IMPACT OF RENEWABLE ENERGY IN DESERT DISTRICT OF RAJASTHAN

A DISSERTATION

Submitted in partial fulfillment of the requirements for the award of the degree of

MASTER OF TECHNOLOGY

in

ALTERNATE HYDRO ENERGY SYSTEMS

By

ILA DASHORA

ALTERNATE HYDRO ENERGY CENTRE
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE - 247 667 (INDIA)

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CANDIDATE'S DECLARATION

I hereby certify that the work which is presented in this dissertation, entitled, "RENEWABLE ENERGY IMPACT ASSESSMENT IN THE DESERT DISTRICT OF RAJASTHAN", **in partial fulfillment of the requirement for the award of the degree of** Master of Technology **in** "Alternate Hydro Energy Systems", **submitted in** Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee **is an authentic record of my own work carried out under the supervisions of** Dr. M. P. Sharma **(Associate Professor)** and Shri. M. K. Singhal, **Senior Scientific Officer,** Alternate Hydro Energy Centre, Indian Institute of Technology Roorkee.

I declare that the matter contained herein has not been submitted by me for the award of any other degree or diploma elsewhere

Date 30 June 2010

Place: Roorkee

(ILA DASHORA)

CERTIFICATE

This is certified that the above statement made by the candidate is correct to best of my knowledge.

Date: 30 June 2010
Place: Roorkee

30/6/10

(M. P. Sharma)
Associate Professor
Alternate Hydro Energy Centre
Indian Institute of Technology, Roorkee
Roorkee-247667

30/6/10

(M. K. Singhal)
Senior Scientific Officer
Alternate Hydro Energy Centre
Indian Institute of Technology Roorkee
Roorkee-247667

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Date: 30^{th} June

Place: Roorkee

Ila Dashora

ABSTRACT

Renewable energy sources have a large potential to contribute to the sustainable development of specific territories by providing them with a wide variety of socio-economic and environmental benefits. The present time puts much emphasis on the environmental benefits (including the reduction of global and local pollutants), while socio-economic impacts have not received a comparable attention. These include diversification of energy supply, enhanced regional and rural development opportunities, creation of a domestic industry and employment opportunities.. With the exception of the diversification and security of energy supply, these benefits have usually been mentioned, but their analysis has been too general and a focus on the regional and, even more so, the local level, has been lacking. At most, studies provide scattered evidence of some of those regional and local benefits, but without an integrated conceptual framework to analyse them.

The dissertation project "Impact of Renewable Energy in Desert District of Rajasthan" aims to impact assessment in the environmental impact assessment in two district of Rajasthan, Jodhpur and Jaisalmer.

Carbon emission reduction calculation using the resources available for the generation of and data collected commencing the site visit is processed out in effective manner for impact assessment has been enclosed in this dissertation thesis. The existing renewable energy projects of solar and wind power generation is a step toward the green energy production. The impact assessment is done with the help of Rapid Impact Assessment Matrix and Network Method.

Rapid Impact Assessment Matrix is a quantities approach and Network Method is a qualitative approach. RIAM is less time consuming whereas Network Method is a qualitative approach and lengthy and expensive too.

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LIST OF ABBRIVATIONS

J	Joule
CBCP	Central Board of Control Pollution
CSP	Cogeneration Solar Plant
EC	Environmental Clearances
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMP	Environmental Management Plan
EPA	Environmental Protection Act
G	Global Solar Potential
GBI	Grant Business Investment
GNP	Gross National Product
Govt.	Government
GW	Giga Watt (10^9)
ha	Hcctare
km	kilo meter
K_t	Cleanness Index
kWh	kilo Watt hour
m	meter
MJ	Mega Joule (10^6)
MoEF	Ministry of Forest and Environment
MoU	Memorandum of Understanding
MT	Metric Tonn
MW	Mega Watt
MWe	Mega Watt Equivalent
NEPA	National Environmental Policy Act
NOC	No Objection Certificate
PW	Peta Watt (10^{15})
RERC	Rajasthan Renewable Energy Corporation
RIAM	Rapid Impact Assessment Matrix
RPO	Renewable Purchase Obligation

S	Sunshine Hours
SPCB	State Pollution Control Board
TW	Tera Watt (10^{12})
TWh	Tera Watt hour
W	Watt
YJ	Yotta Joule (10^{24})

CHAPTER 1

INTRODUCTION

Current world requirement for the energy is increasing rapidly. The nuclear, coal and fossil fuels are the major source of the energy. The exploration of the fuel has so much increases that the fuel is about to finish in near few years. The option for the new era is shifting toward the renewable energy.

