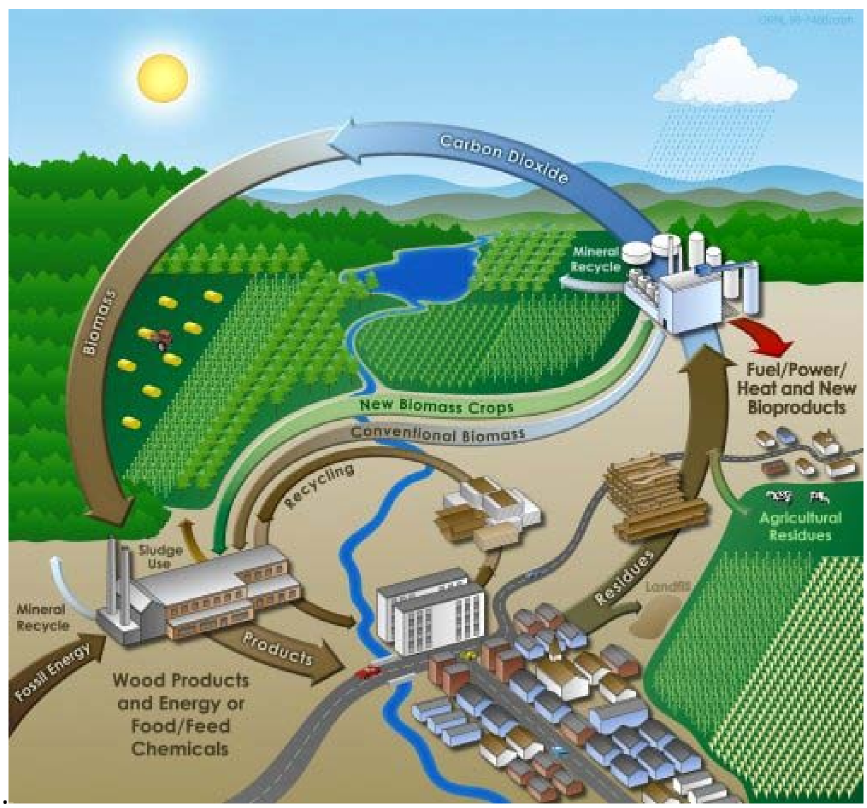
Summary

Based on the study and review, we can say, the performance of the project is a function of the success of proposed two-segment reverse acting and reciprocating grate which the company proposes to import.

In India no such projects are under operation with this grate technology. However we endorse this grate which has been proven successful in many countries.

This project stands viable with government support and CDM revenues. The proposed project activity will lead to GHG emission reduction in the following manner:

- The methane emission is avoided which would otherwise happen due to anaerobic decomposition of MSW in the existing waste disposal site.
- Power exported from the proposed project activity will replace fossil fuel based power from the grid.



12.3.2

RE-14 • SEWAGE TO ENERGY

Municipal waste water treatment plant treat the waste water of whole city and produce water at accepted level of contaminant and sludge which is further treated for dispose.

It is suggested to go for the anaerobic digestion of the sludge generated and produce electricity from the biogas produced. According to the sample of the sewage, around 3480 M^3/Day will be generated by which 4593600 kW electricity can be generated. The anaerobic digestion of sludge is proposed for electricity generation by fuel cell technology. Produced power can be utilize in house and surplus amount can be fed in to grid.

The overall objectives can be outlined as below:

- Replace the traditional sludge drying beds and landfill options with mesophilic digestion of all primary and secondary sludge followed by mechanical dewatering in order to reduce GHG emissions
- Effectively mitigate odor problems from the existing treatment of sludge and sludge liquors through introduction of digestion and removal of sludge drying beds
- Production of fertilizer by mechanical dewatering of the digested stabilized sludge
- Production of electricity from utilization of the biogas fuel cell thereby reducing GHG emissions from electricity production from the grid

Completion of this project will deliver the following key results:

- all primary and secondary sludge thickened and digested as per EU recommendations and guidelines;
- all biogas produced within the digestion process used for power and heat generation via CHP gas engines thus reducing the site electricity requirement from the National grid;
- reduction in site fossil fuel usage as all site-heating requirements will be met from CHP gas engines;
- All sludge stabilized and pathogen free.

i.Technology

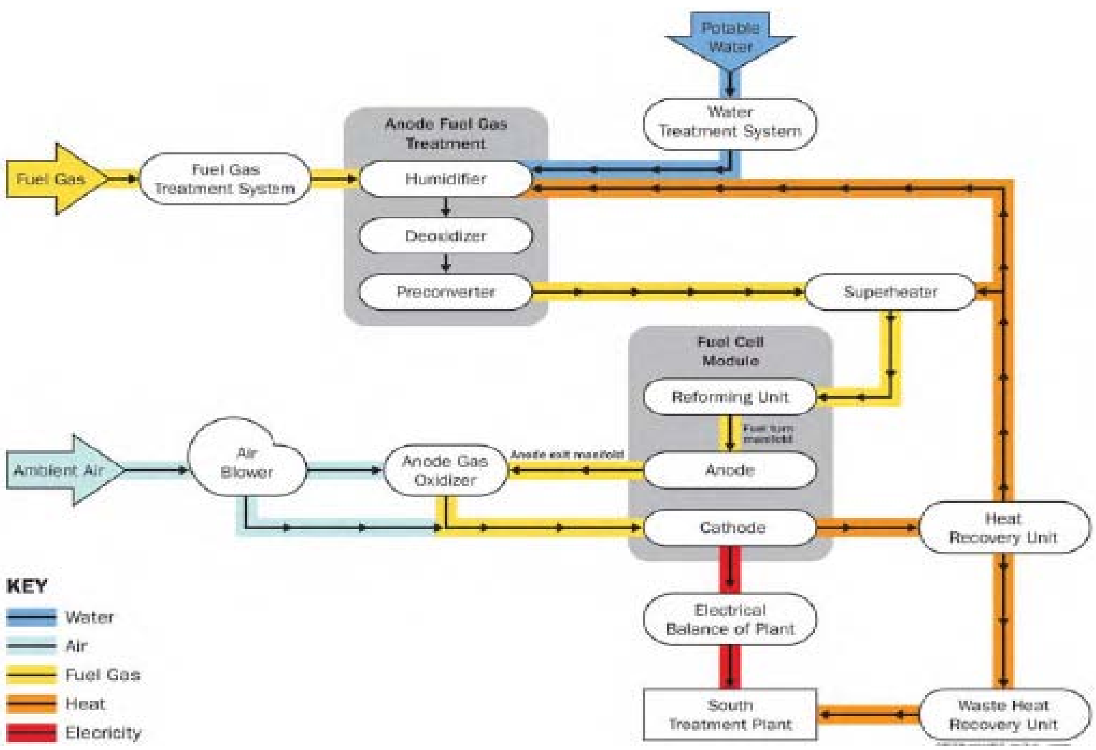


Fig 34 Sewage to Energy Process overview

Fuel Cell Technology and Configuration

Fuel cells produce electrical power directly through an electrochemical reaction using hydrogen and oxygen. The electrochemical conversion of hydrogen to direct current is much more efficient than if the hydrogen were combusted using the two-step process of conventional combustion in which fuel is first burned and then the subsequent heat is used to produce power. Unlike combustion technologies, fuel cells have very low emissions of carbon monoxide, nitrogen oxides, and non-methane organic carbon. The main product of the fuel cell reaction is water, which discharges in the exhaust gas

Hydrogen is produced from methane, the primary compound in natural gas, landfill gas, or anaerobic digester gas; air provides the oxygen. Similar to a battery, the fuel cell houses hundreds of individual cells. Cells are grouped to form stacks. Each stack contains an anode, cathode, and electrolyte. When the fuel gas is combined with steam in the presence of a catalyst, the fuel gas is reformed to hydrogen, which is then fed to the anode while air is fed to the cathode.

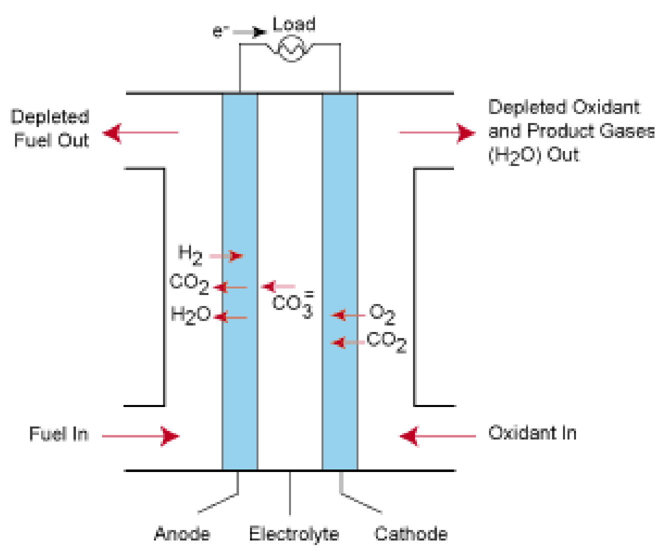


Fig 35 Fuel cell system

Fuel cell system ("power plant") consisted of the systems in the fuel processing, power section, and power conditioning "blocks" and of ancillary systems that supplies water, air, and other materials required to operate the plant.

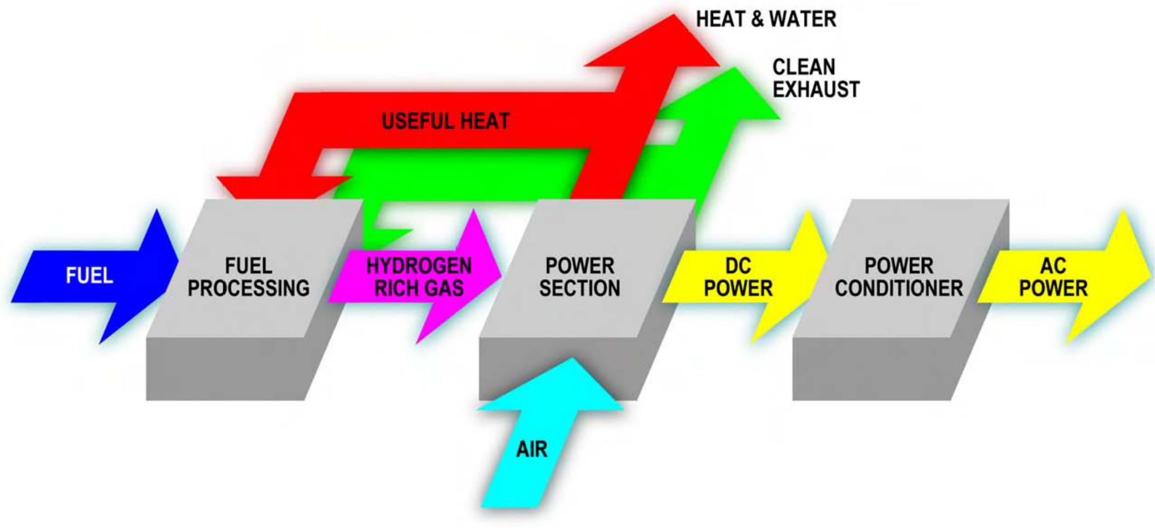


Fig 36 Fuel cell process flow diagram

Sludge calculations:

Average flow : 60,000 M^3/day (60 MLD)

TSS : 300 mg/lit,

BOD_5 : 180 mg/lit,

Incoming TSS : 60,000 x $\frac{300}{1000}$ Kg/day

: 18000 Kg/day

TSS removed from Primary clarifier : 10800 kg/day (60% removal)

Primary Raw sludge : 10800 kg/day

Excess Sludge

(i) Excess sludge generated shall be total of :VSS generated out of BOD reduction (P_x)

(ii) VSS generated out of NH_4N reduction

(i) VSS generated out of BOD reduction

$$Px = yobs \times Q \times (So-S) \times (10^3 g/Kg)^{-1}$$

$$Yobs = \frac{Y}{1 + kd.\theta c}$$

$$\text{Thus } Px\ (VSS) = \frac{Y}{1 + kd.\theta c} \times Q\ (So-S) \times (10^3 g/Kg)^{-1}$$

$$\text{Thus } Px\ (VSS) = \frac{0.6}{1+0.06 \times 5} \times \frac{60000 \times (108-20)}{1000} = 2429 \text{ kg/day}$$

$$Px\ (SS) = 2429/0.8$$

= 3036 kg/day

(ii) SS generated out of NH_4N reduction

$$Yobs = \frac{Y}{1 + kd.\,\theta c}$$

$$Px\ (Autotrophs) = \frac{0.15}{1 + 0.06 \times 5} \times \frac{60,000\ (35-20)}{1000}$$

= 103 kg/day

Thus total excess sludge: 33036 + 103 = 3139 kg/day

Total Volatile solids in Primary & Secondary Sludge

= 10800 x 0.5 + 3139 x 0.75 = 7754 kg/day

<u>Gas Production :</u>

Quantity of VSS destroyed = 7754 x 0.5

= 3877 kg/day

Gas produced @ 0.9 m^3/kg of VSS destroyed = 0.9 x 3877

= 3480 M^3/day

= 145 M^3/hr.

Typical Biogas Composition

Table 52 : Biogas composition

Methane	55-70% by vol.
Carbon dioxide	30-45% by vol

Hydrogen sulphide	200-4000 ppm by vol
Energy content of AD gas product	20-25MJ/standard m3

Power Generation:

Power Generation per day (@2kwh/m3 of biogas) = **290 kW**

Power Generation per day (@4.3Kwh/m3 of biogas) = **624kW**

CDM Benefits

CH4 Reduction

Table 53: CH4 Reduction due to Sewage to energy

Sl.No.	Description	Units	1st year
1	Biogas production	m3 per annual	1148400.00
2	Amount of CH_4 (@ 60% of biomass)	m3 per annual	689040.00
3	Amount in tone		689.04
4	CER	1tone= 21 CER	14469.84
5	Cost of emission reduction	In Lakh Rs	8.68
	Total saving	In Lakh Rs.	11

CO2 Reduction

Table 54: CO2 Reduction due to Sewage to energy

Sl. No.	Description	Units	1st year
1	Power Generate	Lakhs Units	36.59
2	CO_2 emission	tone	3476.09

3	CER	1 tone = 1 CER	3476.09
4	Cost of emission reduction	(@60 per CER) in Lakh Rs	2.09

ii. Energy efficiency Aspects

Table 55: Energy efficiency due to Sewage to energy

Sl. No	Description	Units	**1st Year**
1	Plant Capacity	kW	600
2	Plant Load Factor for Power Plant	PLF %	77%
3	Operational hours of power plant	Hours	6098.4
4	Net power generation	Lakh Units	36.5904
5	In House consumption of generated power	%	10%
6	In House Power Consumption	Lakh Units	3.65904
7	Power available for sale	Lakh Units	32.93136
8	Electricity sold @ 4Rs/kWh	Rs In Lakh	131.72544

iii. Cost estimates

Table 56 : Cost estimates due to Sewage to energy

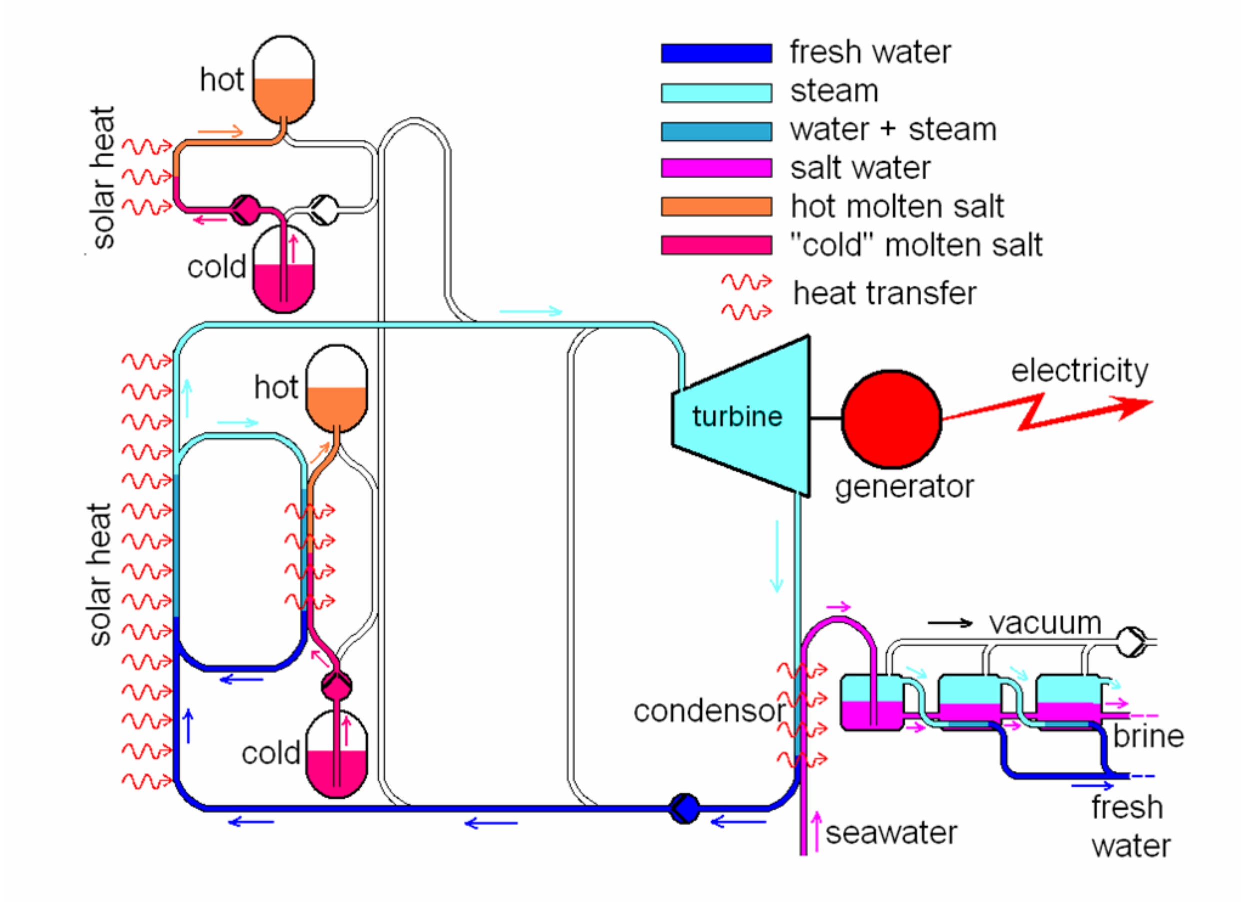
Capital cost	In Lakh Rs	2185
Income from power sale	In Lakh Rs	131.72
Income from CDM	In Lakh Rs	11
Total saving	In Lakh Rs	142
Simple pay back	Years	15.33

Use of solar for desalination:

A **solar powered desalination unit** produces potable water from saline water through direct or indirect methods of desalination powered by sunlight. Countries such as Australia, Italy and Egypt have adopted this system as an alternative source of water for the population.[1]

Direct solar desalination produces distillate directly in the solar collector. An example would be a solar still which traps the Sun's energy to obtain freshwater through the process of evaporation and condensation. Indirect solar desalination incorporates solar energy collection systems with conventional desalination systems such as multi-stage flash distillation, multiple effect evaporation, freeze separation or reverse osmosis to produce freshwater.

The reverse osmosis solar installation (ROSI) uses membrane filtration to provide a reliable and clean drinking water stream from sources such as brackish groundwater. Solar energy overcomes the usually high-energy operating costs as well as greenhouse emissions of conventional reverse osmosis systems. ROSI can also remove trace contaminants such as arsenic and uranium that may cause certain health problems, and minerals such as calcium carbonate which causes water hardness.



Groundwater (which may contain dissolved salts or other contaminants) or surface water (which may have high turbidity or contain microorganisms) is pumped into a tank with an ultrafiltration membrane, which removes viruses and bacteria. This water is fit for cleaning and bathing. Ten percent of that water undergoes nano filtration and reverse osmosis in the second stage of purification, which removes salts and trace contaminants, producing drinking water. A photovoltaic solar array tracks the Sun and powers the pumps needed to process the water, using the plentiful sunlight available in remote regions of Australia not served by the power grid.

Application:

To produce distilled water for use in laboratories, lead acid batteries, army auto-workshops and industry.

iv. Summary

Project focuses on both methane emission reduction as well as the electricity, heat produced, the produced methane from the Gwalior waste water treatment plant will be captured and used in the direct molten carbonate fuel cell to generate electricity, heat and water.