1.1 WORLD ENERGY RESOURCES AND CONSUMPTION

In 2008, total worldwide energy consumption was 474×10^{18} J with 80 to 90 % derived from the combustion of fossil fuels [1]. This is equivalent to an average power consumption rate of 1.504×10^{13} W. Most of the world's energy resources are from the sun's rays hitting earth. Sun is emitting energy in the range from 1412 W m^{-2} in early January to 1321 W m^{-2} in early July if the fluctuation is 6.9%. For the whole Earth, with a cross section of 127,400,000 km^2, the total energy rate is 1.740×10^{17} W, plus or minus 3.5%. The estimates of remaining non-renewable worldwide energy resources vary, with the remaining fossil fuels totalling an estimated 0.4 X 10^{24} J and the available nuclear fuel such as uranium exceeding 2.5 X 10^{24} J. Mostly thanks to the Sun, the world also has a renewable usable energy flux that exceeds 120 PW (8,000 times 2004 total usage), or 3.8 pp/yr, dwarfing all non-renewable resources

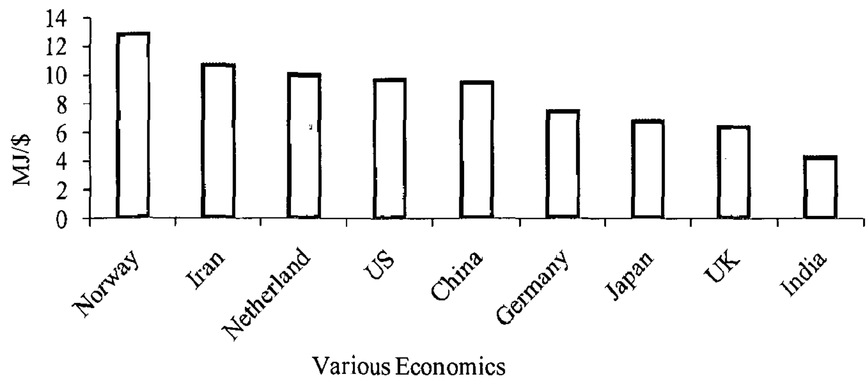


Figure 1.1: Energy intensity of different countries

The Figure 1.1 shows the ratio between energy usage and gross national product for selected countries. GNP is based on 2004 purchasing power parity and 2000 dollars adjusted for inflation [2]. This can be concluded from the above figure that India's energy use is far from the world's other developed countries including developing countries. The difference between the energy use in Norway and India is around 8.5 MJ/$ and the rising economy of China also uses 5.2 MJ/$ more energy than India. The average energy use is 9.28 MJ/$ and again if India has to cover this average, it has to cover 4.8 which is double of the present energy uses.

1.2 PRIMARY ENERGY CONSUMPTION

The United States Energy Information Administration regularly publishes a report on world consumption for most types of primary energy resources. The following Table 1.1 is showing the increment in the fuel consumption in different years. The

Table 1.1: Fuel consumption in the world [3]

Fuel type	**Average power in TW**		
	1980	**2004**	**2006**
Oil	4.38	5.58	5.74
Gas	1.80	3.45	3.61
Coal	2.34	3.87	4.27
Hydroelectric	0.599	0.933	0.995
Nuclear power	0.253	0.914	0.929
Renewable Energy	0.016	0.133	0.158
Total	**9.48**	**15.0**	**15.8**

1.2.1 FOSSIL FUELS

According to the US Energy Information Administration's 2006 estimate, the estimated 471.8 EJ total consumption in 2004 consist of fossil fuels supplying 86% of the world's energy. From 1965 to 2008, the use of fossil fuels has continued to grow and their share of the energy supply has increased. From 2003 to 2008, coal, which is one of the dirtiest sources of energy [4], was the fastest growing fossil fuel.

1.2.2 NUCLEAR POWER

The nuclear power production in 2006 accounted 2,658 TWh (23.3 EJ), which was 16% of world's total electricity production [5] and [6]. In November 2007, there were 439 operational nuclear reactors worldwide, with total capacity of 372,002 MWe. A further 33 were under construction, 94 reactors were planned and 222 reactors were proposed

RENEWABLE ENERGY

In 2004, renewable energy supplied around 7% of the world's energy consumption |. The renewable sector has been growing significantly since the last years of the 20th century, and in 2005 the total new investment was estimated to have been 38 billion US dollars. Germany and China invested of about 7 billion US dollars each, followed by the United States, Spain, Japan, and India. This resulted in an additional 35 GW of capacity addition during the year [8]. The Figure 1.2 gives the renewable energy generation in the world indicating the maximum energy is harnessed from the large and small hydro power plants.

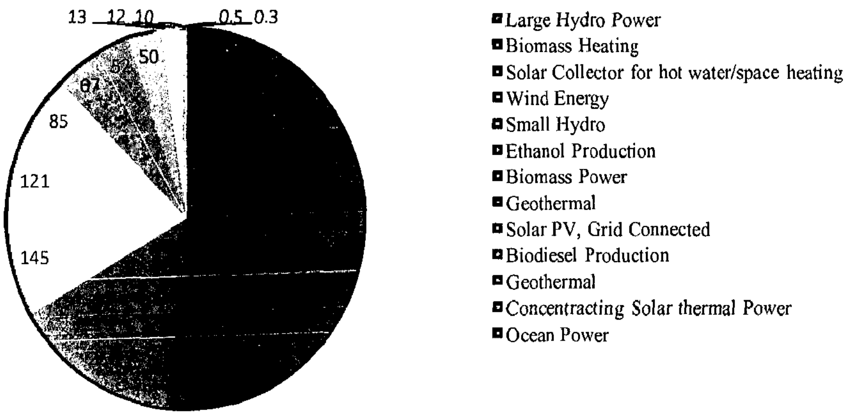


Figure 1.2: Renewable energy generations in year 2008 in the World [0]

The above figure displays that the maximum renewable energy generation is form the hydro power which takes the 57% of the renewable energy generation. Out of these, 5% generation is from small hydro power. The next generation is from the biomass heating. The most percentage of the biomass consumption is in South East Asia. The least production is from geothermal, ocean power and solar thermal. The research is going on these sectors of energy production. Now a day the wind energy production is increasing rapidly. [9]

1.3.1 Hydropower

Worldwide hydroelectricity consumption reached 816 GW in 2005, consisting of 750 GW of large plants, and 66 GW of small hydro installations. Small hydro is having least environmental impact. Large hydro capacity totalling 10.9 GW was added by China, Brazil and India during the year, but there was a much faster growth (8%) in small hydro, with

5 GW added, mostly in China where some 58% of the world's small hydro plants are now located.

1.3.2 Biomass and Bio Fuels

Electricity produced from biomass sources was estimated at 44 GW for 2005. Biomass electricity generation increased by over 100% in Germany, Hungary, the Netherlands, Poland and Spain. A further 220 GW was used for heating (in 2004), bringing the total energy consumed from biomass to around 264 GW. The use of biomass fires for cooking is excluded [8] World production of bio ethanol increased by 8% in 2005 to reach 33 billion liters (8.72 billion US gallons), with most of the increase in the United States, bringing it level to the levels of consumption in Brazil [8].

1.3.3 Wind Power

According to the World Wind Energy Association, the installed capacity of wind power increased by 29 % from the end of 2007 to the end of 2008 to total 121 GW, with over half the increase in the United States, Spain and China [10]. Doubling of capacity took about three years. The total installed capacity is approximately three to eight times that of the actual average power produced as the nominal capacity represents peak output; actual capacity is generally from 13-40% [110] of the nominal capacity [12].

1.3.4 Solar Power

The available solar energy resources are 3.8 YJ/yr (120,000 TW). Less than 0.02% of available resources are sufficient to entirely replace fossil fuels and nuclear power as an energy source. In 2007 grid-connected photovoltaic electricity was the fastest growing energy source, with installations of all photovoltaic increasing by 83% in 2009 to bring the total installed capacity to 15 GW. Nearly half of the increase was in Germany, which is now the world's largest consumer of photovoltaic electricity followed by Japan.

1.3.5 Geothermal

Geothermal energy is used commercially in over 70 countries [130]. In the year 2004, 200 PJ (57 TWh) of electricity was generated from geothermal resources, and an additional 270 PJ of geothermal energy was used directly, mostly for space heating. In 2007, the world had a global capacity for 10 GW of electricity generation and an additional 28 GW of direct heating, including extraction by geothermal heat pumps [14].

1.3.6 Sector wise energy consumption

Industrial users (agriculture, mining, manufacturing, and construction) consume about 37% of the total 15 TW. Personal and commercial transportation consumes 20%; residential heating, lighting, and appliances use 11%; and commercial uses (lighting, heating and cooling of commercial buildings, and provision of water and sewer services) amount to 5% of the total [15].

The other 27% of the world's energy is lost in energy transmission and generation. In 2005, global electricity consumption averaged 2 TW. The energy rate used to generate 2 TW of electricity is approximately 5 TW, as the efficiency of a typical existing power plant is around 38% [16]. The new generation of gas-fired plants reaches a substantially higher efficiency of 55%. Coal is the most common fuel for the world's electricity plants [17].

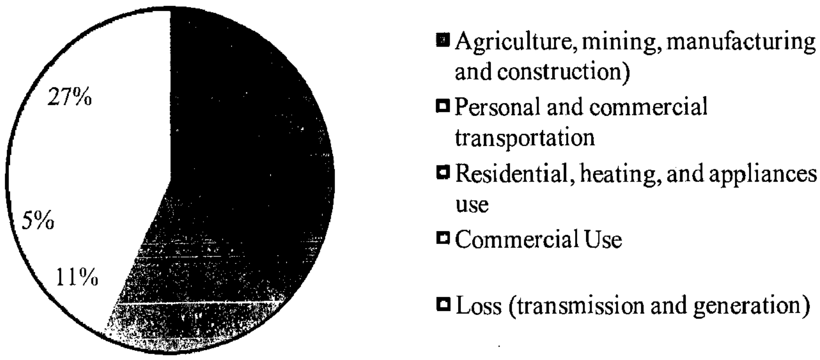


Figure 1.3: Sector Wise Global Energy Consumption (%) in year 2008 [15]

The above figure shows the world energy consumption according to the various sectors. The maximum consumption is in the agriculture, mining, manufacturing and construction work. This diagram shows that the 27% of the total energy is lost in the generation and transmission. The new technology is to develop to reduce these loosed so that this energy can be utilized. The second largest sector for the energy consumption is personal and commercial transport. This shows the increment in the industrialization.