Power generation from sewage will not only treat the sewage it will be cause of reduction of GHG gas in the atmosphere in this way it is an environmental friendly way of power production and also subjected to CDM benefit.

12.3.3

RE-15

- SOLAR PV POWER GENERATING SYSTEM

Solar power is the conversion of sunlight to electricity. Sunlight can be converted directly into electricity using photovoltaic (PV). Solar PV system is an arrangement of photovoltaic array, solar charge controller PCU, Battery bank and protection devices in **which solar energy is converted into direct current electricity via Photovoltaic effect.**

Photovoltaic is the most direct way to convert solar radiation into electricity and is based on the photovoltaic effect. It is quite generally defined as the emergence of an electric voltage between two electrodes attached on a solid or liquid system upon shining light on to this system. Practically all photovoltaic devices incorporate a pn junction in a semiconductor across which the photovoltage is developed. These devices are also known as solar cell.

Types of the system

4. Hybrid system
5. Stand alone system
6. Grid connected system.

Madhya Pradesh is the centre of India. Gwalior is the on of major district of Madhya Pradesh located on latitude 26.22^{o} N and longitude78.18 ^{o} E. Here average annual solar insolation is greater than 5.2 kw/m^2 /day. Solar potential is high on this place compare to other part of India.

Setting a Power System based on solar will not only help to additional power requirement but serve the salient features

- A clean. Silent and eco- friendly source of power
- Negligible maintenance as there are no moving parts
- Long life spam of solar modules
- Simple installation: Can be mounted on the roof to of ground.
- Can be installed at point of use to avoid the transmission losses.

Site Details

(7) Location/Address University of Petroleum & Energy Studies, Bidholi, Dehradun

(8) Altitude 207 M

(9) Latitude 26.22^{o} N

(10) Longitude 78.18 ^{o} E

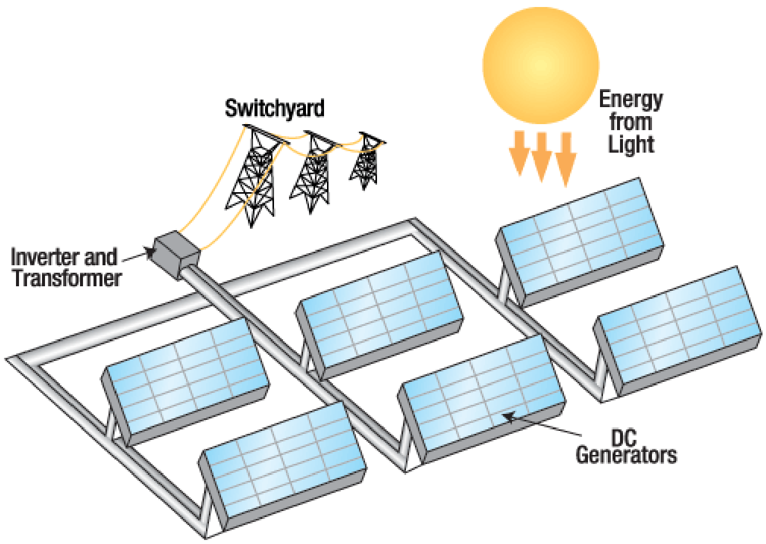
(11) Av rainfall 88.9 cm

(12) Temperature

Summer: 33°C - 45°C,

Winter: 1 °C - 20 °C

i. Technical and Plant Design.



Component of Solar PV System

7 Solar Module
8 Combiner box& main junction box (CB & MJB)
9 Solar module mounting structure
10 ACDB and DCDB
11 Inverter
12 Power Conditioning Unit

Specification of Plant

Capacity of plant	: 5 MW
No. of module	: 2272
Maximum Power of module	: 220W
No. of module in parallel	: 8
No. of module in series	: 284
System voltage	: 240 V

ii. Energy efficiency

Estimation of CDM Benefit

Unit generated = 5 x 0.95 x 300 x 5.2

=74,10,000 kWh / annum

GEI for North Zone = 0.8 kg of CO_2 / kWh

GEI = 74,10,000 x 0.8 = 59,28,000 kg of CO_2 / annum

1 CER = 1000 kg of CO_2

No. of CERs = 59,28,000/ 1000 = 5,928

1 CER = 10 $

CDM benefits / year = 5,928x 10 x 45 = Rs.2667600 = 27 lakh

Approximate cost involved in availing (consultant, validator, registration) CDM benefits is much higher than possible benefits.

iii. Cost estimates

By Simple Payback method

Parameters	= Rs. In Crores
Capital Cost	= **5000 lakhs**
<u>Savings</u>	
Unit Generated	= 74,10,000 kWh / annum

Electricity charge	= 5Rs/kWh
Total saving per year	= 74,10,000 x 5
	= 370.5 Lakh
Payback Period	= **5000/(370.5+27)**
	= 12.57 years

Space required: 15 acres

iv. Summary

The design of a Sun power station depends mainly on the basic technology of its energy conversion system. The MODULE is really the basic building block for real world remote power systems.

Solar energy is very large, inexhaustible source of energy. Currently Gwalior is taking electricity from the state electricity board.The energy demand is increasing day by day. Keeping each point in the mind (cost of power, different losses, uncertain power cut) Extracting power from the solar is the one way to become independent for the need of power.

12.3.4

RE-16 • SOLAR STREET LIGHTING

Technology

Solar street lights are raised light sources which are powered by photovoltaic panels generally mounted on the lighting structure. The photovoltaic panels charge a rechargeable battery, which powers a fluorescent or LED lamp during the night.

Features

Most solar panels turn on and turn off automatically by sensing outdoor light using a light source. Solar streetlights are designed to work throughout the night. Many can stay lit for more than just one night not if sun in not available for a couple of days. Older models included lamps that were not florescent or LED. Solar lights installed in windy regions are generally equipped with flat panels to better cope with the winds.

Latest designs use wireless technology and fuzzy control theory for battery management. The street lights using this technology can operate as a network with each light having the capability of performing on or off the network.

Types

Solar street lights are generally classified into two types

Standalone solar street lights

Standalone solar street lights have photovoltaic panels mounted on the structure. Each street light has its own photovoltaic panels and is independent of the other lamps.

Centrally operated solar street lights

In this type, the photovoltaic panels for a group of street lights are mounted separately. All the street lights in a particular group are connected to this central power source.

Advantages

- Solar street lights are independent of the utility grid. Hence, the operation costs are minimized.
- Solar street lights require much less maintenance compared to conventional street lights.
- Since external wires are eliminated, risk of accidents is minimized.

Table 57 : Requirement of Solar Street Lights as per preliminary survey

Sl.No.	Location	Number of Solar street light required
1	Gandhi road upto Munar	100
2	Race Course Road to Gale ke madir	50
3	Padav to Gurudwara to Indraganj Choraha	50
4	Gole ke madir to Saat Number choraha	50
5	Model tansen to AGO office Bridge	20

6	AGO office to Science College Choraha	15
7	Chetak puri to Maadre ke mata	40
8	Gala rest House	10
9	Nigam Bhavan	15
10	Nagar Crematorium	20
11	Bridge AG office	50
12	Bridge padav	25
13	Bridge Hazira	50
14	Bridge Chandpura	25
	Total	**520**

ii. Recommendations

It is recommended to install Solar Led street lights in the 14 locations to save energy and also to provide light during the frequent power outages occurring in Gwalior.

High-performance LED Solar Street Lighting Systems.

These street lights combine high- performance LEDs along with high-efficiency electronics to deliver more light lumens to customers at lesser cost. Designed with battery back-up of 36 hours, our LED Solar Street Lights are highly reliable and can be used across the country under various climatic conditions.

Some of the key features of our LED Solar Street Lights are as below –

- Aluminum housing
- LEDs for light source
- Optics
- High efficiency driver & MPPT charge controller
- Polycrystalline solar cells
- Strong and safe
- Excellent heat dissipation IP65 protection
- High brightness and high efficacy
- Individual peanut optical lenses for uniform light distribution
- Low power consumption
- Mature technology, Improving Efficiency
- More Rugged
- Ease of availability
- Low discharge rate
- Ideal for Tropical conditions
- Low Maintenance & Long Life
- Long Life
- Back-up Ideal for cloudy conditions
- Rigid and safe
- Corrosion free
- Tubular construction
- 75% Depth of Discharge
- 1.5 days autonomy
- Octagonal Galvanized Pole

Integrated approach for system design extracting best performance from each part –

Top Quality Optics

All the components are optimized for Optimum thermal management and maximum energy efficiency with lowest heat sink design cost

Microprocessor based charge controller (MPPT) and LED driver maximizes the performance of panel & battery

21W LED Solar Street Light

Luminaire

Light Output (after accounting driver loss & charge controller loss)

	: 1800 lumen
LED Efficacy	: 130 lumens / watt
LED Life	:> 50,000 hours
Housing	:IP 65 Aluminium die-cast housing
Total Harmonic Distortion	:0
LM80 report	:To be submitted
Driver efficiency	: >92%
Driver Life	
Luminaire Arm	

Charge Controller

Type	:MPPT (microprocessor based)
Efficiency	:94%
No load current	:Less than 10 mA
Enclosure	:IP65
Solar Panel	:Multi crystalline silicon

Solar cells

Voltage	:12V
Solar cell efficiency	:Min 14%
Solar panel efficiency	:12%
Junction box	:IP65

Mounting Arrangement Powder Coated

Battery and Battery Box :Lead-acid tubular battery of low maintenance

Type :Poly Propylene

Container :Ip 65

Permitted depth of discharge :75%

Mounting position :Approx 5m from ground (anti-theft feature) / bottom

Battery box material and protection :Pre-coated galvanized sheet of 0.6mm thickness

Battery box protection :Powder coating of 60 micron thickness

Pole

Type	:Octagonal Galvanized Pole
Height	:5 m
Duty Cycle	:Automatic dusk to dawn operation
Wind speed resistance of system	:180 Km/hr
System Autonomy	:36 hrs
Inbuilt Protections	:

Overcharge protection for batter, Deep discharge protection for battery, Reverse polarity

iii. Cost estimates

Cost of 1 Street Light : Rs.30,000.00

Cost of 520 Street Lights : Rs.156 lakhs

iv. **Summary**

The most important consideration for the solar street lights is the availability of light during power outages and also autonomy in street light infrastructure.

12.3.5

RE-17 • SPECIAL AREA DEMONSTRATION PROJECTS

The objective of the programme would be to create publicity of the renewable energy technologies, systems and also to disseminate information on technological developments and promotional activities taking place in the area of the New and Renewable energy. Under Special Area Demonstration Project Scheme, additional components has been introduced on demonstration of Renewable Energy Systems/devices at places of National and International Importance, at centralized kitchens, canteens, at roadside eating joints and restaurants where large flow of people and tourists takes place every day with an objective to popularize the renewable energy system and devices to create greater awareness.

Demonstration of Renewable Energy Systems at Prominent Places

Under Special Area Demonstration Project Scheme, additional components has been introduced to demonstrate Renewable Energy Systems/devices at places of National and Inter national Importance, at centralized kitchens and at roadside eating joints, canteens and restaurants where large flow of people and tourists takes place every day. The objective is to popularize the renewable energy system and devices to create greater awareness. The scheme will have following three components:

(I) Demonstration of Renewable Energy Systems at places of National and Inter National Importance

Renewable Energy Systems/ devices will be installed at places of national and inter national importance such as Raj Ghat, Rashtrapati Bhawan, Presidential retreats, Parliament premises, Raj Bhawans, World Heritage sites, and Assembly premises, national parks, tourist and religious places, zoological parks, Science Museums, Secretariats, Collectorates etc. to illuminate these places to

supplement the energy requirement through clean and green energy. The demonstration of Renewable Energy Systems at places of National and Inter national Importance will be taken up in four categories, depending upon the importance /popularity of the site. The details are given below:

(a)Category I :

Rajghat, Rashtrapati Bhawan, Presidential Retreat Building at Mashobara, Shimla and Rastrapati Nilayam, Bolarum, Hyderabad, Parliament premises, Raj Bhawans, and "World Heritage Sites"

Raj Ghat, Rashtrapati Bhawan, Presidential Retreat Building, Mashobara, Shimla and Rashtrapati Nilayam, Bolarum, Hyderabad, Raj Bhawans and Parliament premises are not only places of nation's pride but attract large number of Indian as well as foreign visitors round the year.

In addition, 27 monuments/locations in the country have been inscribed as world heritage sites .Renewable energy systems and devices will be demonstrated at these places so as to illuminate these monuments/locations as also to supplement the energy requirement by way of providing green and clean energy as per the requirement of individual locations. Mainly Solar Power Plant will be used to meet the energy requirement. The amount of battery back up, however, will depend upon the type of load which will be assessed at the time of preparation of the DPR.

Central Financial assistance up to Rs. 100 lakhs per site will be provided for meeting full cost of procurement and installation of systems and devices, Annual Maintenance(AMC) charges for five years, agency charges and for DPR preparation. The support will be as per the DPR prepared for each location for which support of up to Rs. One lakh will be supported by the Ministry(inclusive in the support).

(b)Category II :

i) Places of tourists and religious interest and of national importance

There are number of places of tourist's interest in the country which are frequented by large number of tourists (with at least five lakhs and above visitors per year/site)*. In addition, there are number of religious places of national importance of various religions in the country frequented by large number of pilgrims. The list of these locations is given at Annexure VI. In addition to the above sites, the State Assembly premises will also be covered.

Renewable energy systems and devices will be demonstrated at these places so as to illuminate these locations/monuments as also to supplement the energy requirement by way of providing green and clean energy as per the requirement of individual locations. Mainly Solar Power Plant will be used to meet the energy requirement. The amount of battery back up, however, will depend upon the type of load which will be assessed at the time of preparation of the DPR.

Central Financial assistance up to Rs. 50 lakhs per site will be provided for meeting full cost of procurement and installation of systems and devices, Annual Maintenance(AMC) charges for five years and agency charges. The support will be as per the DPR prepared for each location.

ii) Support for Religious locations with visit of devotees of 10 lakhs/annum or above :

A number of proposal for support for various religious locations are being received for support accordingly the religious locations with more than 10 lakh/year devotees visits will be considered for 50% support limited to Rs. 25 lakhs per location. Confirmation regarding devotees visits will be submitted by the SNAs as certified by the district collector.

iii) Support to heritage schools/colleges/institutes:

A number of schools/colleges/ institutes which are centre of excellence in their field and are operating and have reached heritage status after completing 100 years since their establishments. These are instrumental in grooming future policy makers and decision makers of the country. It will therefore be rather appropriate to create awareness towards renewable at these pillars of knowledge.

Accordingly such institutions will be considered for 50% support limited to Rs. 25lakhs/institution.

Under the SADP project , it is proposed to implement solar lighting and power pack projects at the following sites of national importance in Gwalior.

Table 58: Proposed sites for solar lightings and power pack projects

Sl.No.	Site Details	Category	Proposed project	Budgeted amount (Rs in lakhs)
1.	Gwalior Fort	Fort	50 Solar street lights for the approach road and 10 Kw solar power pack	55.00
2	Lakshmi Bai statue	Monument	10 solar street lights	5.00
3	Italian Garden	Historic and Tourist place	20 solar street lights and 10 Kw power pack	40.00
4	Scindia School	Historic School	5 Kw Solar power pack and 20 solar street lights	25.00

12.4 Energy Efficiency Measures

12.4.1

EE-15

- STREET LIGHTING ENERGY CONSERVATION

Street Lighting Segment in Gwalior: A detailed energy audit of the street lighting segment in the town of Gwalior was carried out jointly by engineers from Elpro Energy Dimension Pvt Ltd and the Municipality. It was found that there are in total 190 switching points in Gwalior. A system mapping was done for the complete city street lighting. The study involved the collection of Primary Data at the Field level and Secondary data through the Municipal Office and EB Office.

For street lighting audit, the data relating to

- Number of Lamps (all categories) installed in the Municipality
- Rating of Lamps
- Power Consumption (Rated, Actual & Recorded by EB)
- No And Location of Switch Points
- Lux Levels at Select Locations
- Annual Hours of Burning
- Monthly Electricity Bills
- Type and Height of Poles
- Type and width of roads

have been collected and used in the analysis

Observations: Each of the 190 points had a mix of fittings connected to them. Various types of fittings like HPSV lamps with different capacities, Metal Halide Lamps with different capacities and FTL were observed. A summary of the inventory of the fittings is brought out in the table below

Table 59 : Inventory of the fittings

Sl No	Type Of Fitting	Wattage	Quantity
1	Incandescent	100w	24
2	Tube Lights (FTL)	40w	5124
3	Sodium Vapor Lamps(SV)	70w	1598
4	Sodium Vapor Lamps (SV)	150w	2399
5	Sodium Vapor Lamps (SV)	250w	8017
6	Sodium Vapor Lamps (SV)	400w	393
7	Metal Halide Lamps(MH)	250w	92
8	Metal Halide Lamps(MH)	400w	44
9	CFL Lamps	18 W	58

The total connected load of street lights is 3249 KW. The average connected load in each switching points is thus around 17.1 KW.

It was observed that most of the panels are having manual control where as only a few switch points are controlled automatically using timers. The overall average illumination is around 15 lux. The per capita consumption of electricity in street lighting alone amounts to 14.79 kwh per head per annum.

The Energy Bills claimed by the utility providers in Gwalior from the Municipality is an average of Rs.40.44 Lakhs per month.

Annual Energy Bill	
Street Lighting Segment	485.27 Lakhs

Table 19: Energy Consumption Estimated

Method Of Estimation	**Load (kW)**	**Energy Consumed (Lakh kWh per year)**	**Energy Charges @ Rs. 3.72 per unit (Lakhs per year)**
Connected Load Basis	3249	130.45	485.27

Based on the data for street lighting it is evident that the municipality will be interested in reducing their existing energy bills. Considerable work has to be done in regularizing the points which are not being metered. However financial analysis has been brought out considering the connected load only

Three major Energy Conservation Measures have been identified for the Street Lighting system. The Energy Conservation Measures that have been identified are:

- Installation of **28 W** (T5 series) FTL with Electronic Ballasts in place of **40 W** conventional FTL with Copper Chokes.
- Installation of stand alone **ETRACS - Litecon**(Energy Tracking & Control System) to regulate and optimize various operating Parameters of the Lighting with Voltage Control accorded top priority.
- Installation of **DIMMERs** for individual SV/MH lamps

iii. Summary of Energy Conservation Recommendations(ECRs)

Table 60 : Energy Conservation Recommendations

No	Proposal	Power Savings	Cost Savings	Investment
		Lakh kWh / y	Rs in Lakhs / Year	Rs in lakhs
1	Installation of **28 W** (T5) Tube Lights with Electronic Chokes in Place of Existing **40 W** FTL with Conventional Copper Chokes	5.15	19.16	35.87
2	Installation of stand alone Energy Tracking and Control System for Street Lighting **ETrACS-Litecon**	44.97	167.28	330
3	Installation of **DIMMER** for SV/MH Lamps	0.51	1.88	5.38
Total		**50.63**	**188.32**	**371.25**

Annual Consumption in kWh = 3249(kW) * 11(hrs/day) * 365(days/year)

= 130.45 Lakh kWh per annum

Annual Consumption in Rs = 130.45(Annual Cons.) * 3.72(Tariff)

= Rs 485.27 Lakhs per annum

iv. Cost estimates

The project indicates that the Municipality can save **39%** of power in Street Lighting (**50,63,000kWh / y**)

The total investment is about **Rs. 371.25 Lakhs** towards cost of energy saving proposals.

v. Summary of entire street lighting

The implementation of all these 3 Energy Saving proposals would call for a one-time investment of Rs 371.25 Lakhs that is expected to save around Rs. 188.32 Lakhs / year on a recurring basis. This is equivalent to 39% of the base Energy Cost Ltd. In addition 4050 Tons of CO2 gases, which would otherwise have been released to the atmosphere causing global warming, have been abated. The CO2 abatement is also on a recurring basis every year. The Simple Payback Period has been estimated as 24 months.

12.4.2

EE-16

- WATER TREATMENT AND PUMPING SYSTEMS

Data Measurements have been taken for 170 pumps. Data also has been collected for 10 nos of ELRs.The connected load of the above 170 pumps works out to 1524 kW the efficiency of the pumps is around 39% and of the motors around 81%.

The Energy consumption of all the 170 pumps has been recorded and is around 6.10 lakhs kWhrs/month and the energy bill being Rs. 18.3 lakhs/month.
Further it has been observed that the average age of these pumps is about 12.5 years and most of the motors have been rewound at least 2 times.

i. **Energy efficiency**

It is recommended to replace all the existing pumps / motors by energy efficient pumps / motors which will save around 15 – 20% of the present energy consumption with a savings of Rs.43.92 lakhs per year and an investment on equipment of Rs.85 lakhs.

ii. **Cost estimates**

Present level of Energy consumption	
For all 170 pumps	= 609981 kwhrs/month
Energy consumption after replacing	
With energy efficient pump & motors	= 487985 kwhrs/month

Savings in Energy per month	= 121996 kwhrs
Savings in Energy per year	= 1463955 kwhrs
Savings in Energy Cost	= Rs. 43.92 Lakhs

Investment for replacing 170 pumps	
With energy efficient pumps	
@ Rs. 0.5 lakhs/pump	= **Rs. 85 Lakhs**
Simple Pay Back Period	= Investment / Savings
	= 85 / 43.92
	= **23.22 or 24 Months**

iii. General recommendations

It is recommended to replace lower size pumps / motors selectively.

It is recommended to build ELRs in different areas and then the water supply can be distributed through pipeline system, instead of present arrangement of bore-well pumps feeding the distribution network.

It is recommended to provide water consumption meters to all the End Users.

It is recommended to provide energy meters to all the pumping stations.

It is recommended to replace the existing GI/metal pipes by HDPE pipes.

iv. Summary

The energy conservation and optimization through simple measure mentioned above can reduce the amount to energy consumption. The awareness of these aspects is highly recommended.

13 Sources of Finance and Financial planning

Project Financing and Business Models

The various stake holders of these projects are

1. The concerned ULB
2. The ESCO Contractor
3. The concerned State Electricity Board.

13.1 ESCO mode-Performance Contracting

Benefits for ULB

The main benefit for the ULB is considerable reduction in the energy bill as well as in the maintenance and repairs expenditure. Thus the amount saved can be utilized for other developmental projects.

In addition to the above financial benefit the concerned ULB will be free from the routine maintenance and repair activities since this area will be taken care by the ESCO Contractor wherever ESCO performance contracting is considered.

The savings are confirmed and backed up by energy performance contract with the ESCO are any other firm.

Types of performance contracts

There are two main types of performance contracts.

1. **Shared savings basis**

The financial risk lies with the ESCO and the savings are shared between the ESCO and the ULB for a negotiated period of time.

The ESCO takes on the risk of third party financing from a lender, putting the loan on the ESCOs balanced sheet.

The savings are shared between the ULB and ESCO with the contract stipulating that the ULB will receive a certain percentage of the savings, but it does not guarantee the magnitude of the savings.

In this scenario, the ESCO is still carrying the cost of the project but without the additional cost of the guarantee. Therefore the ULB is not carrying any risk, but then it is also not assured of any savings, although in practice such as outcome is unlikely. The most likely outcome from a shared savings performance contract is that the ULB will accrue significantly greater financial rewards from the project than if a guaranteed savings contract had been used.

2. **Guaranteed Savings**.

The financial risk lies with the ULB but the ESCO guarantees a certain percentage of savings.

The ULB takes on the third party financing from a lender, putting the loan on the ULBs balance sheet.

The ESCO guarantees that savings will be sufficient to cover the investment cost, and if they are not the ESCO pays the difference between the realized savings and project payments. The excess savings can be shared between the ULB and ESCO.

In this scenario the ULB takes on no risk even though they have the financing because the guarantee covers the financing cost, a known and quantifiable amount. However, guarantees add more risk on to the ESCO and more risk always trickles through as added cost to the project in the form of a higher percentage of the savings being taken by the ESCO.

When a contract some form of guarantee, a contractor normally takes out insurance against that guarantee. Such insurance is generally expensive since insurance company cannot adequately quantify this types of risks. With the cost of insurance policy added, the ESCO negotiate significantly higher percentage of the savings to ensure an adequate profit margin to cover all the risk they assume.

There can also be numerous variations and combinations of this two main types. The essence of a performance contract common all types is that the contract written so that the investment cost are paid from the savings.

13.2 CDM financing

Industrialized countries through the Kyoto protocol's Clean Development Mechanism (CDM) can implement sustainable and environmentally friendly technologies in developing countries to help meet their emission reduction obligations in a cost effective manner. The industrialized countries investing in these projects will receive credits against their Kyoto targets based on the Certified Emission Reductions (CERs) derived from each project. CDM is also beneficial to developing countries by promoting the transfer of clean technology, foreign direct investment, localized environmental improvement and an income stream from the sale of tradable CERs. Engaging in CDM projects can prove to be extremely advantageous for a country like India that has great potential to develop and implement projects based on the sale of CERs. Financing obtained through CDM Mechanism can create additional revenue for an energy efficiency projects and make a project more attractive for third party financing.

13.3 Financial Sources and incentives by the Government of India

India is one of the countries most involved in developing the use of renewable energies and is trying to make the opportunity for investors more attractive than costly.

To promote renewable energy technologies in the country, the government has put in place some subsidies & fiscal incentives. The Indian Renewable Energy Development Agency has been set up under Ministry for Non-Conventional Energy Sources and is a specialized financing agency to promote and finance renewable energy projects. Following is a short list of new measures:

- Income tax breaks
- Accelerated depreciation
- Custom duty/duty free import concessions
- Capital/Interest subsidy

The details are as follows:

- 100 percent income tax exemption for any continuous block of power for 10 years in the first 15 years of operations providers of finance to such projects are exempt from tax on any income by way of dividends, interest or long-term capital gains from investment made in such projects on or after June 1, 1998 by way of shares or long-term finance.
- Accelerated 100-percent depreciation on specified renewable energy-based devices or projects.
- Accelerated depreciation of 80 percent in the first year of operations.
- Interest rate subsidies to promote commercialization of new technology.
- Lower customs and excise duties for specified equipment.

- Exemption or reduced rates of central and state taxes.

Ministry for Non-Conventional Energy Sources mix of fiscal and financial benefits:

- 2/3rd of the SPV project cost subject to a maximum of Rs. 2.00 crore per 100 KW for procurement of modules, structures, power conditioning units, cabling etc. to the implementing agency. The balance cost on land, extension of grid lines, transformers, civil works, foundation and erection and commissioning, etc. is met by the implementing agency.
- Up to Rs.1.0 lakh for the preparation of Detailed Project Report (DPR) for the grid interactive SPV power projects.
- 2.5 percent of its share of project cost, subject to a maximum of Rs.5 lakhs for performance evaluation, monitoring, report writing, etc. to the State Nodal Agency.
- Interest subsidy of up to 4 percent to Financial Institutions including IREDA, Nationalized Banks etc. for captive power projects of maximum capacity 200 KW by industry.

Environmental Legislation of Government of India

13.4 Madhya Pradesh Energy conservation Fund

1. Energy Conservation Act, 2001

Considering the vast potential of energy savings and benefits of energy efficiency, the Government of India enacted the Energy Conservation Act, 2001. The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country.

The important features of this act are:

- Focus on energy efficiency
- Standards and labeling
- Designated consumers requirements
- Energy conservation building codes
- Energy conservation fund
- Bureau of Energy Efficiency

In the clause (c) of sub-section (2) of section 57 read with sub-section (4) of section 16 of the Energy Conservation Act, 2001 (No. 52 to 2001), the State Government, has to provide a fund known as the energy conservation fund. The State government of Madhya Pradesh exercised this power and has laid down rules known as the **Madhya Pradesh State Energy Conservation Fund Rules 2010**.

The ECF shall be applied for the following purposes:-

(i) To incur expenditure through the Madhya Pradesh Urja Vikas Nigam for various awareness Programs for disseminating information to individual consumers, industries, commercial organizations, students, farmers etc., regarding energy conservation and efficient use of energy.

(ii) To meet the expenditure incurred by the Madhya Pradesh Urja Vikas Nigam for training and personnel and specialists for efficient use of energy and its conservation including study tours, exposure visits, interactive exchanges for best practices within India and abroad.

(iii) For promotion of research & development in the field of Energy Conservation.

(iv) To develop necessary equipments and resources for testing certification and verification for consumption, efficiency and management of energy;

(v) To develop & execute demonstration projects related to energy conservation and energy efficiency and to contribute in the projects of bureau of energy efficiency and central government;

(vi) To promote the use of energy efficient processes for the equipments, devices & systems.

(vii) To meet the matching grant to the centrally sponsored schemes and schemes of Bureau of Energy implemented in the State of Madhya Pradesh;

(viii) To meet all the incidental & administrative expenses incurred by the Madhya Pradesh Urja Vikas Nigam for implementation the provisions of the Act.

(ix) To meet the expenses incurred by Madhya Pradesh Urja Vikas Nigam on staff for energy conservation cell.

(x) To incur all incidental & administrative expenses incurred for promotion, installation and maintenance of renewable energy project, as per the policy of State Government and all expenses done in furtherance of above goals.

13.5 MP State Government Incentives to Renewable Energy

- The Government of MP announced a separate scheme for promotion of renewable energy. This scheme is different from MNES guidelines in some respect.
- The Scheme of Incentives by the Government of MP is provided below. As per the notification dated 14/09/98, the GoMP decided to give the following incentives for development of Non Conventional Energy sources:

1. Any industry, institution, or private agency, desirous of installing a power generating unit based on Non Conventional Energy Sources like mini/micro Hydel, wind energy, Bio energy, solar energy etc. in M. P. shall be welcome to establish such a unit and shall be eligible for these incentives

2. The party may set up the unit either by itself or as a joint venture with M.P. Urja Vikas Nigam Ltd.

3. Under this scheme the capacity of Small-mini micro Hydel projects shall be limited up to 3 MW. For projects based on other Non conventional Energy Sources, any power project having a capacity of 50 kW (minimum) and above shall be eligible. The party may use the power generated themselves at the point of generation or at any other place or sell it to the MPEB (the Madhya Pradesh State Electricity Board) or to a third party, provided such a third party is a H.T. (High Tension) consumer of the M. P. Electricity Board (MPEB).

4. For wheeling of power from the point of generation to any other place for the party's own use or for selling it to third party wheeling through MPEB'S transmission/distribution system will be allowed on payment of 2% wheeling charges. The state government will separately compensate MPEB towards line losses etc. at the rate of 4% of the power wheeled. The wheeling charges will be 2% irrespective of the distance to which the power is wheeled.

5. Power generated through Non Conventional Energy Sources will be purchased by MPEB at the rate of Rs. 2.25 per unit. For sale of power to a third party, the rates are to be settled mutually between the generating party and the third party.

6. Electricity generated from Non Conventional Energy and sold either to the MPEB, or to a third party, or consumed by the party itself will be exempted from payment of electricity duty 5 years.

7. Any industrial unit which is a consumer of MPEB and which establishes a power generating unit from Non Conventional Energy Sources for its own use will be given exemption from the demand cut to the extent of 30% of the installed capacity of the Non Conventional Energy unit.

8. Metering equipment for the sale of power will be provided by the party at its cost at points decided by MPEB. The meters will be duly approved and tested by MPEB.

9. The transmission / distribution lines and transformers required for transmitting power from a Non Conventional Energy generating unit to the nearest grid /sub station of MPEB and any equipment required for synchronizing, protection etc. will be provided by the party as per the specification of MPEB, alternatively, these can be provided by the MPEB at the cost of the party, however these lines / equipment will be maintained by MPEB, but the party will be required to pay operation and maintenance charges as decided by MPEB.

10. Government land (GO MP revenue dept. circular of 16-3/ 93/ seven/2a, Bhopal , dated 25.10.97) if available, will be made available to the party , subject to renewal. For the first five years the land will be given on a token premium / rental of rupee one per annum and thereafter the premium and the annual rent will be decided on terms and conditions prescribed by the government from time to time. The premium and the lease rent after the expiry of the five years will be decided based on the market rate of land in sixth year. For Wind Energy Projects the open land required for

free flow of wind (other than the land required for the project) will be provided free of cost on the basis of the proposal from energy department This open land will remain in the possession of the Energy Department.

11. In case of non-availability of government land, private land will be acquired by the Government and made available to the party at acquisition cost. No service charges will be payable. Permission for conversion of land use will not be required. The party will only be required to inform the District Collector for use to be made.

12. Power generating units based on Non Conventional Energy Sources will be treated like industry and all the concessions applicable to new industrial units will be applicable to these power-generating units also.

13.6 Solar Energy Policy Government of Madhya Pradesh 2010

Objective of the Policy

The key objectives of the Madhya Pradesh Solar Energy Policy- 2010 are:

(a) Accelerate the harnessing and development of solar energy in the state

(b) Enhance energy security

(c) Promoting efficient & cost-effective solar installations by providing fiscal and non-fiscal incentives

(d) Promotion of local manufacturing facilities

(e) Harnessing solar energy by developing local capabilities and enhancing public awareness

Applicability

To all solar energy based power project developers (Solar PV/Solar thermal) and manufacturing units of equipment and ancillaries related to solar power projects.

Nodal Agency

The Madhya Pradesh Urja Vikas Nigam (MPUVN) Limited shall be the nodal agency for implementation of the Madhya Pradesh Solar Power Policy – 2010

Facilities & Incentives

(a) Plant & Machinery

Only new plant & machinery shall be eligible for installation under this policy.

(b) Electricity duty

All generating units, including captive units also, are entitled for exemption of Electricity Duty and Cess the date of commissioning of the project, provided the unit generates at-least 70% of the power generation declared in the Detailed Project Report (DPR). For generation less than 70% power, the documents establishing that reasons were beyond the control of the unit have to be provided for satisfaction of the State Government / M.P Urja Vikas Nigam, after examination of the same M.P. Government can allow exemption in the matter.

(c) Land allotment

MPUVN shall identify suitable Government revenue land in the State and create and develop a land bank. Land use permission be given to the project developers as per procedure. However, the developer may identify any other site as potential site, within the State of Madhya Pradesh for installation of solar project.

(d) Other incentives

Solar energy equipments and other items related to the equipments will be exempted from Entry Tax. This shall also be applicable for Rooftop PV/Small Power Generators of capacity less than 1 MW connected to grid and Off-grid applications.

Notwithstanding anything contained in this resolution, the provisions of the Electricity Act – 2003, and the MPERC order, as issued from time to time, shall prevail, for the purpose of the implementation of this policy. For Solar energy, this policy shall prevail over the “Incentive Policy for encouraging generation of power in Madhya Pradesh through Non-conventional Energy sources 2006”.

This Policy shall come into effect from the date of issuance and shall remain effective until further orders.

NRSE Policy- Madhya Pradesh

Government of MP has decided to give the following incentives for power generation through Non-conventional Energy Sources.

- Any industry, institution or private unit (either by itself or as a joint venture) be eligible for incentives under this policy
- Minimum capacity for stand-alone solar photovoltaic unit shall be 5 KW. The maximum.
- Capacity for other projects shall be based on available potential.
- The sale of power from one company to its sister concern shall be deemed as captive user of power.
- Power so generated can be utilized by generator itself or for sale to MPSEB or its Successor Company or sale to any consumer.
- Public sector units will also be eligible for benefits.
- Unit will have to commence and commission the project in the prescribed time limit.

Facilities & Incentives

Purchase Rate: The rate of power generated by non-conventional energy sources will be decided by MPERC, The power purchase rate for the power generated from wind energy are applicable as per MPERC order issued on dated 11.6.2004 and 1.3.2006 as follows:

1st Year: Rs.4.03/ Kwh

2nd Year: Rs.3.86/ Kwh

3rd Year: Rs.3.69/ Kwh

4th Year: Rs.3.52/ Kwh

5th Year to 20th Year: Rs.3.36/ Kwh

Green Energy Fund: A green energy fund has created through cess collected from power consumers.

Open Access: NRSE Power projects shall be exempted from open access charges.

Land Allotment

(a) For 30 years or for the project life the land use permission @ Rs1/-(token) premium per year will be given,

(b) Private land will be acquired by the Government and made available to the party at acquisition cost.

• 50 percent exemption on stamp duty on private land will be given.

• The guidelines issued by the Ministry of Environment and Forest Gov of India & State Govt, would be applicable for forest land. Application for survey of the forest land shall be submitted to the concerned regional Conservator of Forest (CF) through M. P. Urja Vikas Nigam.

Concession under Income Tax Rules

Under Income Tax Rules following concessions are available to the non-conventional energy sector:

- Section 32

Accelerated 80% depreciation on specified RE- based devices/projects.

- Section 80 IA

Industrial undertakings set up in any part of India for the generation or generation and distribution of power at any time during the period beginning on the 1st day of April, 1993 and ending on the 31s' day of March 2003. A hundred per cent deduction is allowable from profits and gains for first five years and thereafter 30 per cent of the profits and gains. This benefit can be availed for any 10 consecutive assessment years failing within a period of 15 assessment years beginning with the assessment year in which that industrial undertaking begins generation or generation and distribution of power. The budget for 2001-2002 has proposed a 10-year tax holiday for the core sectors of infrastructure, including solid waste management systems. This may be availed during the initial 20 years. Further, the Budget has also proposed a 10-year tax holiday for the generation and distribution of power, to be availed during the initial 15 years.

- Section 115 J

Exemption from MAT to industrial undertakings on profits derived from the business of generation and distribution of electricity.

- Section 80JJA

100% deduction in respect of profit and gains from business of collecting and processing biodegradable wastes.

- Section 10 (23G)

Income by way of dividends, interest or long-term capital gains of infrastructure capital fund or infrastructure Capital Company from investments by way of shares or long-term finance in any enterprise wholly engaged in the business of developing, maintaining and operating any infrastructure facility and which has been approved by the Central Government on an application made by it in accordance with the rules made in this behalf and which satisfies the prescribed conditions.

13.7 IREDA Initiatives and Financing schemes

IREDA is a Public Limited Government Company established in 1987, under the administrative control of **Ministry of New and Renewable Energy (MNRE)** to promote, develop and extend financial assistance for renewable energy and energy efficiency/conservation projects with the motto:"**ENERGY FOR EVER ".**

The main objectives of IREDA are:

1. To give financial support to specific projects and schemes for generating electricity and / or energy through new and renewable sources and conserving energy through energy efficiency.
2. To maintain its position as a leading organization to provide efficient and effective financing in renewable energy and energy efficiency / conservation projects.
3. To increase IREDA`s share in the renewable energy sector by way of innovative financing.
4. Improvement in the efficiency of services provided to customers through continual improvement of systems, processes and resources.

5. To strive to be competitive institution through customer satisfaction.

Table 62 : FINANCING NORMS FOR BIOMASS POWER/ COGENERATION /WASTE TO ENERGY/ BIO-MASS POWER

Sl. No	Sector	Interest Rate (%) p.a	Maximum Repayment Period [Years]	Term Loan/ lending Norms of IREDA
1	Biomass Power Generation (Direct combustion mode)- 1 MW to 10 MW (Minimum applicable boiler pressure will be 63 Kg/cm^2)	11.50 to 12.15	10	Up to 70% of total project cost
2	Waste to Energy	12.75	10	Up to 70% of total project cost
3	Biomass Gasification	12.75	10	Up to 70% of total project cost
4	Biomass Gasification for Power Generation with 100 % producer gas engine. (0.50 MW and above)	12.75	10	Up to 70% of total project cost

Table 63 : IREDA Interest Rate under Solar Thermal Sector

Sl. No	Sector	Interest Rate (%) p.a	Maximum Repayment Period [Years]	Term Loan/ lending Norms of IREDA
1	**Intermediaries** **a) Non-Commercial :** Individuals, Institutions, Trusts, Charitable Organizations (Non - Profit making Organization i.e. not claiming 100% depreciation)	12.5	6	Up to 80% of total project cost
2	**b) Commercial:** Industries, hotels, hospitals and other business establishments	12.5	6	Up to 80% of total project cost
3	**Intermediaries** **a) Non-Commercial:** Individuals, Institutions, Trusts,Charitable Organizations (Non - Profit making Organization i.e. not claiming 100% depreciation)	12.5	6	Up to 80% of total project cost
4	**b) Commercial:** Industry, Hotels,	12.5	6	Up to 80% of total project cost

	Hospitals other business establishments / commercial organizations (Profit making Organization i.e. claiming 100% depreciation)			

* Rate of interest would be reduced by 1% in the event of borrower furnishing security of Bank Guarantee / FDRs issued by Scheduled Commercial Bank.

IREDA financial norms for Solar Photovoltaic systems

Solar photovoltaic systems eligible under IREDA schemes

- Solar Lantern
- Solar Home system
- Street Lighting system
- Small Capacity SPV Power plants
- Solar Generators
- Building integrated photovoltaic (BIPV) Systems.