1.4 INDIAN POWER SCENARIO

India is world's 6th largest energy consumer, accounting for 3.4% of global energy consumption. Due to India's economic growth, the demand for energy has grown at an average of 3.6% per annum over the past 30 years [18]. In December 2010, the installed power generation capacity of India stood at 156092.23 MW [19] while the per capita power consumption stood at 704.2 kWh [20]. The country's annual power production increased from about 190 billion kWh in 1986 to more than 572 billion kWh in 2009 [21]. The Indian government has set an ambitious target to add approximately 78,000 MW of installed generation capacity by 2012 [22]. The total demand for electricity in India is expected to cross 950,000 MW by 2030 [23].

The figure 1.4 gives that about 52% of the electricity consumed in India is generated by thermal power plants, 23.6 % by hydroelectric power plants and 2.6% by nuclear power plants [24]. More than 50% of India's commercial energy demand is met through the country's vast coal reserves [18]. The country has also invested heavily in recent years on renewable sources of energy such as wind energy [25]. As of 2008, India's installed wind power generation capacity stood at 9587.14 MW [27]. Additionally, India has committed massive amount of funds for the construction of various nuclear reactors which would generate at least 30,000 MW [27]. In July 2009, India unveiled a $19 billion plan to produce 20,000 MW of solar power by 2020 [28].

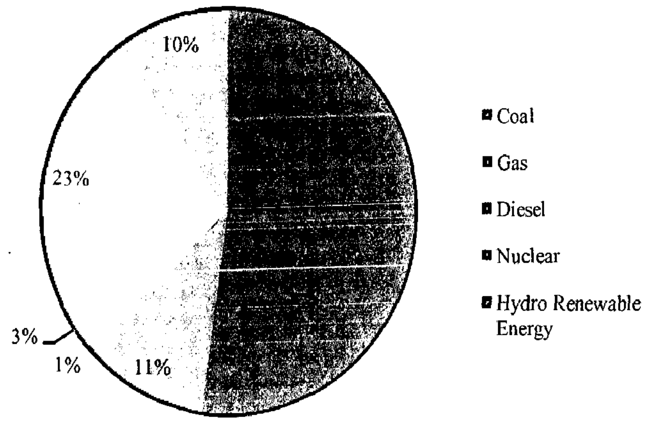


Figure 1.4: Installed Generation Capacity (As on 31-12-09) [29]

1.5 RENEWABLE ENERGY IN INDIA

While fossil fuels and hydro-electricity will continue to play a dominant role in the Indian energy scenario in the next few decades, conventional energy resources like as coal, oil, and natural gas are limited and non-renewable also not environmental friendly due to the environmental emission. On the other hand, renewable energy resources are indigenous, non-polluting and virtually inexhaustible sources of energy. India, being a tropical country, enjoys their abundance. Table 1.2gives the status of renewable energy in India and achievement made as on 2010.

Table 1.2: Renewable energy in Indian scenario [30]

No.	Sources / Systems	Achievements (MW)during 2009-10	Cumulative Achievements (MW) 2009-10
I. Power From Renewable (MW)			
A. Grid-interactive renewable power			
1.	Biomass Power (Agro residues)	153.30	865.60
2.	Wind Power	1565.00	11807.00
3.	Small Hydro Power (up to 25 MW)	305.27	2735.42
4.	Cogeneration-bagasse	295.30	1334.03
5.	Waste to Energy	4.72	64.96
6.	Solar Power	8.15	10.28
	Sub Total (in MW) (A)	**2330.42**	**16817.29**
B. Off-Grid/Distributed Renewable Power (including Captive/CHP Plants) (MW)			
7	Biomass Power / Cogen.(non-bagasse)	50.80	232.17
8.	Biomass Gasifier (MWeq.)	13.28	122.14
9.	Waste-to- Energy (MWeq.)	15.88	46.72
10.	Solar PV Power Plants (MWp)	0.16	2.46
11.	Aero-Generators/Hybrid Systems (MW)	0.22	1.07
	Sub Total (B)	**80.34 MWeq**	**404.56 MWeq**
	Total (A + B)	**2410.76 MW**	**17221.86 MW**
II.	**Remote Village Electrification**	1013 Villages & Hamlets	5348 villages / 1408 hamlets
III. Decentralized Energy Systems			
12.	Family Type Biogas Plants	1.06 lakh	42.40 lakh
13.	SPV Home Lighting System	72,886 nos.	5,83,429 nos.
14.	Solar Lantern	82,999 nos.	7,92,285 nos.
15.	SPV Street Lighting System	8680 nos.	88,297 nos.
16.	SPV Pumps	106 nos.	7,334 nos.
17.	Solar Water Heating - Collector Area	0.62 Mln. sq.m.	3.53 Mln. sq.m.