S.NO	Feature	Implementation through IREDA
1	Eligible categories of	All categories of users including intermediaries and

	beneficiaries	commercial organizations
2	Rate of Interest	7% (commercial borrowers who can claim depreciation benefits) 5% (individuals and other organizations) Financial intermediaries who borrow funds from IREDA for on – lending at 5% or 7% rate of interest will be charged an interest rate of 2.5% or 4.5% respectively by IREDA. Such intermediaries will not be able to claim depreciation benefit and the on-lending arrangement will not be treated as a lease arrangement.
3	Loan period	3 Yrs
4	Moratorium	1 Year
5	Amount of loan	80% of the cost of the project
6	Upper Limits for a loan	No Limit
7	Service Charges	1% of the loan disbursed
8	System Covered	All types of SPV Systems except solar pumps. Loans will not be provided at subsidized rates for systems that are available with capital subsidy. With the exception of solar generators for which both subsidies and soft loans will be available.

9	Eligible Suppliers	Only those SPV systems and power plants, which confirm to the MNES specifications & guidelines for 2001 – 02 or 2002 – 03 programmes and have obtained test certificates form SEC / Other Authorized Test Centers will be eligible for supply and other benefits under this scheme .

Eligible Category of Beneficiaries

SPV Systems	**Eligible Categories of Beneficiaries**
Solar Home Systems	All Categories of individual beneficiaries & non profit Institutions / Organizations. No individual would be given more than one system.
Street Lighting Systems	All categories of non – commercial institutions / organizations, State Nodal Agency, Electricity Boards, Panchayats, Zilla Parishads and DRDA's.
SPV Power Plants / Others Systems	All categories of non – commercial institutions / organizations, State Nodal Agency, Electricity Boards, Panchayats, Zilla Parishads and DRDA's.

Minimum loan eligibility from IREDA

Minimum loan for a project should be of Rs. Rs. 5 Lakhs for Direct User and Rs. 10 Lakhs for Intermediaries.

13.8 IREDA financing for energy efficiency and conservation measures (DSM)

IREDA finances the end user energy efficiency retrofit projects, DSM Projects taken up by utilities, projects promoted by Energy Service Companies (ESCOs) and power plants based on recovery of energy from exhaust gasses. IREDA also extend line of credits to financial intermediaries to onlend/ lease the energy saving equipment.

Any equipment/ device/ system, which contributes to energy saving shall be considered by IREDA for financing.

13.9 MNRE Schemes

The Ministry has notified a Scheme **on Biomass Energy and Co-Generation (non-bagasse) in Industry** with the following objectives:

1. To encourage the deployment of biomass energy systems in industry for meeting thermal and electrical energy requirements.
2. To promote decentralized / distributed power generation through supply of surplus power to the grid.
3. To conserve the use of fossil fuels for captive requirements in industry.
4. To bring about reduction in greenhouse gas emissions in industry
5. To create awareness about the potential and benefits of alternative modes of energy generation in industry.

The scheme has a provision for providing Central Financial Assistance for encouraging setting up Biomass Gasifiers and Biomass Co-generation (non-bagasse) projects in the industries for meeting their thermal and electricity requirements.

Objectives

The main objectives of the programme on Biomass Energy and Co-Generation (non-biogas) in Industry are given below :

- To encourage the deployment of biomass energy systems in industry for meeting thermal and electrical energy requirements.
- To promote decentralized / distributed power generation through supply of surplus power to the grid.
- To conserve the use of fossil fuels for captive requirements in industry.
- To create awareness about the potential and benefits of alternative modes of energy generation in industry.

Central Financial Assistance (CFA)

Central Financial Assistance in the form of capital subsidy would be provided to biomass gasifier projects and biomass co-generation (non-bagasse) projects in industries. However, in respect of co-generation projects based on conventional fuels and their rejects, Central Financial Assistance would be provided only for promotional and awareness creation activities. The details of Central Financial Assistance and other provisions are given below :

Capital subsidy for Biomass Gasifiers for thermal and electrical applications

- Rs. 2.0 lakh / 300 KW_{th} for thermal applications.
- Rs. 2.5 lakh / 100 KW_e for electrical applications through dual fuel engines.
- Rs. 8.00 lakhs / 100 Kw_e for 100% producer gas engines with gasifier system.
- Rs. 6.00 lakhs / 100 Kw_e for 100% producer gas engine alone.

Capital subsidy for Biomass Co-generation (non-bagasse) projects

Capital subsidy @ Rs. 20.00 lakhs/MW_e would be provided to promoters for installation of Biomass Co-generation (non-bagasse) projects, including captive projects based on direct combustion.

The capital subsidy will be considered subject to the following :-

- The amount of capital subsidy would be calculated on the basis of installed capacity;
- CFA would be limited to a maximum capacity of 5 MW, irrespective of the installed capacity of the project.
- In case of Special Category States (NE Region, Sikkim, J&K, Himachal Pradesh and Uttaranchal), 20% higher capital subsidy than that for General Category States would be provided.

Incentives for the installation of co-generation projects based on conventional fuels and rejects

Promotional incentives @ Rs. 1.00 lakh / MW, subject to maximum of Rs. 5.00 lakhs/project for professional technical services would be provided to consultancy firms helping to bring a project to financial closure including preparation of DPR.

Incentives / service charges to SNAs.

Incentives / service charges @ Rs. 1.00 lakh / MW_e (or equivalent) would be provided to SNAs on pro-rata basis, subject to a ceiling of Rs. 5.00 lakh / project, including for Industrial Co-generation projects, for their active involvement in promoting Biomass Power / Co-generation projects .

Implementation Arrangements

- The projects will be implemented by private and public sector industry, including through Energy Service Companies (ESCOs), in which case the ESCO would be eligible for the CFA.

- IREDA, other financial institutions or commercial banks shall forward the Detailed Project Reports received from the promoters / ESCOs to the Ministry along with their Appraisal Note indicating the techno-economic viability of the projects, taking into account the eligible capital subsidy. The promoters would be required to also submit an advance copy of their proposal to the Ministry directly. The prescribed format for submission of the proposal is given in the Annexure.

- For projects to be implemented by the promoter without debt financing / loans from domestic FIs / banks, the proposals should be directly submitted to the Ministry for financial support.

13.10 Jawaharlal Nehru National Solar mission

Guidelines for Off-grid and Decentralized Solar Application

The Government has recently launched the Jawaharlal Nehru National Solar Mission, which is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security challenge. It will also constitute a major contribution by India to the global effort to meet the challenges of climate change. The immediate aim of the Mission is to focus on setting up an enabling environment for solar technology penetration in the country both at a centralized and decentralized level. The first phase (up to March 2013) will, inter alia, focus on promoting off-grid systems including hybrid systems to meet / supplement power, heating and cooling energy requirements. These systems still require interventions to bring down costs but the key challenge is to provide an enabling framework and support for entrepreneurs to develop markets. In order to create a sustained interest within the investor community, it is proposed to support viable business models. Flexibility is an integral feature of this scheme. The scheme is completely demand driven as it offers a bouquet of incentive instruments from which eligible entities can tailor a package appropriate to their needs and circumstances within the boundary conditions of the scheme

Objectives:

- To promote off-grid applications of solar energy (both SPV and Solar Thermal) for meeting the targets set in the Jawaharlal Nehru National Solar Mission for Phase-I.
- To create awareness and demonstrate effective and innovative use of Solar systems for individual/ community/ institutional/ industrial applications.
- To encourage innovation in addressing market needs and promoting sustainable business models.
- To provide support to channel partners and potential beneficiaries, within the framework of boundary conditions and in a flexible demand driven mode.
- To create a paradigm shift needed for commoditization of off-grid decentralized solar applications.
- To support consultancy services, seminars, symposia, capacity building, awareness campaigns, human resource development, etc.
- To encourage replacement of kerosene& diesel, wherever possible.

Funding Pattern

Funding under the scheme would be in Project mode, i.e. there must be a project report which would, inter alia, include client details, technical & financial details, O&M and monitoring arrangements. The total project cost shall be funded through a mix of debt and incentives where the promoters' equity contribution would be at least 20%. Techno-economic specifications for a minimum cut-off level for the requirement of the project mode would be specified by MNRE.

MNRE would provide financial support through a combination of 30 % subsidy and/or 5% interest bearing loans. The bench mark project cost for 2010-11 have been worked out for these systems and the CFA of 30% .

For the year 2010-11, the benchmark price for photovoltaic systems with battery back-up support is considered as Rs.300/- per Wp. In case of the systems, which do not use storage battery such as water pumping systems, the installed PV system cost is considered as a maximum of Rs.210 per Wp.

Capital subsidy of 90% of the benchmark cost, would be available for special category states, viz. NE, Sikkim, J&K, Himachal Pradesh and Uttarakhand. In addition, it would be extended for setting up only stand alone rural solar power plants / packs (both PV and thermal projects) in remote and difficult areas such as Lakshadweep, Andaman & Nicobar Islands, and districts on India's international borders. However, for funding solar thermal systems in these areas, the subsidy would be limited to 60% for all categories of beneficiaries. The subsidy pattern detailed above can be accessed by only Central and State Government Ministries, Departments and their organizations, State Nodal Agencies and Local bodies.

There would be a provision for channel partners, operating in the market mode to access a combination of capital subsidy and a low cost interest for the end consumer, provided they can tie up with a lending institution. These lending institutions could then enter into an agreement for refinance/ interest subvention with IREDA. MNRE would provide IREDA fund handling charges at the rate of 2% for the capital subsidy/interest subvention portion.

Funds received by IREDA from MNRE without cost may be made available by it for PAC approved projects directly at interest rate not exceeding 5% p.a as also by way of refinance to the primary lending institutions at a rate of interest not exceeding 2% p.a, subject to the condition that the rate of interest charged by the lending institution to the borrower in respect of the loan does not exceed 5% p.a.

The Interest Subsidy under the Scheme would be made available to Non- Banking Financial Companies (NBFCs) and Scheduled Commercial Banks (excluding Regional Rural Banks) by way of refinance from IREDA.

IREDA would also make available funds received from MNRE under this Scheme, to NABARD, NHB, SIDBI and any other institution as may be specified by the MNRE in this behalf, for providing refinance on the same terms, to Regional Rural Banks, Housing Finance Companies, or any other primary lending institutions included by them, in their respective refinance schemes. MNRE would provide a service charge of 0.5% to IREDA for this.

- **RE Voucher/Stamp**

A Transaction-cost free redeemable financial instrument, denominated in physical or monetary units. Placed in the hands of ultimate beneficiary it empowers him by giving him enhanced degree of freedom to choose. Hence, it can be used as an effective instrument to gauge and enhance consumer satisfaction at the retail level.

- **Capital Subsidy (Credit Linked and non credit linked)**

An instrument which lightens the burden of financing the initial project cost to enable financial closure of viable business proposition.

- **Interest Subsidy**

An instrument aimed at neutralizing the high cost of capital given after due diligence of credit appraisal by FIs, NBFC, Micro finance institutions.

- **Viability Gap Funding**

Financial support provided mostly in the form of initial grant in one or more installments to finance the project cost so as to create a viable business model. PPP Scheme of Ministry of Finance has this arrangement for physical infrastructure projects. It is supplemented by similar arrangement at the state level.

- **Green Energy Bonds**

A form of low interest bearing long-term redeemable security, which could be issued by IREDA/ MNRE for Renewable Energy Projects. Analogy: Infrastructure Bond/Gold Bonds.

13.11 Solar Off-Grid Refinance Scheme

Refinance scheme for promotion of solar off-grid (photovoltaic & thermal) & decentralized applications

Scope of the Solar Off-Grid Refinance Scheme

The Solar Off-Grid Refinance Scheme would be applicable to all parts of India and would, to begin with, be co-terminus with Phase-I (up to 2013) of the Jawaharlal Nehru National Solar Mission.

The coverage of the **Solar Off-Grid Refinance Scheme** would be as under:

- Various off-grid solar photo voltaic systems / applications up to a maximum capacity of 100 kWp per site and off-grid and decentralized solar thermal applications as specified by the Government from time to time, to meet /

supplement power, heating and cooling energy requirements would be eligible for being covered under the Scheme.

- For mini-grids for rural electrification, applications up to a maximum capacity of 250 kW per site would be supported.
- Soft loans for projects, including a component for working capital, will be available to SME manufacturers of solar thermal systems and Balance of systems manufacturers for Solar PV, in order to promote technology upgradation, improvement in technology, expansion in production facilities, etc.

Structure of the Solar Off-Grid Refinance Scheme

The manner of providing assistance in terms of the Solar Off-Grid Refinance Scheme is as under:

Refinance

In terms of the Solar Off-Grid Refinance Scheme, IREDA would provide refinance in respect of projects approved by the Project Approval Committee (PAC) of the MNRE, to eligible institutions at a rate of interest not exceeding **two per cent** per annum, subject to the condition that the rate of interest charged by the lending institution to the borrower in respect of the loan does not exceed **five per cent** per annum.

Bulk Funds

IREDA would make available bulk funds received from MNRE, to the National Bank for Agriculture & Rural Development (NABARD), National Housing Bank (NHB), Small Industries Development Bank of India (SIDBI) and any other institution as may be specified by the MNRE in this behalf, to enable them to provide refinance in terms of their own respective refinance schemes on the same terms as at paragraph 4.1 above, to Regional Rural Banks (RRBs), Housing Finance Companies (HFCs), or other primary lending institutions financed by them.

Interest Subvention

The respective refinancing institution / primary lending institution may, at its option, choose to avail Interest Subvention instead of refinance. The mechanism for availing Interest Subvention instead of refinance is indicated in subsequent paragraphs.

Capital Subsidy

IREDA would make available credit linked Capital Subsidy in respect of the projects covered under the above Refinance / Interest Subvention / Bulk Finance mechanism, through the above financial institutions, for being made available to the respective borrowers on successful implementation of the projects.

Eligibility conditions for refinance from IREDA under the Scheme are as under:

Institutions eligible to avail refinance:

Non-Banking Financial Companies (NBFCs) and Scheduled Commercial Banks (excluding Regional Rural Banks) would be eligible for refinance from IREDA under this Scheme. Grant of refinance shall be at the sole discretion of IREDA. The availability and extent of refinance to a primary lending institution would be determined by IREDA, based on its internal credit assessment norms. The scheduled commercial banks and housing finance companies shall be required to satisfy, *inter alia*, the following parameters to be eligible for refinance under the Scheme**:**

- The Gross Non-Performing Assets as percentage of the Gross Advances should not exceed 5% for the entire portfolio of the primary lending institution.
- The Capital Adequacy Ratio should be as per the norms prescribed by the Reserve Bank of India.
- The primary lending institution should be profit making for the last three years and should have no accumulated losses.

Scale of refinance

Refinance from IREDA under the Scheme will be available to the extent of **100 per cent** of the eligible loans

Rate of Interest

Refinance from IREDA will be made available at a fixed rate of interest, presently not exceeding **two per cent** per annum, subject to the condition that the rate of interest charged by the lending institution to the borrower in respect of the corresponding loan does not exceed **five per cent** per annum.

Term of Refinance

The refinance shall be repayable in a period not exceeding **five years.**

13.12 Multilateral Financial Institutions

Apart from the funding opportunities by the Government of India and Madhya Pradesh. Gwalior can also get finding from Multilateral financial institutions. The various Multilateral Institutions that could be considered are

- World Bank The World Bank's Investment Framework for Clean Energy and Development
- Asian Development Bank
- German Development Bank Kfw.
- European Investment Bank Group ,The Global Energy Efficiency and Renewable Energy Fund (GEEREF)

14.0 Advancing the implementation of the Solar City Master Plan for Gwalior-Action Plan

Three main steps in advancing implementation in Gwalior

1. **Develop an act ion plan with key stakeholder's and Utilities Action**

- Develop and implement an engagement strategy to learn from local stakeholders about implementing the solar city action plan in Gwalior (utilities, chamber of commerce, Industrial associations, large scale retailers, resident associations, etc.)
- Divide between corporate versus community initiatives.
- Use the Energy Advisory Committee to move forward Renewable energy and energy efficiency actions with reference to the Master Plan of solar city development for Gwalior city.

2. **Continue To Improve Local Energy Information for Gwalior Action**

- Confirm demand side management (DSM)and conservation demand management (CDM)programs to be delivered in Gwalior by local utilities
- Adopt indicators to measure the progress of actions for meeting energy and GHGs
- Work with local agencies to resolve potential areas identified during solar city master plan preparation exercise.

3. **Invest in the Resources and Knowledge to Advance Energy Efficiency Action and implement renewable energy projects**

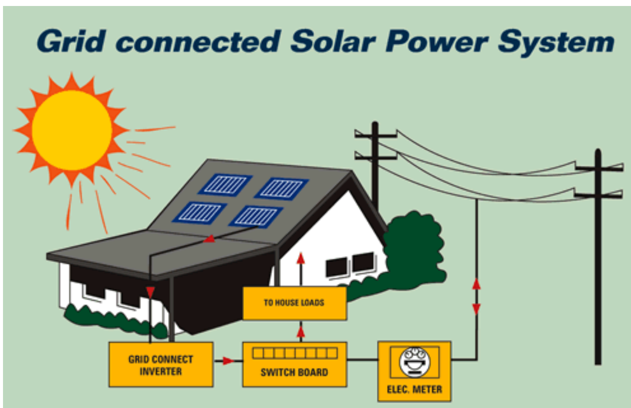
- Gwalior Municipal Corporation should work with local Electrical utility to evaluate if electric infrastructure can support potential future demand.
- Undertake pre-feasibility analysis for areas where high energy demand identified

15 Key areas of focus for Gwalior and Pilot projects

Pilot -1

RE-2

- ROOFTOP PV & SMALL SOLAR POWER GENERATION PROGRAMME(RPSSGP)



Setting a Power System based on solar will not only help to additional power requirement but serve the salient features

- A clean. Silent and eco- friendly source of power
- Negligible maintenance as there are no moving parts
- Long life spam of solar modules
- Simple installation: Can be mounted on the roof to of ground.
- Can be installed at point of use to avoid the transmission losses.

Objective of this project

Objectives of the project are

6. To implement a 5 Mw Rooftop PV & Small Solar Power Generation Programme(RPSSGP) in Gwalior City
7. To use the most effective and environmental friendly power saving method.
8. Shift portion of day time lighting load to Solar Power.

9. Reduce the pollution.
10. Reduce the GHG emission.

It is proposed to install 1 Kw or 2 kw solar PV grid connected power generating system to be installed on roof tops in Gwalior city on a maximum of 5000 houses. The project developer is proposed to be GMC in association with a private/semi Government entity.

Financials

Total Investment: Rs.105 crores

Installed Capacity: 5 Mw

Table 29:Financials for 5 Mw rooftop solar SPV project

1	Assumed cost of 1 Wp as per MNRE guidelines			Rs	210
2	Cost of 1 Kw of Solar PV grid connnected system			Rs.	210000
3	System Capacity			Kw	1
4	Hours of sunlight per day			Hours	5.5
5	No. of sunny days			Days	330
6	Cost of Energy Paid per kwh to EB			Rs. Per Kwh	5
7	Annual Generation of energy by solar			Kwh pa	1815
8	Cost of Energy Paid per kwh by EB to project developer				
				Rs per kwh	15.49

First Phase: 10 years

9	Annual Generation of energy by solar	Kwh pa	1815
10	Amount per Kwh of generated energy paid by developer to	Rs per kwh	1
	house owner		
11	Net amount per unit of Kwh generated earned by developer	Rs per kwh	14.49
12	Amount earned by house owner in first 10 years	Rs	18150
13	Amount earned by developer	Rs	262993.5

Second Phase: 10 years

14	Annual Generation of energy by solar	Kwh pa	1633.5
15	Amount per Kwh of generated energy paid by developer to	Rs per kwh	5.49
	house owner		
16	Net amount per unit of Kwh generated earned by developer	Rs per kwh	10
17	Amount earned by house owner in second 10 years	Rs	89679.15
18	Amount earned by developer in second 10 years	Rs	163350

Third Phase: 5 years

19	Annual Generation of energy by solar	Kwh pa	1470.15
	Amount per Kwh of generated energy paid by developer to	Rs per kwh	7.745
20	house owner		
21	Net amount per unit of Kwh generated earned by developer	Rs per kwh	7.745
22	Amount earned by house owner in third 5 years	Rs	56931.55
23	Amount earned by developer in third 5 years	Rs	56931.55

Table 30 : Life Cycle earnings

Developer		
Phase 1	10 years	262993.5
Phase 2	10 years	163350
Phase 3	5 years	56931.55
Total		483275.05
Average monthly receipts		
	Rs.	**2685**

House Owner

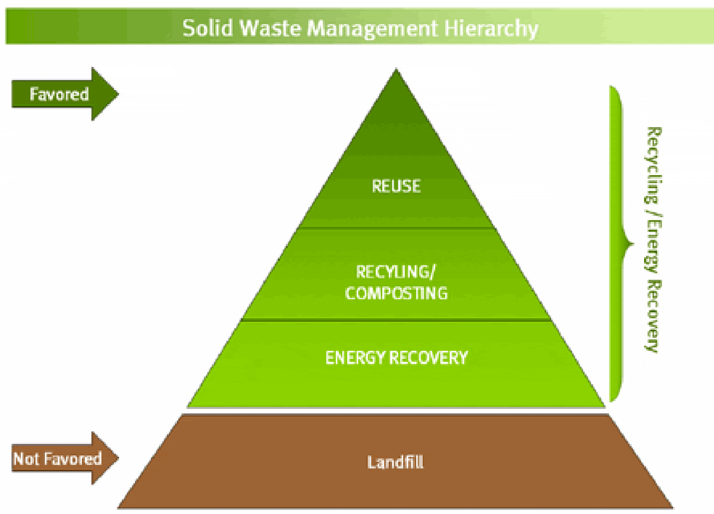
Phase 1	10 years	18150
Phase 2	10 years	89679.15
Phase 3	5 years	56931.55
Total		164760.70

Average Monthly receipts Rs.915

Pilot -2

RE-13 • MUNICIPAL SOLID WASTE(MSW) TO ENERGY

Municipal Solid Waste(MSW) to energy



The waste production rate of the Gwalior is estimated to be 735 tones per day from waste stream, primary households, business and commercial waste, collectively termed as Municipal Solid Waste, MSW. A huge potential of the power generation from this waste is estimated to be 110250 MW per year. If it will be utilized fully then it can meet up to 33 % of annual energy required. Net calorific value off the MSW is 11508 Kcal/kg.the composition of the solid waste is as follow:

Total CDM benefit = 9542960 lakh Rs / year

Cost estimates

Table 51 : Cost estimates of MSW to energy

Capital cost	Rs Lakh	7160.00
Income	Rs Lakh/annum	1754.165

Simple pay back	Year	4

Pilot-3

RE-14 • SEWAGE TO ENERGY

Municipal waste water treatment plant treat the waste water of whole city and produce water at accepted level of contaminant and sludge which is further treated for dispose.

It is suggested to go for the anaerobic digestion of the sludge generated and produce electricity from the biogas produced. According to the sample of the sewage, around 3480 M^3/Day will be generated by which 4593600 kW electricity can be generated. The anaerobic digestion of sludge is proposed for electricity generation by fuel cell technology. Produced power can be utilize in house and surplus amount can be fed in to grid.

The overall objectives can be outlined as below:

- Replace the traditional sludge drying beds and landfill options with mesophilic digestion of all primary and secondary sludge followed by mechanical dewatering in order to reduce GHG emissions
- Effectively mitigate odor problems from the existing treatment of sludge and sludge liquors through introduction of digestion and removal of sludge drying beds
- Production of fertilizer by mechanical dewatering of the digested stabilized sludge
- Production of electricity from utilization of the biogas fuel cell thereby reducing GHG emissions from electricity production from the grid

Completion of this project will deliver the following key results:

- all primary and secondary sludge thickened and digested as per EU recommendations and guidelines;
- all biogas produced within the digestion process used for power and heat generation via CHP gas engines thus reducing the site electricity requirement from the National grid;
- reduction in site fossil fuel usage as all site-heating requirements will be met from CHP gas engines;
- All sludge stabilized and pathogen free.

i.Technology

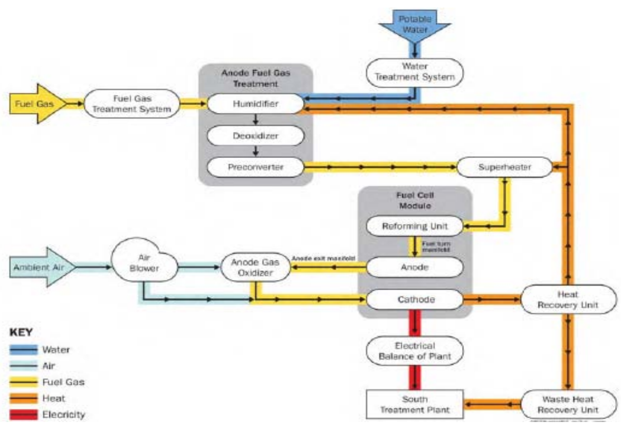


Fig 34 Sewage to Energy Process overview

Cost estimates due to Sewage to energy

Capital cost	In Lakh Rs	2185
Income from power sale	In Lakh Rs	131.72
Income from CDM	In Lakh Rs	11
Total saving	In Lakh Rs	142
Simple pay back	Years	15.33

Pilot-4

RE-16 • SOLAR STREET LIGHTING

Technology

Solar street lights are raised light sources which are powered by photovoltaic panels generally mounted on the lighting structure. The photovoltaic panels charge a rechargeable battery, which powers a fluorescent or LED lamp during the night.

Features

Most solar panels turn on and turn off automatically by sensing outdoor light using a light source. Solar streetlights are designed to work throughout the night. Many can stay lit for more than just one night not if sun in not available for a couple of days. Older models included lamps that were not florescent or LED. Solar lights installed in windy regions are generally equipped with flat panels to better cope with the winds.

Table 57 : Requirement of Solar Street Lights as per preliminary survey

Sl.No.	Location	Number of Solar street light required
1	Gandhi road upto Munar	100
2	Race Course Road to Gale ke madir	50
3	Padav to Gurudwara to Indraganj Choraha	50
4	Gole ke madir to Saat Number choraha	50

5	Model tansen to AGO office Bridge	20
6	AGO office to Science College Choraha	15
7	Chetak puri to Maadre ke mata	40
8	Gala rest House	10
9	Nigam Bhavan	15
10	Nagar Crematorium	20
11	Bridge AG office	50
12	Bridge padav	25
13	Bridge Hazira	50
14	Bridge Chandpura	25
	Total	**520**

v. Recommendations

It is recommended to install Solar Led street lights in the 14 locations to save energy and also to provide light during the frequent power outages occurring in Gwalior.

vi. Cost estimates

Cost of 1 Street Light : Rs.50,000.00

Cost of 520 Street Lights : Rs.260 lakhs

Pilot-5

RE-17

- SPECIAL AREA DEMONSTRATION PROJECTS

The objective of the programme would be to create publicity of the renewable energy technologies, systems and also to disseminate information on technological developments and promotional activities taking place in the area of the New and Renewable energy. Under Special Area Demonstration Project Scheme, additional components has been introduced on demonstration of Renewable Energy Systems/devices at places of National and International Importance, at centralized kitchens, canteens, at roadside eating joints and restaurants where large flow of people and tourists takes place every day with an objective to popularize the renewable energy system and devices to create greater awareness.

Table 58: Proposed sites for solar lightings and power pack projects

Sl.No.	Site Details	Category	Proposed project	Budgeted amount (Rs in lakhs)
1.	Gwalior Fort	Fort	50 Solar street lights for the approach road and 10 Kw solar power pack	55.00
2	Lakshmi Bai statue	Monument	10 solar street lights	5.00
3	Italian Garden	Historic and Tourist place	20 solar street lights and 10 Kw power pack	40.00
4	Scindia School	Historic School	5 Kw Solar power pack and 20 solar street lights	25.00

Pilot-6

EE-15	• STREET LIGHTING ENERGY CONSERVATION

Street Lighting Segment in Gwalior: A detailed energy audit of the street lighting segment in the town of Gwalior was carried out jointly by engineers from Elpro Energy Dimension Pvt Ltd and the Municipality. It was found that there are in total 190 switching points in Gwalior. A system mapping was done for the complete city street lighting. The study involved the collection of Primary Data at the Field level and Secondary data through the Municipal Office and EB Office.

The total connected load of street lights is 3249 KW. The average connected load in each switching points is thus around 17.1 KW.

It was observed that most of the panels are having manual control where as only a few switch points are controlled automatically using timers. The overall average illumination is around 15 lux. The per capita consumption of electricity in street lighting alone amounts to 14.79 kwh per head per annum.

Cost estimates

The project indicates that the Municipality can save **39%** of power in Street Lighting (**50,63,000kWh / y**)

The total investment is about **Rs. 371.25 Lakhs** towards cost of energy saving proposals.

Summary of entire street lighting

The implementation of all these 3 Energy Saving proposals would call for a one-time investment of Rs 371.25 Lakhs that is expected to save around Rs. 188.32

Lakhs / year on a recurring basis. The Simple Payback Period has been estimated as 24 months.

16 Year Wise goals-Renewable Energy

No	Project Details	Investment (Rs. Lakhs)	2012	2013	2014	2015	2016	2017	2018
	RESIDENTIAL SECTOR								
1	RESIDENTIAL SOLAR WATER HEATERS	1050							
2	ROOFTOP PV & SMALLSOLAR POWER GENERATION PROGRAMME(RPSSGP)	10500							
3	SOLAR COOKER - BOX AND PARABOLA*	200							
4	PASSIVE BUILDING TECHNIQUES AND GREEN BUILDINGS								
	COMMERCIAL & INSTITUTIONAL SECTOR								
5	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOTELS	93.6							
6	IMPLEMENTATION OF SOLAR WATER HEATERS IN HOSPITALS	106							
7	250 KWP SOLAR PV AND 30,000 LPD SOLAR WATER HEATER AT BORDER SECURITY FORCE(BSF) ACADEMY GWALIOR	717							
	INDUSTRIAL SECTOR								
8	IMPLEMENTATION OF PILOT BIOGAS PLANT IN TANNING INDUSTRY	375							
9	USE OF SOLAR PRE HEATED WATER FOR BOILERS	TBA							
10	USE OF SOLAR PV LED STREET LIGHTING	250							
11	USE OF PARABOLIC STEAM GENERATORS	TBA							
12	IMPLEMENTATION OF BIOMASS COGENERATION IN COLD STORAGES FOR PRODUCING POWER AND CHILLING	TBA							
	MUNICIPAL SECTOR								
13	MUNICIPAL SOLID WASTE (MSW) TO ENERGY	7160							
14	SEWAGE TO ENERGY	2185							
15	SOLAR PV POWER GENERATING SYSTEM	8450							
16	SOLAR STREET LIGHTING	260							
17	SPECIAL AREA DEMONSTRATION PROJECTS								
	GWALIOR FORT	55							
	LAKSHMI BAI STATUE	5							
	ITALIAN GARDEN	40							

	SCINDIA SCHOOL	25							
	Municipal Sector Sub Total	18180							
	Total	**31472**							

Year wise Goals - Energy Efficiency

No	Project Details	Investment (Rs. In Lakhs)	2012	2013	2014	2015	2016	2017	2018
	RESIDENTIAL SECTOR								
1	USE OF CFL-BACHAT LAMP YOJANA	1.5							
2	IMPLEMENTATION OF T-5 INLINE BALLAST	93.5							
3	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS	500							
4	IMPLEMENTATION OF DUCTED AIR COOLERS	1000							
5	ENERGY STAR RATED REFRIGERATORS	2000							
6	DEVELOPMENT OF A ZERO ENERGY HOME/OFFICE	1000							
7	ESTABLISHMENT OF ENERGY CENTRE FOR SERVICE AND DEMONSTRATION	135							
	Awareness Campaign	58							
	COMMERCIAL & INSTITUTIONAL SECTOR								
8	IMPLEMENTATION OF T-5 INLINE BALLAST IN COMMERCIAL BUILDINGS	93.5							
9	IMPLEMENTATION OF CFLs IN PLACE OF ICLS IN COMMERCIAL BUIDINGS	10							
10	IMPLEMENTATION OF 5-STAR RATED AIR CONDITIONERS IN COMMERCIAL BUILDINGS	500							
11	SOLAR HEAT-REFLECTING CLEAR WINDOW FILMS	480							
12	LED BULBS	900							
13	UPVC WINDOWS COMMERCIAL BUILDINGS	750							
	INDUSTRIAL SECTOR								
14	ENERGY EFFICIENCY AUDITS AND IMPLEMENTATION*	2184.27							
	MUNICIPAL SECTOR								
15	STREET LIGHTING ENERGY CONSERVATION	371.25							

16	WATER TREATMENT AND PUMPING SYSTEMS	85							
	Total	**10162.02**							

Advancement in Renewable energy technologies:

Hydrogen energy:

Hydrogen is a clean fuel and an energy carrier that can be used for a broad range of applications as a possible substitute to liquid and fossil fuels. The Ministry has supported research, development and demonstration projects on various aspects of hydrogen energy including its production, storage and use as a fuel for generation of mechanical/thermal/electrical energy. The application of hydrogen in fuel cells for power generation has been demonstrated as a result of initiatives taken by this Ministry. Hydrogen fuelled small power generating sets, two wheeler (motor cycles), three wheeler and catalytic combustion systems for residential and industrial sectors have also been developed and demonstrated.

200 Watt Hydrogen Generator developed by Central Electrochemical Research Institute, Karaikudi, Tamilnadu

Fuel Cells:

Fuel Cells are environmentally benign. Hydrogen is the primary fuel for fuel cells. Other fuels can also be used to produce hydrogen gas with the aid of reformers. Because of modular nature, fuel cells are ideally suited for de-centralized power generation and for automotive application. Prototypes of polymer electrolyte membrane or proton exchange membrane fuel cells (PEMFCs) and phosphoric acid fuel cells (PAFCs) have been developed in kW size in India. The applications of these prototypes have been demonstrated for power generation (PEMFC & PAFC) and transport sectors (PEMFC).A fuel cell-battery hybrid vehicles with indigenously developed PEMFC stack of 10kW had undergone field performance evaluation. Efforts made are expected to lead to the indigenous production and wider applications of fuel cell systems in the country. This programme focuses on development and demonstration of fuel cells, which produce electricity, water and heat through reaction between hydrogen and oxygen/air. Hydrogen is the primary fuel for fuel cells. Hydrogen for fuel cells can be produced by reformation of other fuels. It can also be produced from coal and biomass and by electrolysis of water. Renewable energy sources and nuclear energy can also be used for production of hydrogen. Because of their modular nature, fuel cells are ideally suited for distributed power generation. Small fuel cell power packs can be used for power generation by industrial and residential users. Fuel Cells are emerging as power sources for automobiles.

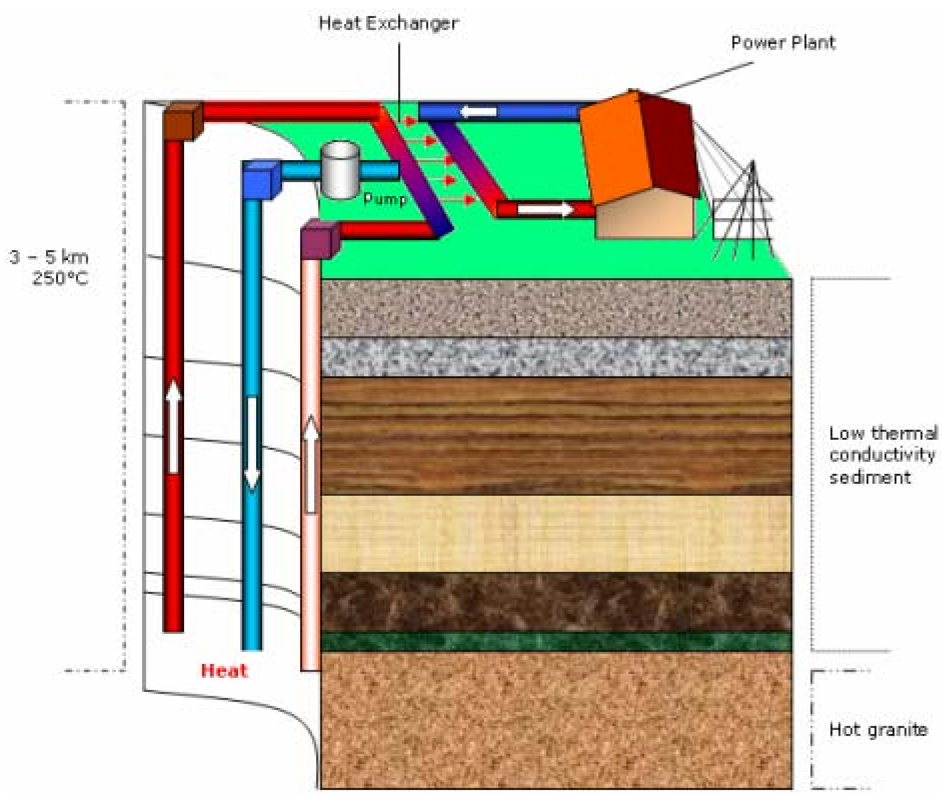
Ongoing Projects in Fuel Cells:

1. Development of Direct Alcohol Fuel Cell and Test Protocols (IIT Delhi).
2. Solid Oxide Fuel Cells that operate directly on hydrocarbon feedstock (IIT Delhi).
3. Development of High performance intermediate temperature solid oxide fuel cells (IT-SOFC) by low cost ceramic processing techniques (IMMT, Bhubaneshwar).
4. Design and development of Alkaline fuel cell : Scaling up from bench scale i.e. 185 W to 500W (SICES Degree College of Arts, Science and Commerce, Ambernath (W), Mumbai).

5. Development of high performance direct Methanol Fuel Cell (University of Calcutta).
6. Development of PEM For fuel cell by plasma process (Institute of Advanced Study in Science Technology, Guwahati).
7. Development of Non-fluorinated Polymeric Membrane for Direct Methanol Fuel Cell (Birla Institute of Technology, Ranchi).

Geothermal energy:

Geothermal energy can be used very effectively in both on- and off-grid developments, and is especially useful in rural electrification schemes. Its use spans a large range from power generation to direct heat uses, the latter possible using both low temperature resources and "cascade" methods. Cascade methods utilise the hot water remaining from higher temperature applications (e.g., electricity generation) in successively lower temperature processes, which may include binary systems to generate further power and direct heat uses (bathing and swimming; space heating, including district heating; greenhouse and open ground heating; industrial process heat; aquaculture pond and raceway heating; agricultural,drying,et).



Technology

Mile-or-more-deep wells can be drilled into underground reservoirs to tap steam and very hot water that drive turbines that drive electricity generators. Four types of power plants are operating today:

Flashed steam plant

The extremely hot water from drill holes when released from the deep reservoirs high pressure steam (termed as flashed steam) is released. This force of steam is used to rotate turbines. The steam gets condensed and is converted into water again, which is returned to the reservoir. Flashed steam plants are widely distributed throughout the world.

Dry steam plant

Usually geysers are the main source of dry steam. Those geothermal reservoirs which mostly produce steam and little water are used in electricity production systems. As steam from the reservoir shoots out, it is used to rotate a turbine, after sending the steam through a rock-catcher. The rock-catcher protects the turbine from rocks which come along with the steam.

Binary power plant

In this type of power plant, the geothermal water is passed through a heat exchanger where its heat is transferred to a secondary liquid, namely isobutene, iso-pentane or ammonia–water mixture present in an adjacent, separate pipe. Due to this double-liquid heat exchanger system, it is called a binary power plant. The secondary liquid which is also called as working fluid, should have lower boiling point than water. It turns into vapor on getting required heat from the hot water. The vapor from the working fluid is used to rotate turbines. The binary system is therefore useful in geothermal reservoirs which are relatively low in temperature gradient. Since the system is a completely closed one, there is minimum chance of heat loss. Hot water is immediately recycled back into the reservoir. The working fluid is also condensed back to the liquid and used over and over again.

Hybrid power plant

Some geothermal fields produce boiling water as well as steam, which are also used in power generation. In this system of power generation, the flashed and binary systems are combined to make use of both steam and hot water. Efficiency of hybrid power plants is however less than that of the dry steam plants.

Enhanced geothermal system

The term enhanced geothermal systems (EGS), also known as engineered geothermal systems (formerly hot dry rock geothermal), refers to a variety of engineering techniques used to artificially create hydrothermal resources (underground steam and hot water) that can be used to generate electricity. Traditional geothermal plants exploit naturally occurring hydrothermal reservoirs and are limited by the size and location of such natural reservoirs. EGS reduces these constraints by allowing for the creation of hydrothermal reservoirs in deep, hot but naturally dry geological formations.EGS techniques can also extend the lifespan of naturally occurring hydrothermal resources.

Projects to be Implemented

The potential areas for implementing Geothermal plants.