Although the potential is based on surplus agro-residues, in practice there are several barriers in collection and transportation of such agro-residues to the generation site and biomass power generation units prefer to use fuel-wood for techno-economic reasons. A potential of 45,000 MW_e from around 20mha of wastelands assumed to be yielding

10MT/ha/annum of woody biomass having 4000 k-cal/kg with system efficiency of 30% and 75% PLF has not been taken into account. In order to realize this potential a major inter-Ministerial initiative involving, among others, Environment & Forests, Agriculture, Rural Development, and Panchayati Raj would be required. Further, a Biomass Atlas is under preparation which is expected to more accurately assess state-wise renewable energy potential from agro-residues.

Potential based on areas having wind power density greater than 200 W/m^2 assuming land availability in potential areas @ 1 per cent and requirement of wind farms @ 12 ha/MW, not all of which may be technically feasible for grid-interactive wind power. In line with international practice for setting up grid-interactive wind power systems on sites having greater than 300 W / m^2, potential would be 5000 MW. Further, preliminary surveys do not at this juncture suggest a sizeable grid-interactive off-shore wind power potential.

Technically feasible and economically viable hydro potential is generally accepted at 40% of the total estimated potential. Accordingly, the technically feasible and economically viable small hydropower potential could be around 6000MW.

With new sugar mills and modernization of existing ones, technically feasible potential is assessed at 5000 MWe, not all of which may be economically viable. Furthermore, several sugar companies/cooperatives are unable to develop bankable projects on account of their financial and liquidity positions.

With expansion of urban population post census 2001, current technically feasible municipal waste-to-energy potential is assessed at 1700 MWe, not all of which may be economically viable. However, subsidy disbursement under the municipal waste to energy programme had been kept in abeyance on the orders of the Supreme Court in the case of a PIL, in May 2005. This stay has now been vacated for setting up 5 pilot projects.

Not all of this renewable energy potential may be suitable for grid-interactive power for technical and / or economic reasons. Further, estimate excludes potential for solar power which is dependent on future developments that might make solar technology cost-competitive for grid-interactive power generation application

1.5.1 Solar Energy

India receives solar energy equivalent to over 5,000 trillion kWh per year from 4 -7 kWh per square meter solar radiation. The annual average global solar radiation on horizontal surface, incident over India is about 5.5 kWh per square meter per day for 300 clear sunny days. Remote part of the country where grid connection is not available solar energy can replace four to five million diesel powered water pumps, each consuming about 3.5 kilowatts, and off-grid lighting. Some large projects have been proposed, and a 35,000 km^2 area of the Thar Desert has been set aside for solar power projects, sufficient to generate 700 to 2,100 giga watts.

In July 2009, India unveiled a $19 billion plan, Jawaharlal Nehru National Solar Mission, to produce 20 GW of solar power by 2020 [31]. Under the plan, solar-powered equipment and applications would be mandatory in all government buildings including hospitals and hotels [32]. 18 November 2009, it was reported that India is ready to launch its Solar Mission (Jawaharlal Nehru National Solar Mission) under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013 [33]. Table 1.3 shows the installed capacity of solar energy in India

Table 1.3: Installed capacity of the solar power in India [34]

Particulars	**Installed capacity**
Number of solar street lighting systems	55,795
Number of home lighting systems	342,607
Solar lanterns	560,295
Solar photovoltaic power plants	1566 kW
Solar water heating systems	140 km^2 of collector area
Box-type solar cookers	575,000
Solar photovoltaic pumps	6,818

Above table 1.3 shows the installation capacity of the solar projects. The amount of solar energy produced in India is merely 0.4% compared to other energy resources [34]. The Grid-interactive solar power as of June 2007 was merely 2.12 MW [35]. Government-funded solar energy in India only accounted for approximately 6.4 megawatt-years of power as of 2005 [34]. However, as of October 2009, India is currently ranked number one along with the United States in terms of installed Solar Power generation capacity [36].

1.5.2 Wind Power Programme [37]

The broad based Wind Power Programme of the Ministry aims to catalyse commercialisation of grid interactive wind power. The Wind Resource Assessment Programme has so far covered 25 States and Union Territories involving establishment of 1050 wind monitoring and wind mapping stations. The cost of setting up a wind monitoring station is shared between Central and State Governments in ratio of 80:20 whereas it is 90:10 for the North Eastern Region and hilly States. **233 potential sites** have been identified in the country [38]. The Potential for wind power generation for grid interaction has been estimated at about 48,500 MW taking sites having wind power density greater than 250/W sq. m at 50 m hub-height with 3% land availability in potential areas for setting up wind farms @12 ha/MW. The table 1.4 shows the yearly wise generation in the various states of the India. Initially the generation was highest in Tamil Nadu. But in next year it come to no generation point. Again the rapid increase in the generation in Tamil Nadu and Maharashtra. Now a day the utmost generation in Tamil Nadu. Then Gujarat and Karnataka takes place.