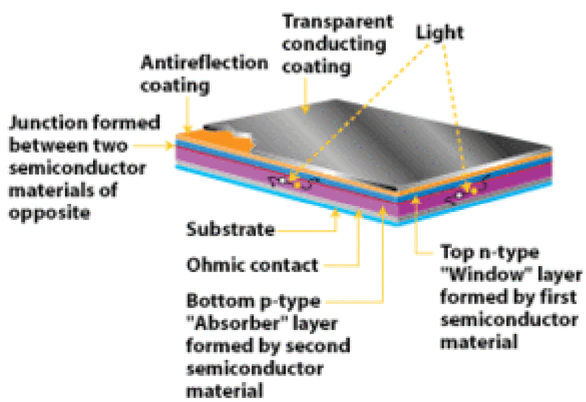
There are no operational geothermal plants in India.

Geothermal Field	Estimated (min.) reservoir Temp (Approx)	Status
Puga geothermal field	240°C at 2000m	From geochemical and deep geophysical studies (MT)
Tattapani Sarguja (Chhattisgarh)	120°C - 150°C at 500 meter and 200 Cat 2000 m	Magnetotelluric survey done by NGRI
Tapoban Chamoli (Uttarakhand)	100°C at 430 meter	Magnetotelluric survey done by NGRI
Cambay Garben (Gujrat)	160°C at 1900 meter (From Oil exploration borehole)	Steam discharge was estimated 3000 cu meter/ day with high temprature gradient. Magneto-telluric study was done by NGRI
Badrinath Chamoli (Uttarakhand)	150°C estimated	Deep drilling required to ascertain geothermal field
Geothermal Field	Reservoir Temp (Approx)	Status

Surajkund Hazaribagh (Jharkhand)	110^{o}C	Magneto-telluric study was done by NGRI. Heat rate 128.6 mW/m^2

Thin Film Technology:

Thin film solar panels are commercially available for installation onto the roofs of buildings, either applied onto the finished roof, or integrated into the roof covering. The advantage over traditional PV panels is that they are very low in weight, are not subject to wind lifting, and can be walked on (with care). The comparable disadvantages are increased cost and reduced efficiency.



A silicon thin film technology is being developed for building integrated photovoltaics (BIPV) in the form of semitransparent solar cells which can be applied as window glazing. These cells function as window tinting while generating electricity.

17 Conclusion

The development of Gwalior Counter Magnet Area has been announced by the Madhya Pradesh Government. The plan to develop the Counter Magnet Area has been conceived to reduce the congestion of the National Capital Region which has been witnessing huge influx of migrant population, taxing, thereby, its drinking water, electricity, transport and other basic infrastructural facilities.

This will necessitate a structured and systematic development of the energy infrastructure in Gwalior city.There are four nascent drivers that will assist the implementation of Solar Cities Program in Gwalior: the rising cost of electricity in India; the rising perception of the need, at personal and community levels, to reduce GHG footprints; the cost to distributors of managing supply to meet peak demand, which inexorably is growing; and widely distributed PV supply and information systems for in-home monitoring and control of loads are going to grow so poles and wires owners (i.e. distribution companies) have to learn to deal with small- to mid-scale embedded generation.*The projects enumerated in the solar city master plan are vital to energy markets/users/suppliers in a transition to a low carbon economy and against a landscape of increasing energy bills*.

The Solar Cities project provide a living model of how solar energy; energy efficiency and responsive market signals can deliver economic and environmental benefits in an integrated package. Notwithstanding these broader benefits, at its heart the projects implemented will act as a learning experience for the central Government, State and local governments; electricity market participants; businesses (including financial institutions, energy service providers, and hardware suppliers and installers) and consumers

- Consumers will better understand their energy use and be rewarded for managing energy wisely.

- Electricity companies will understand the extent of cost savings in servicing peak electricity demand periods and investing in infrastructure, as well as building new client relationships.
- Industry will be able to test new sustainable energy options in a low-risk environment, strengthen corporate citizenship and improve market position.
- Government will have access to better information on the environmental and economic costs and benefits of the various energy options, on which to base future energy and climate change policy.
- Successful strategies that are sustainable in the longer term can be replicated in other towns and cities around Madhya Prades and will be an exciting showcase for the rest of India.

Key Metrics

Sector Wise Summary upto 2013

Sector	Energy Conservation in Lakh Kwh		Renewable Energy in Lakhs Kwh		Total in Lakh Kwh
	upto 2013	Annually	Upto 2013	Annually	Upto 2013
Residential	387.16	193.58	1185.00	592.50	1572.16
Commercial	368.25	184.12	30.68	15.34	398.93
Industrial	397.14	198.57	16.02	8.01	413.16
Municipal	130.52	65.26	1264.08	632.04	1394.60
Total	1283.07	641.53	2495.78	1247.89	3778.84

Solar City Master Plan Target versus Planned measures in MToE

Sector	Energy consumed in Million Tonnes of Oil Equivalent		Percentage savings	
	upto 2013	Baseline	%	
Total	0.03249	0.15603	20.82	

List of Annexures

Annexure-1

ALL Bulk HT consumers LT consumers Having Annual Demand on more than 10 lakhs

Annexure-2

List of cold storages in Gwalior

Annexure-3

ALL Comm. And Industrial HT consumers LT consumers Having Annual Demand more than 10 lakhs

Annexure-4

Category wise energy consumption

Annexure-5

Excerpts from National Urban Data Base Indicators (NUDB&I)

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Electricity Tariff Projections

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Madhya Pradesh draft solar policy2010

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Load Variation of Gwalior City

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Solar PV specifications

Annexure-1

ALL Bulk HT consumers LT consumers Having Annual Demand on more than 10 lakhs

Bulk Supply

Sl. No.	Category	Purpose	Name	half yearly Sanction/contact demant in kW/HP/kVA	consumption during month
1	HV 6	Bulk Supply	N.C.C. Women Trg. College	150	29440
2	HV 6	Bulk Supply	G.E. (M.E.S.) Pintopark	200	69550
3	HV 6	Bulk Supply	G.E. (MES)Bulk Supply	3600	1470800
4	HV 6	Bulk Supply	B.E.C.I.L.	200	89958
5	HV 6	Bulk Supply	,L.N.I.P.E.	800	119660
			Total	**4950**	**1779408**

Annexure-2

List of cold storages in Gwalior

Cold Storage

Sl. No.	Category	Purpose	Name	half yearly Sanction/contact demant in kW/HP/kVA	consumption during month
1	HV-3.2	Cold Storage	Prakash cold storage	105	15650
2	HV-3.2	Cold Storage	Parikshit cold storage	110	17800
3	HV-3.2	Cold Storage	Agrasen cold storage	105	13480
4	HV-3.2	Cold Storage	RVS Cold Storage	146	27320
5	HV-3.2	Cold Storage	Jai Mahakal Cold Storage	125	17870
6	HV-3.2	Cold Storage	Bansal Cold Storage, Gwl	155	41735
			Total	746	133855

Annexure-3
ALL Comm. And Industrial HT consumers LT consumers Having Annual Demand more than 10 lakhs

Sl. No.	Category	Purpose	Name	half yearly Sanction/contact demant in kW/HP/kVA	consumption during month
1	HV 3.2	Non-Ind	Station Engg.(HPTV)	136	43840
2	HV 3.2	Non-Ind	G.E. (MES)D.R.D.E.	500	109833
3	HV 3.2	Non-Ind	Sr.. D.E.E. ,ResidencyTansen Road	200	47165
4	HV 3.2	Non-Ind	Hotal Sheltor	250	46330
5	HV 3.2	Non-Ind	Principal , Scindia School Fort	300	75770
6	HV 3.2	Non-Ind	Director,(O&M) B.E.C.I.L	162	24170
7	HV 3.2	Non-Ind	Commissioner Nagar Nigam	200	8140
8	HV 3.2	Non-Ind	Pratap Wahini S K S S (MPCT)	200	36420
9	HV 3.2	Non-Ind	A.B.V. I.I.I.T.M.	700	235120
10	HV 3.2	Non-Ind	Scindia Kanya Vidhyalaya	130	46520
11	HV 3.2	Non-Ind	E.E. (P.H.E.) Department	400	140093
12	HV 3.2	Non-Ind	M.I.T.S.	262	50050
13	HV 3.2	Non-Ind	Dy.Commissioner, Income Tex	200	16335
14	HV 3.2	Non-Ind	M.P. State Tourism (Motel Tansen)	140	34164
15	HV 3.2	Non-Ind	,S.B.I.	190	36597
16	HV 3.2	Non-Ind	D.M. L.I.C.	122	27935
17	HV 3.2	Non-Ind	S.B. Hotel	200	59958
18	HV 3.2	Non-Ind	Hotel Land Mark	200	38840
19	HV 3.2	Non-Ind	Seeta Cooling (Hotel Seeta Manor)	125	16980
20	HV 3.2	Non-Ind	Rajasthan Patrika	260	26769
21	HV 3.2	Non-Ind	Kanha Shopping Mall	125	19615
22	HV 3.2	Non-Ind	G.E. (MES) Airfield	3700	1405800
23	HV 3.2	Non-Ind	The D.E.E. , IRCAM	125	22540
24	HV 3.2	Non-Ind	I.I.T.T.	150	37950
25	HV 3.2	Non-Ind	High Court	550	111300
26	HV 3.2	Non-Ind	Bharti Telinet	200	83904
27	HV 3.2	Non-Ind	G.M. Telicome	200	16660
28	HV 3.2	Non-Ind	G.E. (R&D) DRDE Navlakha Pared	2000	430440
29	HV 3.2	Non-Ind	Vivaswan Hotel (Central Park Hotel)	300	81740

30	HV 3.2	Non-Ind	Nayantara Construction	250	23443
31	HV 3.2	Non-Ind	Adityaz Hotel	300	54980
32	HV 3.2	Non-Ind	Director Sports & Youth welfare	100	21100
33	HV 3.2	Non-Ind	Scindia Investment	275	88050
34	HV 3.2	Non-Ind	Prem Moters	120	20520
35	HV 3.2	Non-Ind	N. R. I. IIITM	60	15055
36	HV 3.2	Non-Ind	G. M. State Bank Of India	156	22020
37	HV 3.2	Non-Ind	Precise Media	250	5030
38	HV 3.2	Non-Ind	A.G.M.P.	700	119600
39	HV 3.2	Non-Ind	Raj Event & Entertainment	250	14013
40	HV 3.2	Non-Ind	People Samachar	300	13490
41	HV 3.2	Non-Ind	(TRD)Gwalior	24000	5332000
42	HV 3.2	Non-Ind	E. E. IIDC	150	0
43	HV 3.3	Non-Ind	M/s All India Radio Rairoo	110	13260
44	HV 3.4	Non-Ind	M/s Ananadpur Trust Hospital, Gwl	200	21565
45	HV 3.5	Non-Ind	B.S.F.(Hospital) Dabra)	500	92580
46	HV 3.6	Non-Ind	B.S.F.(Cenwesto) Dabra	250	52340
47	HV 3.7	Non-Ind	B.S.F.(STC) Dabra	350	78220
48	HV 3.8	Non-Ind	A.E. (tel) Datia	80	22840
			Total	40628	9341084

Educational institutions

Purpose	Name	half yearly Sanction/contact demant in kW/HP/kVA	consumption during month
Educational	I.T.M. Sitholi	350	68360
Educational	N.I.T.M	90	14910
Educational	Deen dayal Krishi (I.P.S.)	250	28914
Educational	R.J.I.T(Dabra)	150	11990
	Total	**840**	**124174**

ALL HT consumers LT consumers Having Annual Demand on more than 10 lakhs

Sl. No.	Category	Purpose	Name	Half yearly Sanction/contact demant in kW/HP/kVA	consumption during month

1	HV 3.1	Industrial	Sr. DEE(CR) Laxmanpura	500	156853
2	HV 3.1	Industrial	Hindustan Vidhyut Products	200	14700
3	HV 3.1	Industrial	Cold Storage & General Mills	250	108150
4	HV 3.1	Industrial	Harshit Textile	700	188364
5	HV 3.1	Industrial	Romy Oil Industries	100	22550
6	HV 3.1	Industrial	R.R. Wire & Cable	118	25985
7	HV 3.1	Industrial	Apex Industries	200	23673
8	HV 3.1	Industrial	Surya Roshni Ltd.	150	37170
9	HV 3.1	Industrial	Diksha Packing	100	51615
10	HV 3.1	Industrial	Akash Industries	125	27215
11	HV 3.1	Industrial	Quality Food Products	100	15518
12	HV 3.1	Industrial	Deeksha Contener	200	3033
13	HV 3.1	Industrial	The D E E.(CR) Rly Sation	450	203650
14	HV 3.1	Industrial	Unipetch Rubber	260	58226
15	HV 3.1	Industrial	J.B. Mangharam	400	237240
16	HV 3.1	Industrial	Gupta Refrectories	180	21355
17	HV 3.1	Industrial	M.P. Industries	200	40920
18	HV 3.1	Industrial	B.P. Food	425	220100
19	HV 3.1	Industrial	C.P. Industries	800	185080
20	HV 3.1	Textile	Takshashila Textile	300	78055
21	HV 3.1	Industrial	Kapoor Strips	250	24970
22	HV 3.1	Industrial	Brijlal/Daulatram	195	37388
23	HV 3.1	Industrial	Acme Plast	380	62983
24	HV 3.1	Industrial	Kailash Industries	200	60420
25	HV 3.1	Industrial	Sheetal Industries	150	65690
26	HV 3.1	Industrial	Paras White Gold Indu.	154	54122
27	HV 3.1	Industrial	Pawan Kumar /Budhamal	167	38500
28	HV 3.1	Industrial	Moolchand / Madhav Das	120	25340
29	HV 3.1	Industrial	Shiv Shakti Till Mills	100	22544
30	HV 3.1	Industrial	D.E.(F.R.S.) Telephone Exc	340	155483
31	HV 3.1	Industrial	Ramanand Enterprises	300	107280
32	HV 3.1	Industrial	S.A. Trading Co.	200	43650
33	HV 3.1	Industrial	Parinamitra Electricals	160	10737
34	HV 3.1	Industrial	Gangwal Industries	250	71520
35	HV 3.1	Industrial	R.R. Floor Mills	370	56290
36	HV 3.1	Industrial	Cadbury India Ltd	2500	1619900
37	HV 3.1	Industrial	S.R.F. Ltd.	4000	459600
38	HV 3.1	Industrial	A.V.N. Tubes	600	52400
39	HV 3.1	Industrial	Lapinous Rock Wools	630	216360

40	HV 3.1	Industrial	Punchsheel Rubber	595	165760
41	HV 3.1	Industrial	Pee Cee Cosma	180	27432
42	HV 3.1	Industrial	Jai Maruti Gas Cyl.	176	16210
43	HV 3.1	Industrial	Crompton Greaves	1000	572389
44	HV 3.1	Industrial	Godrej consumer Products	3320	1444000
45	HV 3.1	Industrial	Super -Sack	600	0
46	HV 3.1	Industrial	Jamuna Auto Ltd	1500	793680
47	HV 3.1	Industrial	Supreem Industries	1200	420240
48	HV 3.1	Industrial	Supreem Industries (PVC Film)	150	11600
49	HV 3.1	Industrial	S.K. Industries	275	108320
50	HV 3.1	Industrial	Vikram Woolens	1500	701040
51	HV 3.1	Industrial	Atlas Cycle	650	169280
52	HV 3.1	Industrial	M.P. Telilinks	700	61480
53	HV 3.1	Industrial	Ranbaxy Laboratories	650	307867
54	HV 3.1	Industrial	Asha Oil Industries	550	82620
55	HV 3.1	Industrial	G.K.B. Opticals	200	24890
56	HV 3.1	Industrial	Eminnence India	500	38200
57	HV 3.1	Industrial	Gwalior Tank & Veesuals	150	30180
58	HV 3.1	Industrial	Kodak India	150	19930
59	HV 3.1	Industrial	Hemco Engineers	315	57020
60	HV 3.1	Industrial	Malanpur Rubber	200	9010
61	HV 3.1	Industrial	Starling Agro	2000	890340
62	HV 3.1	Industrial	Marval Vinayal	850	336840
63	HV 3.1	Industrial	Shriniwas Cable	200	29040
64	HV 3.1	Industrial	Vishal Air Products	180	112000
65	HV 3.1	Industrial	Badri Narayan Rubber	460	162400
66	HV 3.1	Industrial	Venkat Raman Food	350	70310
67	HV 3.1	Industrial	V.R.S. Food	2500	988800
68	HV 3.1	Industrial	Essel Plast	125	42777
69	HV 3.1	Industrial	Kurlon Limited	325	71040
70	HV 3.1	Industrial	Surya Roshni Limited	3000	687900
71	HV 3.1	Industrial	Tewa API	1750	639825
72	HV 3.1	Industrial	Kashish Rubber	200	43560
73	HV 3.1	Industrial	Surya Roshni (Component)	1100	546640
74	HV 3.1	Industrial	season Rotogravre	250	16480
75	HV 3.1	Industrial	Surya Roshni Ltd.	1500	136200
76	HV 3.1	Industrial	M/s Bharat Petrolium Rairoo	150	14430
77	HV 3.1	Industrial	M/s Gwalior Distillers Rairoo	1170	357040

78	HV 3.1	Industrial	M/s Hindustan Petrolium Rairoo	150	10030
79	HV 3.1	Industrial	M/S Rail Spring Karkhana Sitholi	1200	226010
80	HV 3.1	Industrial	M/s Indian Oil Corpn.Rairoo	200	43938
81	HV 3.1	Industrial	M/S Jain stone	250	21330
82	HV 3.1	Industrial	M/S Naiduniya news	200	18135
83	HV 3.1	Industrial	M/S Balaji gangsaw Industries	125	20100
84	HV 3.1	Industrial	M/S Stone India	140	17765
85	HV 3.1	Industrial	M/S Mathura Stones Export	120	14745
86	HV 3.1	Industrial	M/s Jindal Oil Industries	250	102805
87	HV 3.1	Industrial	M/s G.D.P. Agro Industries Gwl.	137	56900
88	HV 3.1	Industrial	M/s Jai Baba Industreis. Vill Birawali	167	26300
89	HV 3.1	Industrial	M/s Shree Jee Biofuels, Purani Chawani, Gwalior	130	22670
90	HV 3.1	Industrial	M/s Bihariji Oils Pvt.Ltd.	250	140120
91	HV 3.1	Industrial	Gwalior Sugar Co Dabra	500	80040
92	HV 3.1	Industrial	Econ Antari	180	32840
93	HV 3.1	Industrial	Savitri Foods Product, Dabra	140	14809
94	HV 3.1	Industrial	G.M. (TSU) BSF,Tekenpur	376	49770
95	HV 3.1	Industrial	Agro Solvent Product Datia	1500	579780
96	HV 3.1	Industrial	Kachhawah Minerals, Datia	117	4748
		Total		**53627**	**16594234**

Malls

Sl. No.	Category	Purpose	Name	half yearly Sanction/contact demant in kW/HP/kVA	consumption during month
1	HV 3.3	Shopping-Mall	Fairy land Hotel & Resorts	290	51939
2	HV 3.3	Mall	Deendyal Mall	1800	364500
			Total	2090	416439

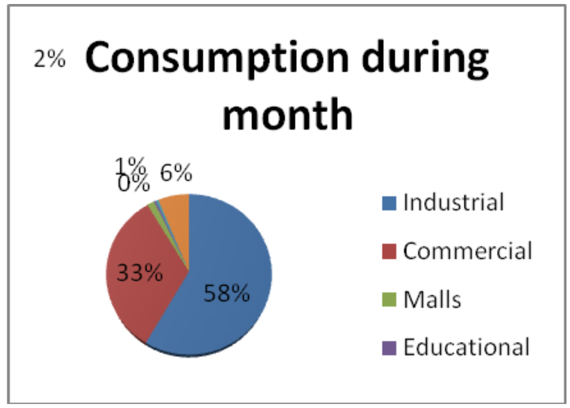
2008-2009 Consumer mix

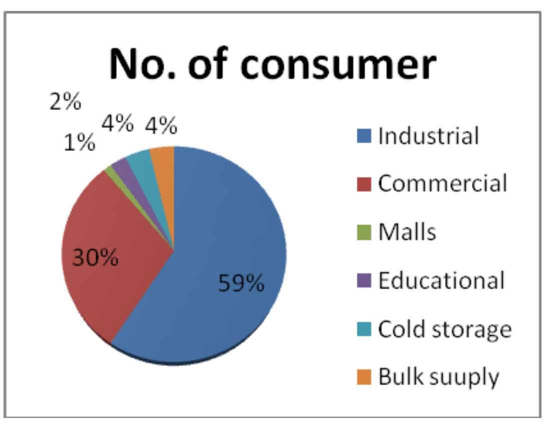
S.N.	Category	No. of consumers	unit consumed(MU)
1	DLF	560843	599.27
2	Non DLF	78813	180.59
3	Water Works	3003	50.41
4	Industrial	12959	89.13
5	Agriculture	121147	1049.62
6	Street Light	672	20.96
7	Traction	4	247.68
8	HT Consumer	340	419.25
9	GRAND TOTAL	777781	2656.91

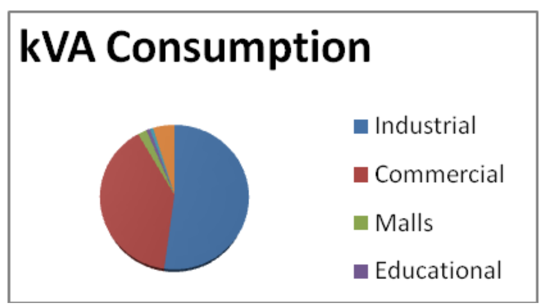
Annexure-4

Category wise energy consumption

Sl.No.	Type of Consumer	No. of consumer	kVA Consumption	Consumption during month
1	Industrial	96	53627	16594234
2	Commercial	48	40628	9341084
3	Malls	2	2090	416439
4	Educational	4	840	124174
5	Cold storage	6	746	133855
6	Bulk suuply	6	4950	1779408
		162	102881	28389194







Annexure-5

Excerpts from National Urban Data Base Indicators (NUDB&I)

Proforma For Data Collection At Town/Ward Level

TABLE 1 : PHYSICAL ASPECTS AND LOCATIONAL PARTICULARS

1.1. Name of Town

G	W	A	L	I	O	R				

1.2. Name of the District

G	W	A	L	I	O	R											

1.3. Name of the State

M	A	D	H	Y	A	P	R	A	D	E	S	H

1.4. Physical aspects of the town

Size/class of Town	Civic Status	Annual average rainfall in	Annual average Temperature in degree centigrade

		millimeters	Minimum	Maximum
B	M.CORP.	475.6	17.5	30.92

1.5 Area of the Town in (Sq.kms.)

Ward	Area in (Sq.kms.)	
	1991	2001
1	-	39.14
2	-	1.43
3	-	3.2
4	-	11.31
5	-	4.1
6	-	4.01
7	-	7.26
8	-	3.15
9	-	0.2
10	-	0.77
11	-	0.65
12	-	0.6
13	-	0.52

14	-	0.96
15	-	0.79
16	-	1.01
17	-	1.15
18	-	1.3
19	-	4.96
20	-	5.45
21	-	1.64
22	-	6.8
23	-	3.12
24	-	11.87
25	-	32.85
26	-	2.99
27	-	1.12
28	-	2.85
29	-	70.68
30	-	1.79
31	-	2.38
32	-	0.36
33	-	1.59
34	-	0.4
35	-	0.69
36	-	0.56
37	-	3.09
38	-	7.01

39	-	7.56
40	-	2.69
41	-	0.52
42	-	0.82
43	-	0.52
44	-	0.41
45	-	2.45
46	-	1.28
47	-	0.79
48	-	2.86
49	-	3.41
50	-	0.35
51	-	0.7
52	-	0.54
53	-	1.84
54	-	11.47
55	-	1.76
56	-	1.16
57	-	0.46
58	-	2.55
59	-	0.62
60	-	4.31
Town total	-	**292.82**

1.6 Distance in Kms. from Town

Sl.No	Description	Name	Distance km.
i	State Head Quarters	**BHOPAL**	**389**
ii	District Head Quarters	**GWALIOR**	**0**
iii	Tahsil/Taluk/Mandal Head Quarters	**GWALIOR**	**0**
iv	Nearest city (having 1 lakh and above population)	**MORENA**	**40**
v	Nearest Railway Station	**GWALIOR**	**0**
vi	Nearest Air port	**GWALIOR**	**0**
vii	Nearest Port	**NIL**	**NIL**

1.7 Major Nearness/Distance of River/Canal from the Town

Sl.No.	River name	Distance in Kms.	Canal name	Distance in Kms.

1	SINDH	52	MALANPUR	20
2	CHAMBAL	70	HARSI	40

TABLE 4: **INDUSTRIAL ASPECTS (***For Ward/Town)*

Sl. No	Type of Industries	No. of units					
		2001	2002	2003	2004	2005	2008
1	Large	-	-	-	2	2	1
2	Medium	-	-	-	4	4	2
3	Small / House Hold	4450	4550	4671	5292	5901	-
4	Hazardous	--	--	--	--	--	-

6.2 Water Supply details (*For Ward/Town)*

Ward	Source of Drinking	Quantity of Water Supplied	No. of Connections	Per Capita Consumption	Area Covered	Capacity of WTPs	Treatment of Total Water

	water	(MLD)		(LPCD)	(sq.kms)		supply (%age)
1	TUBE WELL,PIPE LINE,HAND PUMP, WELL	2.954	866	135	2.36	144 MLD	80%
2		3.127	1190	135	2.50		
3		3.032	1651	135	2.43		
4		2.755	615	135	2.20		
5		1.754	734	135	1.40		
6		2.641	940	135	2.11		
7		3.228	1500	135	2.58		
8		2.651	1100	135	2.12		
9		1.399	480	135	1.12		
10		1.534	900	135	1.23		
11		1.677	666	135	1.34		
12		1.732	616	135	1.39		
13		1.473	1140	135	1.18		
14		2.416	600	135	1.93		
15		1.751	1572	135	1.40		
16		1.452	1575	135	1.16		
17		1.716	742	135	1.37		
18		1.195	600	135	0.96		
19		2.729	1688	135	2.18		
20		2.934	1759	135	2.35		
21		3.598	1430	135	2.88		
22		3.539	1497	135	2.83		
23		4.003	1559	135	3.20		

24		2.867	1222	135	2.29		
25		5.598	92	135	4.48		
26		2.421	1739	135	1.94		
27		2.548	1518	135	2.04		
28		2.555	1313	135	2.04		
29		1.265	NIL	135	1.01		
30		2.579	1547	135	2.06		
31		2.409	2050	135	1.93		
32		2.129	1505	135	1.70		
33		2.043	1610	135	1.63		
34		1.441	1156	135	1.15		
35		1.870	1200	135	1.50		
36		1.860	1071	135	1.49		
37		2.188	797	135	1.75		
38		1.677	1077	135	1.34		
39		3.298	1850	135	2.64		
40		1.997	1750	135	1.60		
41		1.336	758	135	1.07		
42		1.550	1200	135	1.24		
43		1.741	830	135	1.39		
44		1.204	910	135	0.96		
45		3.698	1900	135	2.96		
46		2.018	840	135	1.61		
47		1.292	1584	135	1.03		
48		2.900	1190	135	2.32		

49		2.469	1500	135	1.98		
50		1.440	1613	135	1.15		
51		1.433	840	135	1.15		
52		1.784	1195	135	1.43		
53		2.456	1055	135	1.96		
54		3.028	1291	135	2.42		
55		1.599	1915	135	1.28		
56		1.754	1300	135	1.40		
57		1.900	2200	135	1.52		
58		2.164	783	135	1.73		
59		1.978	1200	135	1.58		
60		3.074	1282	135	2.46		
Total Town		**136.853**	**72303**	**8100**	**109.45**		

6.2.1 Is there any scheme for recycling of waste water in the town.

Yes	No

6.2.2 Is the ground water table receding in the city?

100 M AVG.

If yes, please give present water table

Yes	No

6.2.3 Is there any separate water supply line for non-drinking purposes such as industry, parks etc.

√

If yes, give area covered under the scheme

Yes	No

TABLE 7: ELECTRICITY (Town wise)

Source/distance (in Kms.) of Power plant	Total Electricity Demand (MW)	Total electricity Supply (MW)	Total Consumption (MKWH)
MANIKHEDA— 150 KM	**36**	**29**	**25**

Type	Residential	Commercial	Industrial	Others	Total
No. of Electric Connections	**145608**	**23838**	**5907**	**1244**	**176597**
Electric Consumption (KWH)	**15MKWH**	**3.5MKWH**	**6MKWH**	**0.5MKWH**	**25**

TABLE 10: MEDICAL FACILITIES

10.1 Number of hospitals, dispensaries, etc., doctors, nurses, paramedical staff and total number of beds available therein

Type of Hospital	No. of Units		No. of Beds		No. of Doctors		No. of Nurses		No. of Paramedical staff		Patients Treated	
Hospital	Govt.	Private	Govt.	Private	Govt.	Private	Govt.	Private	Govt.	Private	Govt.	Private
Allopathic	7	302	470	712	37		62	112	78	17	151886	216715
Ayurvedic	1	NIL	4	NIL	12	NIL	14	NIL	9	NIL	19765	NIL
Homeopathic	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Unani	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Family welfare & maternity center	1	1	NIL	NIL	2	2	4	5	NIL	NIL	678	792
Others	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Dispensary												

Allopathic	17	NIL	NIL	NIL	53	NIL	39	NIL	42	NIL	251423	NIL
Ayurvedic	11	NIL	NIL	NIL	10	NIL	13	NIL	NIL	NIL	203650	NIL
Unani	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Homeopathic	5	NIL	NIL	NIL	3	NIL	5	NIL	NIL	NIL	47812	NIL
Others	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL
Primary Health Centres	124		NIL		-		-		-		28716	
Nursing Home	616		-		-		-		-		31167	

TABLE 9: EDUCATIONAL FACILITIES

10.1 Number of hospitals, dispensaries, etc., doctors, nurses, paramedical staff and total number of beds available therein

Type of Institutions	**No. of Institutions**	**No. of Class Rooms**	**Enrolment**	**No. of teachers**
School	**Govt./ Private**	**Govt./ Private**	**Govt./ Private**	**Govt./ Private**
Anganwadi	**757**	**1514**	**2118**	**111**
Primary	**1760**	**5280**	**253548**	**4435**
Middle	**1231**	**4924**	**73275**	**2765**
Secondary	**156**	**2340**	**26575**	**2748**
Senior Secondary	**144**	**2880**	**20266**	**771**
Colleges				
General	**31**	**775**	**7750**	**620**
Medical	**1**	**50**	**600**	**40**

Engineering Law Others	**123**	**3690**	**36900**	**2468**
Vocational Training	--	--	--	--
Adult Education program	--	--	--	--
Others	--	--	--	--

TABLE 12: SOLID WASTE MANAGEMENT (Ward wise data)

12.1Solid waste generation

Ward	Average generation (Tons/day)	Average collection (Tons/day)	No. of Houses covered for House to House Collection	Total Area Used for Sanitary Land Fill (sq. Km)	Manpower deployed	No. of Sites used for Land Fill
1	4.923325	4.184826	2673	25.8 H	14	1
2	3.4815	2.959275	1962		20	
3	5.144975	4.373229	2606		30	
4	4.473975	3.802879	2529		28	
5	2.995025	2.545771	1597		20	
6	4.471225	3.800541	2387		10	
7	5.017925	4.265236	2994		24	
8	4.4759	3.804515	2609		16	
9	2.3892	2.03082	1431		9	
10	2.6301	2.235585	1458		64	
11	2.87155	2.440818	1746		18	
12	2.967525	2.522396	1670		17	
13	2.51845	2.140683	1459		20	

14	**4.13325**	**3.513263**	**2291**		**20**	
15	**2.936725**	**2.496216**	**1768**		**17**	
16	**2.490675**	**2.117074**	**1452**		**14**	
17	**2.933975**	**2.493879**	**1602**		**21**	
18	**2.044625**	**1.737931**	**1123**		**10**	
19	**4.6321**	**3.937285**	**3141**		**15**	
20	**5.032225**	**4.277391**	**3127**		**14**	
21	**6.1611**	**5.236935**	**3554**		**13**	
22	**5.854475**	**4.976304**	**3629**		**20**	
23	**6.817525**	**5.794896**	**3813**		**25**	
24	**4.82295**	**4.099508**	**2857**		**30**	
25	**9.2521**	**7.864285**	**6156**		**25**	
26	**4.136825**	**3.516301**	**2484**		**26**	
27	**4.3516**	**3.69886**	**2343**		**26**	
28	**4.381575**	**3.724339**	**2307**		**42**	
29	**2.31715**	**1.969578**	**1116**		**20**	
30	**4.421175**	**3.757999**	**2700**		**25**	
31	**4.0986**	**3.48381**	**2513**		**20**	
32	**3.637975**	**3.092279**	**1921**		**38**	
33	**3.442175**	**2.925849**	**1832**		**23**	
34	**2.46235**	**2.092998**	**1520**		**19**	
35	**3.19715**	**2.717578**	**1790**		**34**	
36	**3.136375**	**2.665919**	**1799**		**40**	
37	**3.7048**	**3.14908**	**2084**		**38**	
38	**2.82645**	**2.402483**	**1808**		**20**	
39	**5.000325**	**4.250276**	**2764**		**18**	
40	**2.2869**	**1.943865**	**1232**		**21**	
41	**2.6543**	**2.256155**	**1448**		**28**	

42	2.90125	2.466063	1682		34	
43	2.05755	1.748918	1244		37	
44	6.322525	5.374146	3483		33	
45	3.384425	2.876761	1921		34	
46	2.97055	2.524968	1681		20	
47	2.143075	1.821614	1269		16	
48	4.9676	4.22246	2727		37	
49	4.219325	3.586426	2303		25	
50	2.46565	2.095803	1408		30	
51	2.455475	2.087154	1505		26	
52	3.031325	2.576626	1719		23	
53	4.114825	3.497601	2234		25	
54	4.73715	4.026578	2610		31	
55	2.7357	2.325345	1537		14	
56	2.997775	2.548109	1644		16	
57	3.313475	2.816454	1902		40	
58	3.58105	3.043893	2002		22	
59	3.3594	2.85549	1818		28	
60	4.1459	3.524015	2247		22	
Total Town	227.4322	193.3173	130231		1465	

13.1 Community Facilities (Town**/**Ward wise)

Sl.No	Facilities	Numbers
1	Corporation Gardens	106
2	Community Hall	67
3	Swimming Pool	4
4	Corporation Playgrounds	16
5	Gymnasia	7
6	Corporation Stadium	8
7	Cinemas	14
8	Open Air Theatres	1
9	Zoo	1
10	Public libraries	24
11	Art Galleries	3
12	Museum	1
13	Other (specify)	1
14	Fire Services	1
	No. of Fire stations	1
	No. of fire tenders	
	Personnel	102
15	Cremation/Burial Ground	-
16	Petrol/Gas Station	33
17	Hotels and Eating Places	222
18	Others	--

13.2 Number of banks and credit societies

No. of Banks	Agricultural credit societies	Non-agricultural credit societies
42	**5**	**12**

TABLE 15: HOUSING (Ward wise)

15.1 Distribution of House Holds (HHs.), No. of persons and Tenure

	Number of	Distribution of Persons by living rooms

Tenure Status	HHs	Persons	One room	Two rooms	Three rooms	Four rooms	Five & above
Owned	137570	850000	65025	90440	181220	229245	154700
Rental	24277	144600	6885	15960	31980	40455	27300
Sub-letting	nil	nil	nil	nil	nil	nil	Nil
Rent free	nil	nil	nil	nil	nil	nil	Nil
Squatter without Rent	nil	nil	nil	nil	nil	nil	Nil
Squatter with Rent	nil	nil	nil	nil	nil	nil	Nil
Others	nil	nil	nil	nil	nil	nil	Nil
Total	161847	994600	71910	106400	213200	269700	182000

15.2 Categories of Houses

Type of Houses	No. of Houses
Pucca with RCC Roof and flooring	**112000**
Pucca with Tiles Roof and Kaccha floor	**36000**
Semi pucca	**25000**
Kaccha	**8500**
Others	**500**
Total	**182000**

Annexure -6

Electricity Tariff Projections

Category	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19
LV									
Domestic	4.80	5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09
Non domestic	4.80	5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09
schools,colleges,hostels									
Commercial	5.70	5.99	6.28	6.60	6.93	7.27	7.64	8.02	8.42
Street lights	3.60	3.78	3.97	4.17	4.38	4.59	4.82	5.07	5.32
Water Pumps	3.50	3.68	3.86	4.05	4.25	4.47	4.69	4.92	5.17
Industrial	4.80	5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09
HV									
Industrial	4.70	4.94	5.18	5.44	5.71	6.00	6.30	6.61	6.94
Commercial	5.10	5.36	5.62	5.90	6.20	6.51	6.83	7.18	7.54

Shopping Malls	5.10	5.36	5.62	5.90	6.20	6.51	6.83	7.18	7.54
Power Industries	3.80	3.99	4.19	4.40	4.62	4.85	5.09	5.35	5.61

Tariff considered for payback calculations

Sector	Rs/unit
Residential	5.6
Commercial	6.6
Industrial	5.6
Government	
Utilities	4.2
Buildings	6.6

Annexure-7

Madhya Pradesh draft solar policy

Draft Solar Energy Policy
Government of Madhya Pradesh
2010

Contents

2 Draft Solar Energy policy government of Madhya Pradesh-2010

1. PREAMBLE

Energy is the prime mover of the development of any economy. While conventional fuels viz coal and oil has been the primary sources for energy, their long term availability has been an area of concern. Besides their increased usage has led to high concentrations of greenhouse gases (GHGs) in the atmosphere which is an increasingly important concern with regard to global warming and resultant climate changes.

The current energy requirement of the state of Madhya Pradesh is heavily dependent on the conventional energy sources. The Government of Madhya Pradesh acknowledges the increasing issues related to climate change & global warming and has recognised the urgent need to address these issues. The promotion of renewable energy is one of the key measures taken by the Government of Madhya Pradesh in this direction. Today renewable energy is increasingly becoming an integral part of energy security initiative in the state of Madhya Pradesh.

The promotion of solar energy in Madhya Pradesh should be seen from a broader and long term perspective. Today the cost of generation of solar energy is relatively high, however harnessing the solar energy offers energy security & environmental benefits and other benefits namely:

(a) Contribute to enhancing power availability, reducing the energy shortage, stabilisation of tail-end grid & addressing the peak demand deficit faced by the state of Madhya Pradesh.

(b) Enhancing energy security by developing diverse energy mix: Majority of electricity generation in Madhya Pradesh is based on conventional energy; solar energy can contribute towards diversifying the energy base to reduce dependence on conventional energy sources.

(c) Providing clean & reliable energy: Solar energy helps in meeting the energy requirements of people in remote rural areas.

(d) Leads to sustainable development: Promotion of solar energy will contribute directly towards the overall improvement of living standard of rural populace. It will also help maintain ecological balance, replacing conventional energy use, generate additional employment opportunities, improve health and increase access to education to rural children.

The state of Madhya Pradesh is endowed with high solar radiation with around 300 days of clear sun. The state offers good sites having potential of more than 5.5 kWh/ sq.m. for installation of solar based power projects. The Government of Madhya Pradesh (GoMP) wants to incentivize the promotion of solar energy in the state.

The Policy endeavours to create an enabling environment to attract public & private investments in generation and manufacturing of solar energy based plant & machinery. The Madhya Pradesh Solar Energy Policy – 2010 aims to provide a comprehensive policy for promotion of solar energy in the state of Madhya Pradesh.

2. TITLE

The Policy shall be known as the "Madhya Pradesh Solar Energy Policy -2010"

3. OBJECTIVE OF THE POLICY

The key objectives of the Madhya Pradesh Solar Energy Policy- 2010 are:

(a) accelerate the harnessing and development of solar energy in the state

(b) enhance energy security

(c) promoting efficient & cost-effective solar installations by providing fiscal and non-fiscal incentives

(d) promotion of local manufacturing facilities

(e) harnessing solar energy by developing local capabilities and enhancing public awareness

4. APPLICBILITY

To all solar energy based power project developers (Solar PV/Solar thermal) and manufacturing units of equipment and ancillaries related to solar power projects.

5. TARGETS

The Government of Madhya Pradesh targets a total capacity of 500 MW from solar power generators for installation during the operative period of the policy.

A minimum capacity of a large grid connected Solar Power Generator (SPG), in case of solar photovoltaic & solar thermal, shall be 1 MW each.

6. NODAL AGENCY

The Madhya Pradesh Urja Vikas Nigam (MPUVN) Limited shall be the nodal agency for implementation of the Madhya Pradesh Solar Power Policy – 2010.