Table 1.4: Yearly wind generation (MW) in India [39]

State	Upto March 2002	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	Total
Andhra Pradesh	93.2	0.0	6.2	21.8	0.45	0.80	0.0	0.0	122.45
Gujarat	181.4	6.2	28.9	51.5	84.60	283.95	616.36	179.80	1432.71
Karnataka	69.3	55.6	84.9	201.5	143.80	265.95	190.30	173.10	1184.45
Kerala	2.0	0.0	0.0	0.0	0.0	0.0	8.50	12.50	23.00
Madhya Pradesh	23.2	0.0	0.0	6.3	11.40	16.40	130.39	0.0	187.69
Maharashtra	400.3	2.0	6.2	48.8	545.10	485.30	268.15	82.00	1837.85
Rajasthan	16.1	44.6	117.8	106.3	73.27	111.75	68.95	132.20	670.97
Tamil Nadu	877.0	133.6	371.2	675.5	857.55	577.90	380.67	250.30	4123.72
West Bengal	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.10
Others	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.20
Total	**1666.8**	**242.0**	**615.2**	**1111.7**	**1716.17**	**1742.05**	**1663.32**	**829.90**	**9587.14**

1.5.3 Small Hydro Power Programme [40]

Hydropower is a renewable, non-polluting and environmentally benign source of energy. Out of the total power generation installed capacity of 156092 MW (December, 2009) in the country, hydro power contributes about 23% i.e. 36,885 MW.

An estimated potential of about 15,000 MW of small hydro power projects exists in India. Ministry of New and Renewable Energy has created a database of potential sites of small hydro and 5,415 potential sites with an aggregate capacity of 14,305.47 MW for projects up to 25 MW capacity have been identified. During the 10th Plan, Following have been year-wise capacity addition from SHP projects. A target of adding 1400 MW during the 11th Plan (2007-2012) has been fixed.

The Table 1.5 portraits the overview of small hydro programme in India. The installation capacity is increasing as the years go. In the years 2007-08 and 2008-09 the installation is increased rapidly. Government is also promoting the renewable energy projects by giving subsidy.

Table 1.5: Installed small hydro capacities

Year	Target (in MW)	Capacity addition during the year (in MW)	Cumulative SHP installed capacity (in MW)
2002-03	80	80.39	1519.28
2003-04	80	84.04	1603.32
2004-05	100	102.31	1705.63
2005-06	130	120.80	1826.43
2006-07	160	149.16	1975.59
2007-08	200	205.25	2180.84
2008-09	250	248.93	2429.77

1.5.4 Biomass

Biomass materials successfully used for power generation include bagasse, rice husk, straw, cotton stalk, coconut shells, Soya husk, de-oiled cakes, coffee waste, jute wastes, groundnut shells, saw dust etc. The technologies being promoted include combustion/ cogeneration and gasification either for power in captive or grid connected modes or for heat applications.The current availability of biomass in India is estimated at about 500 millions metric tones per year. Studies sponsored by the Ministry has estimated surplus biomass availability at about 120 – 150 million metric tones per annum covering agricultural and forestry residues corresponding to a potential of about 16,000 MW. This apart, about 5,000 MW additional powers could be generated through bagasse based cogeneration in the country's 550 Sugar mills, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them. [41]

1.5.5 Energy Recovery from Urban Wastes

According to a recent estimate, about 42 million tonnes of solid waste (1.15 lacs tonnes per day) and 6000 million cubic meters of liquid waste are generated every year by our urban population. Three projects for energy recovery from Municipal Solid Wastes with an aggregate capacity of 17.6 MW have been installed at Hyderabad, Vijayawada and

Lucknow. Other urban waste projects include a 1 MW project based on cattle manure at Haebowal, Ludhiana; a 0.5 MW project for generation of power from biogas at sewage treatment plant at Surat; a 150 kW plant for vegetable market and slaughterhouse wastes at Vijayawada; and a 400 kWeq. Plant for production of biogas from slaughterhouse wastes at M/s Alkabeer Exports Ltd., Medak, A.P. Another 300 kW project based on vegetable market waste is under commissioning at Chennai. In all Total of 8 Projects for energy recovery from urban wastes with an aggregate capacity of 19.05 MWeq. have so far been set up in the country. [42]

1.6 LITERATURE REVIEW

McHarg [43] showed a comprehensive highway route-selection method. His approach is a system employing transparencies of environmental characteristics overlaid on a regional base map. Eleven to sixteen environmental and land-use characteristics are mapped. The maps represent three levels of the characteristics, based upon 'compatibility with the highway'. These references do not indicate how this compatibility is to be determined but available documentation is cited. The value of this approach is in screening alternative project sites or routes. Within this limited field, it is applicable to a variety of project types. Resource requirements of the McHarg approach are not too demanding, in terms of data, because information is not directly quantified, only categorized into three levels. High degrees of skill and training are required, however, to prepare the map overlays. The approach seems most useful as a 'first-cut method' of identifying and sifting alternative project sites, preliminary to detailed impact analysis.

Leopold [44] showed A Procedure for Evaluating Environmental Impact: This is an open-cell matrix approach identifying 100 project activities and 88 environmental characteristics or conditions. For each action involved in a project, the analyst evaluates the impact on every environmental characteristic in terms of impact magnitude and significance. These evaluations are subjectively determined by the analyst. Ecological and physical-chemical impacts are treated comprehensively, social and indirect impacts are less well handled, and economic and secondary impacts are not considered. Because the assessments are subjective, resource requirements are very flexible; the approach was not developed in reference to any specific type of project and may be broadly applied with some alterations.

Sorensen [45] illustrated a flow-chart approach suitable for EIA was declared by. The approach is not a full system but rather a guide to the identification of impacts. Several potential uses of the California coastal zone are examined with flow-charts, relating uses: (a) to causal factors (project activities; (b) to first order changes; (c) to second. and third-order changes; and finally (d) to effects. The major strength of the approach is its ability to identify the pathways by which both primary and secondary environmental impacts are produced. The second research indicated the types of data relevant to each identified effect, though no specific measurable indicators are suggested. In this reference, some general criteria for identifying projects of regional significance are suggested, based on project size and types of impacts generated, particularly land-use impacts.

Krauskopf and Bunde [46] presented Evaluation of environmental impact through a computer modelling process. This approach employs an overlay technique *via* computer mapping. Data on a large number of environmental characteristics are collected and stored in the computer on a grid system of 1 km^2 cells. Highway route alternatives can either be evaluated by the computer (by noting the impacts on the cells) or may be generated *via* a program identifying the route of least impact.

US Bureau of Reclamation [47] reported the checklist procedure for quantitative assessment of impacts with 78 specific environmental parameters defined within the four categories of ecology, environmental pollution, aesthetics, and human interest. The approach does not deal with economic or secondary impacts; social impacts are only partially covered within the human interest category. Impacts were measured *via* specific indicators and formulas defined for each parameter. Parameter measurements are converted to a common base of 'environmental quality units' through specified graphs or value functions. Impacts can be aggregated using a set of preassigned weights. The resource requirements are rather high, particularly data requirements. These requirements probably restrict the use of the approach to assessments of major projects.

Stover [48] developed a checklist procedure for a general quantitative evaluation of environmental impacts from development activities. The type and range of these activities is not specified, but is believed to be comprehensive. Fifty different impact parameters are sufficient to include most possible effects, and thereby allow much flexibility. Sub-parameters indicate specific impacts, but there is no indication of how the individual measures are aggregated into a single parameter value. While spatial differences in impacts are not indicated, both initial and future impacts are included and explicitly compared. Resource requirements are moderate to heavy. The impact criteria are only partially quantitative, with seven possible values ranging from an extremely beneficial impact to an extremely detrimental one. Therefore, there is potential for ambiguous and subjective results, with only moderate replicability. Impact areas are implicitly assumed to be of equal importance. A specific method is mentioned for choosing the optimum alternative in terms of benefits and adverse effects. The procedure for comparison of alternatives may be the most interesting aspect of the procedure, with results given in terms of the proportional significance of an impact *vis-à-vis* other alternatives. There is no explicit mention of either public involvement in the process, or environmental risks.

Planning Methodology for Water Quality Management [49] was used for impact assessment defies ready classification since it contains elements of checklist, matrix, and other approaches. Areas of possible impacts are defined by a hierarchical system of 4 categories (ecology, physical/chemical, and aesthetic, social), 19 components, and 64 parameters. An inter-action matrix is presented to indicate which activities associated with water-quality treatment projects generally impact which parameters. The range of parameters is comprehensive, excluding only economic variables.
Impact measurement incorporates two important elements. A set of 'ranges' is specified for each parameter to express impact magnitude on a scale from zero to one. The ranges assigned to each parameter within a component are then combined by means of an 'environmental assessment tree' into a summary environmental impact score for that component. The significance of inputs on each component is quantified by a set of assigned weights. A net impact can be obtained for any alternative by multiplying each component score by its weight factor and summing across components.