7. ELIGIBLE SITES

The solar power project may be set up at sites identified by Madhya Pradesh Urja Vikas Nigam (MPUVN) and/ or any other sites identified as potential site, within the State of Madhya Pradesh by the project developer.

8. ELIGIBLE UNITS

Any enterprise willing to establish power generation projects based on solar energy (Solar PV/Solar thermal) in Madhya Pradesh shall be eligible for incentives under this policy. Eligibility for availing benefits under this scheme shall be based on techno-economical viability and available resources. Captive units will also be eligible to get benefits under this policy as an investor/consumer.

9. FACILITIES & INCENTIVES

(a) Plant & Machinery

Only new plant & machinery shall be eligible for installation under this policy.

(b) Fossil fuel usage

The usage of fossil fuel (coal, gas, lignite, naptha, diesel, wood etc.) shall not be allowed in the grid connected solar thermal power projects.

Hybrid systems shall be allowed as per the guidelines of the Ministry of New and Renewable Energy (MNRE).

(c) Purchase Rate

The purchase rate of electricity generated by solar power generators will be as per the orders of the Madhya Pradesh Electricity Regulatory Commission (MPERC).

The power will be purchased by the distribution licensee in Madhya Pradesh or MP Power Trading Company Limited based on quantity, rate and terms & conditions, as decided by the MPERC from time to time. The quantity of power purchased from power generated by the solar energy based power projects will be shown by the distribution licensee in their annual tariff proposal for approval of MPERC. This will include details of the power purchased in the previous year.

(d) Renewable Purchase Obligation

As per the MPERC (Cogeneration and Generation of Electricity from Renewable Sources of Energy) Regulations 2008, the following Renewable Purchase Obligation (RPO) has been specified:

Financial Year	Wind	Biomass	Cogeneration & other sources
2010-11	6%	2%	2%
2011-12	6%	2%	2%

The purchase of electricity from solar projects will form part of the 2% RPO fixed for Cogeneration & other sources. This will be subject to any amendments and further Regulations provided by the MPERC from time to time. The MPERC may define separate sub-limits for purchase of electricity from solar energy based power projects.

(e) Wheeling Charges

Facility of wheeling will be available to the solar power project through M.P. Power Transmission Company, as per wheeling charges decided by the MPERC. For above wheeling charges, Govt. of Madhya Pradesh will provide grant of 4% and the balance, if any, shall be borne by the project developer.

(f) Open Access charges

Solar power projects will be exempted from open access charges. This will be subject to any amendments and further Regulations provided by the MPERC from time to time.

(g) Third Party Sale

Third party sale will be eligible as per Electricity Act 2003 (No. 36 of 2003) and the orders issued by the MPERC, from time to time, for which purchase rate can be mutually decided between generating unit and consumer unit.

(h) Electricity duty

All generating units, including captive units also, are entitled for exemption of Electricity Duty and Cess the date of commissioning of the project, provided the unit generates at-least 70% of the power generation declared in the Detailed Project Report (DPR). For generation less than 70% power, the documents establishing that reasons were beyond the control of the unit have to be provided for satisfaction of the State Government / M.P Urja Vikas Nigam, after examination of the same M.P. Government can allow exemption in the matter.

(i) Demand Cut

Those Industrial units who are consumers of MPSEB/Successor Company, if they install unit for generation from solar energy for captive use or purchase generated power from solar energy as a third party, then such units shall be given facility to reduce their contract demand equivalent to the 50% of the installed capacity of the solar power generators & these units can utilize full power generated from solar energy.

(j) Metering

Metering equipments for the power generation & sale will be installed at site by unit at their own cost as per specification of MPSEB/Successor Company. Testing of these equipments will be carried out by MPSEB/Successor Company at Units cost.
Locations at which where more than one projects are installed, MPUVN will develop common infrastructure (Power evacuation facility, Road, etc.) and make necessary arrangements. For individual investor, facility for separate metering will be done as per the consultation and cost of investor.

(k) Power Evacuation Facility

Power evacuation will be an integral part of the solar power project. All expenses for power evacuation facility shall be borne by the project developer. Transmission, distribution line and synchronizing equipment required for installation will be installed by project developer as per technical details of MPSEB/Successor Company or it shall be provided by MPSEB/Successor Company at the cost of solar power project developer. Maintenance of the above line & equipments shall be done by MPSEB/Successor Company at the cost of solar power project developer. All incidental/operational cost towards power evacuation shall be borne by the project developer during the entire life span of the project.

10. LAND ALLOTMENT

Identification of Land

MPUVN shall identify suitable Government revenue land in the State and creat and devlop a land bank. Land use permission be given to the project developers as per procedure. However, the developer may identify any other site as potential site, within the State of Madhya Pradesh for installation of solar project.

Allotment of land

I. For cases where Government revenue land is available, the use of land permission @ Rs. 1/- (token) land premium per year will be given for 30 years or the project life whichever is less. Revenue land will be allocated and transferred to the Non-Conventional Energy Department (GoMP), which will give permission for “use of land” for the project period.

II. For cases where Government land is not available, GoMP may acquire private land, as per Land Acquisition Act & existing government policies, made available to be provided to the project developer at the acquired cost. For this no service charges will be payable. For use of land, the permission for diversion is not required. Only information regarding use of land will have to be given to the concerned District Collector.
III. If the unit purchases private land for the project, then they will be eligible for an exemption of 50% on stamp duty & if they do not install the project on this land, then their exemption given will be withdrawn and recovery will be made as per notification of no: 1208 dated 16th May 2008.

11. IMPLEMENTATION

(a) Approval of projects

Applications for installation of solar power projects in the specified formats with specified fees shall be submitted to the M.D., MPUVN.
The complete transparency in allotment of the projects shall be ensured for evaluation of the potential project developer. A comprehensive qualification criteria document shall be designed for inviting proposals listing out technical and financial eligibility parameters of the potential eligible project developers, which would be approved by the dept. of NCE, GoMP.
On the basis of financial & technical parameters contained in the qualification criteria document, proposal would be evaluated by a Project Evaluation Committee appointed by the GoMP. The final approval for allotment of the project shall be given by department of NCE, GoMP.
After getting the above mentioned approval for installation of the project from the GoMP, the period for commissioning & other milestones/activity by the large grid connected solar project shall be as under, then only they will get benefit under the policy, failing which the approval granted for installation of the project will be cancelled.

S. No.	Activity/Milestone	Timeline for Solar PV projects	Timeline for Solar thermal projects
1	Signing of Power Purchase Agreement (PPA)	3 months from the date of Approval	3 months from the date of approval
2	Financial Closure of the project	6 months from the date of signing of PPA	6 months from the date of signing of PPA
3	Commissioning of the Project	12 months from the date of signing of PPA	28 months from the date of signing of PPA

If the project is delayed due to any unavoidable circumstances, the time period can be extended by the GoMP, on the advice of MPUVN/MPSEB after examining the reasons for the delay.

(b) **Implementation of the Project**

In order to ensure speedy implementation of approved projects, an Empowered Committee will be constituted under the chairmanship of Chief Secretary of GoMP and Principal Secretaries of departments (Finance, Revenue, Forest, WRD, Energy and Non-Conventional Energy) as members. M.D., MPUVN will be the Member Convener of the Committee.

12 Registration fee

For large grid connected solar power projects, along with application, developer shall have to pay @ Rs. 50,000/- per megawatt as non-refundable registration fee. The maximum limit for registration fee shall be Rs 50 lakhs per project. The Board of MPUVN may change the registration fee from time to time. No change, however, will have any retrospective effect.

13 Migration of application under 2006- State policy to MP Solar Policy 2010

Under State policy of 2006, various applications have been received which can be clarified under following 3 categories:

(a): only application / proposal / DPR received.

(b): Registration fees received and registered

(c): MOU signed

The following procedure shall be followed to migrate the above category of cases into the new Policy:

Category (a) : these applicants shall have to apply afresh under the New Policy

Category (b) : Upon application by category B cases requesting migration to new policy 2010, they shall be deemed to be registered under the new policy and & new registration fees structure under the new policy and balance amount shall be refunded to them without interest.

Those category (B) cases who do not apply to migration to new policy within 60 days of its notification, shall be deemed to expire and then registration fees shall be confiscated

Category (c) : Considering the overall RPO for solar energy of State of Madhya Pradesh, the existing category (C) cases shall be considered for a maximum of 25MW projects under the new Policy up on their application. The registration fee adjustment shall be same as for category (B) cases.

14 Security Deposit

The large grid connected Solar project developer shall be required to provide a irrevocable Bank guarantee on any scheduled bank @ 30 lacs per MW at the time of signing of the Power Purchase Agreement (PPA) with the distribution licensee and in case the project developer fails to achieve the Commercial operation within time period as mentioned in the PPA, the Bank Guarantee shall be forfeited.

If the developer achieves the commercial operation within the time period mentioned in the PPA or extended as per the policy, the Bank Guarantee shall be refunded within 15 days of applying to the concerned distribution utility.

15 Minimum Equity to be held by the Promoter

The Company developing the large grid connected solar power project shall provide the information about the Promoters and their shareholding in the company to MPUVN indicating the controlling shareholding. No change in the shareholding in the Company developing the Solar Power Project shall be permitted from the date of submitting the application and till the execution of the PPA. This shall not be applicable to the Solar Power Projects developed by the public listed companies.

After execution of PPA, the controlling shareholding (controlling shareholding shall mean at least 26% of the voting rights) in the Company developing the project shall be maintained up to a period of (5) five year after commencement of commissioning of the project. Thereafter, any change may be undertaken only after permission of the MPUVN, who may charge fee as decided by the Board of MPUVN.

16. THER FACILITIES

(a) **Solar Technology Parks**

Solar technology parks for generation and manufacturing units in equipment & related ancillaries for solar systems shall be promoted and established at appropriate locations in the state of Madhya Pradesh. The MPUVN shall be the nodal agency for establishing the Solar technology parks. The SME sector will be promoted for manufacture of various components and systems for solar systems. The Solar technology parks will be given preference in land allocation and creating of essential facilities by the state government.

(b) Research & Development

A State level Solar Research Committee will be set up to oversee the strategy, taking into account ongoing projects, availability of research capabilities and resources and possibilities of international collaboration. The Committee will be under the chairmanship of P.S. (Non-Conventional Energy) in which M.D., MPUVN will be as Member-Secretary and representatives from other concerned Departments/institutions will be included.

(c) **Capacity Building & Awareness generation**

The MPUVN shall be responsible for capacity building & awareness generation aspects related to promotion of solar energy in the state. This may include:

Training for entrepreneurs, NGOs, managers, women on aspects related to the management of solar systems

Capacity building on technical operations of the systems systems to target potential technicians for operating and maintaining the solar systems

Focussing on business skills i.e., marketing, finance, accounting, billing and project development targeting NGOs, Community Based organisations and entrepreneurs

Creating awareness and educating masses on the adoption of solar energy sources

Encourage the schools, polytechnics, colleges and universities in the state to include importance of solar energy in the educational curricula

Conducting stakeholder conferences from time to time

The MPUVN may collaborate with state/national/international institutions or technical experts to undertake the capacity building and awareness generation activities.

(d) **Technical library & Data bank**
The MPUVN shall establish & maintain a technical library, a data bank and/or information centre and to collect and correlate information regarding solar energy sources. The MPUVN shall consistently update the information related to solar energy sources on website.

17 Clean Development Mechanism (CDM) benefits

The CDM benefits are proposed to be shared on a gross basis with the distribution licensee, as per GoI norms or equal (50:50) between the developers and the distribution licensee from day one. The distribution licensee shall pass on 10% of the CDM benefits from its share to the MPUVN.

18 Other incentives

Solar energy equipments and other items related to the equipments will be exempted from Entry Tax. This shall also be applicable for Rooftop PV/Small Power Generators of capacity less than 1 MW connected to grid and Off-grid applications.

Notwithstanding anything contained in this resolution, the provisions of the Electricity Act – 2003, and the MPERC order, as issued from time to time, shall prevail, for the purpose of the implementation of this policy. For Solar energy, this policy shall prevail over the "Incentive Policy for encouraging generation of power in Madhya Pradesh through Non-conventional Energy sources 2006".

This Policy shall come into effect from the date of issuance and shall remain effective until further orders.

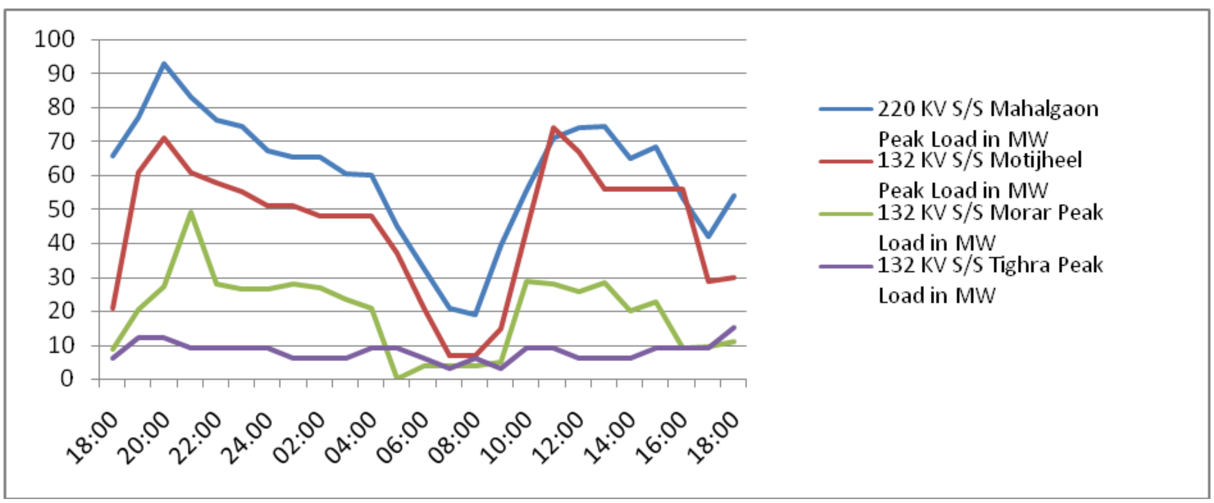
Annexure – 8

Load Variation of Gwalior City

Load Variation of EHV Sub Station Under Testing Dn. I MPPTCL Gwalior

		Name of Sub Station			
Date	Time	220 KV S/S Mahalgaon	132 KV S/S Motijheel	132 KV S/S Morar	132 KV S/S Tighra
		Peak Load in MW	Peak Load in MW	Peak Load in MW	Peak Load in MW
8.8.11	18:00	66	21	8.6	6
8.8.11	19:00	77	61	20.2	12
8.8.11	20:00	93	71	27	12

8.8.11	21:00	83	61	49	9
8.8.11	22:00	76.5	58	27.8	9
8.8.11	23:00	74.5	55	26.2	9
8.8.11	24.00	67.5	51	26.4	9
9.8.11	01:00	65.5	51	28	6
9.8.11	02:00	65.5	48	26.8	6
9.8.11	03:00	60.5	48	23.4	6
9.8.11	04:00	60	48	20.6	9
9.8.11	05:00	45	37		9
9.8.11	06:00	32.5	21	3.6	6
9.8.11	07:00	21	7	3.8	3
9.8.11	08:00	19	7	3.8	6
9.8.11	09:00	39.5	14.8	5	3
9.8.11	10:00	55.5	44	28.6	9
9.8.11	11:00	71	74	28	9
9.8.11	12:00	74	67	25.6	6
9.8.11	13:00	74.5	56	28.4	6
9.8.11	14:00	65	56	20	6
9.8.11	15:00	68.5	56	22.8	9
9.8.11	16:00	53.5	56	9.2	9
9.8.11	17:00	42	29	9.6	9
9.8.11	18:00	54	30	11	15



Annexure- 9

Solar PV Specifications

Electrical data - All data refers to STC (AM 1.5, 1000w/m², 25°C)

Type	ELV 190	ELV195	ELV 200	ELV 205	ELV 210
Nominal power Pmpp (0~+4.99Wp)	190 Wp	195 Wp	200 Wp	205 Wp	210 Wp
Nominal voltage Vmpp (V)	35.70	35.75	35.80	35.85	35.90
Nominal current Impp (A)	5.35	5.46	5.60	5.75	5.85
Open circuit voltage Voc (V)	43.90	43.95	44.00	44.05	44.10
Short circuit current Isc (A)	5.95	6.05	6.20	6.35	6.45
Module efficiency (%)	13.02	13.36	13.71	14.05	14.39

* Electrical Parameters tolerance ± 3% except Pmpp

Temperature coefficients (Tc) and permissible operating conditions

Tc of Open circuit voltage (β)	-0.32 % /°C
Tc of short circuit current (α)	0.04 % /°C
Tc of Power (γ)	-0.45 % /°C
Maximum system voltage	1000 V(TUV), 600V(UL)
NOCT	45°C ± 2°C
Temperature range	-40°C to + 85°C

* NOCT irridance 800 w/m², ambient temperature 20° C, wind speed 1 m/sec

Mechanical specification

Length	1486 ± 1.5mm
Width	982 ± 1.5mm
Height	36mm
Weight	15.5 Kgs
Junction Box	IP65, sunbolts / Tyco with 3 bypass diodes
Cable & Connectors	4mm², TUV & UL Certified, 1000 mm
Application class	CLASS A (Safety Class II)
Front cover	High Transmission, Low Iron, Tempered Glass
Cells	72 pcs Poly -Crystalline solar cells , 2BB & 3 BB
Cell encapsulation	EVA (Ethylene Vinyl Acetate)
Back cover	Composite film
Frame	Anodized aluminium frame with twin wall profile
Maximum surface load capacity	According to IEC 61215, 5400 Pa

Technical Specifications: For Inverter

TECHNICAL DETAILS

INVERTER				
Nominal Battery Voltage*	48V	96V	120V	240V
Nominal Capacity	3kVA	6kVA	10kVA	15kVA
Synchronized Voltage Range	230V ± 15%			
Synchronized Frequency Range	50Hz. ± 5%			
Efficiency	> 85%			
SOLAR CHARGE CONTROLLER				
Type	MPPT			
MPPT Charge Controller Range*	1 – 3KWp	4 – 6KWp	10 – 12KWp	15 – 20KWp
MPPT Range	60-130V_{mp}	120-230V_{mp}	150-250V_{mp}	300-450V_{mp}
Max. PV Voltage	170V ∝	300V ∝	320V ∝	600V ∝
MAINS CHARGER				
Input Voltage	230V ± 15%			
Input Frequency	50Hz. ± 5%			
OTHERS				
Display	Graphical Display with Keypad			
LED Indications	• Mains On • Alarm On • Buzzer Mute			
Protections	• Inverter Over voltage • Inverter Over Load • Inverter Over Temperature • PV Under / Over Voltage Cut-off • Battery Reverse Polarity Protection • Mains Under / Over Frequency		• Mains Under / Over Voltage • Battery Under Voltage • Short Circuit Protection • Surge Protection • Anti-Islanding	
Display Parameters	• Inverter Voltage & Current • Battery Voltage & Current • CO_2 Saved		• Mains Voltage & Current • PV-V, PV-KWhr. • Ambient Temp.	
Features	• Three stage battery charging for better battery life • Battery current limiting • Temp. compensation for VRLA type battery • Battery type supported – Lead Acid Tubular, VRLA, Ni-Cd. • Inbuilt data logging • GPRS mounting of all parameters			
Communication Type	RS-232 or RS-485 or GPRS (To be specified with order)			
Operating Temperature	0°C to 50°C			
Enclosure	IP-31, Wall mounted (upto 6KVA) / Floor standing indoor type			

Different voltage can also be offered.

*** Higher rating MPPT with different inverter rating can also be offered.**

Technical Specification – Module Mounting Structures	
Material	MS Galvanized
Overall dimension	As per design
Coating	Hot dip Galvanized with 80 micron thickness / aluminium painted for MS
Wind rating	150 km/hr
Tilt angle	Fixed angle, depends on the site
Foundation	PCC for roof top fixing
Hardware	SS 304 fasteners

Juntion boxes:

Technical	
Type	PV Insulated, sheath & UV resistance
Material	Copper
Voltage	Max. 1100V
Test Voltage	650V/1.1KV
Temperature	10 – 70 °C
Colour	Red/ Black / Green

Cables

Technical Specification –	
Type	PV Insulated, sheath & UV resistance
Material	Copper
Voltage	Max. 1100V
Test Voltage	650V/1.1KV
Temperature	10 – 70 °C
Colour	Red/ Black / Green