Dee et al [50] presented an assessment of the usage of environmental assessment methodologies in environmental impact statements. The Environmental impact assessment methodologies have been designed to identify, integrate, and interpret environmental impacts resulting from federally funded and/or regulated projects. At the present time, these methodologies are largely ignored by practitioners involved in preparing impact statements. Three reasons have been identified for their non-use: (1) different perspectives on the role of EIS held by the methodology developers and practitioners, (2) the limited direction provided by administrative guidelines related to EIS implementation, and (3) the pressures initiated by the political arena. These methodologies will be incorporated into the EIS process when they are (1) responsive to the needs of the preparer, (2) perceived by the EIS actors such as CEQ and proponent agencies to yield more superior information, and (3) required by CEQ or the proponent agencies. (Authors' abstract)

Assessment of Major Industrial Applications was carried out by Clark et al [51]. In which the hydrological aspects of major development applications were developed like landscape character assessment for the appraisal of major development applications. Method for determining the zone of visual influence of a proposed industrial installation. Approach to assessing ecological impacts. Framework for estimating the impact of a proposed industrial development on local employment. Method for estimating immigrant flow arising from a proposed industrial development. Transport considerations in the appraisal of major development applications. Method for assessing the impact of airborne emissions from industrial installations. Water pollution considerations in the assessment of major industrial applications. Assessment of the impact of noise and vibration from proposed industrial installations.

Developed a computer model was decleartion by Rabinovich [52] to analyse the possible impact. A point model simulates the dynamics of water, using seven mathematical functions describing five key processes: rain interception by the forest, water infiltration in the soil, evapotranspiration, percolation, and erosion. The inputs and outputs of the point model were produced dividing the watershed into a grid of 40 contiguous cells of 55 by 55 km; in every cell, the point model was applied, using the day as the time unit. The daily superficial and sub-superficial run-offs produced by the point model were integrated in time and space, applying time-lags estimated from cross-correlations between rain and river flow series. In addition to the physical-biological point model, the GURI model also considers the economic aspects of the region. A timber sub-routine estimated the profits from wood extraction activities; an agricultural sub-routine estimated the profits from corn, manioc, and bovine cattle; and another sub-routine considered the profits of the hydroelectric activities. All profits were accumulated during the 50 year simulation period, at an 8% discount rate.
Due to the character of the potential conflict of interests existing in the area, two types of actions were evaluated as possible environmental interventions: the rate of timber exploitation and the proportion of the area exploited for timber that is turned into agricultural production. Both actions were implemented at five different levels of intensity, producing a total of 25 intervention strategies; for each of them, the GURI model was processed during 50 simulated years. The physical, biological, and economic results of the simulation model were analysed for different time horizons, and the output was compressed to facilitate its use by administrators in decision-making by means of Peterman's desk-top optimisation method, which involved the isoline representation of the output.

The results show that as the time horizon used for planning increases, profits can still be maximized, but at the expense of a lower environmental degradation. The desk-top optimisation process showed the decision actions that could be made depending upon the environmental degradation constraints used by the administrator. With a low permissible ecological deterioration value (10-20%), the decision would be: extract any amount of wood, but no agriculture should be allowed; with higher permissible environmental degradation (30-50%), the decision would be: minimize the extraction of wood, and allow agriculture to use about 50-60% of the area affected by wood extraction.

Duke at el [53] determined the environmental effects of water resource project alternatives which are consistent with the Principles and Standards proposed by the US Water Resources Council. The methodology is structured as a checklist of factors describing biological resources, physical resources, human resources, human enjoyment/recreation - water, and human enjoyment/recreation-land. The key feature of the methodology is to focus on the significant environmental factors of a project. A screening procedure is employed to reduce the large number of factors to the most important ones. Guidelines for determining the importance of a factor are also developed as part of the methodology. The approach addresses many of the shortcomings of existing methodologies. It is designed to focus on key environmental elements, to be used by regional staff, and to maintain measurement data throughout the evaluation. It does not use weightings or indices in the evaluation process.

Matthews [54] analysed the environmental impacts, and descriptions of methodologies for conducting them, have not always been explicitly cognizant of the subjective value judgements that must be made in the process of collecting, refining, assessing, and presenting objective scientific information. He outlined the types of objective and subjective judgements that are made in each of the following major steps of the analysis: identifying major activities; selecting environmental components; selecting types of impacts; assessing the possibilities and/or probabilities of occurrences; determining the degree of the impacts; determining the time frame of impacts; designating impacts as positive, neutral, or negative; and determining trade-offs among activities and impacts.

The subjective judgements that must be made are based on values, feelings, beliefs, and prejudices, and are functions of the personal, institutional, professional, and societal contexts of the analyst. If great care is not taken in making these judgements, and in making very explicit the value framework used, the effectiveness and credibility of the analyst may be sharply reduced. There is also the danger that society and its decision-makers will be presented with an analysis having so many built-in biases that the legitimate role of the decision-makers in assessing the analysis and then making important value trade-offs is seriously compromised.

Gevirtz and Rowe [55] developed a method is presented which combines environmental indices and estimates the, inputs from various land uses to aid in environmental impact assessments. Unweighted pair/group cluster analyses are used to obtain relationships between easily observable environmental indices, such as vegetation types, soils, and geology, based on their mutual recurrence. These relationships are shown by using an ordination technique which shows the nature of complex impacts on a natural system. Results are used to develop an *environmental effects sequence diagram* based on known scientific and engineering principles and observed natural relationships. The diagram may be used in conjunction with land-use data to estimate the possible magnitude of impacts on the pre-existing system which may result from such land use. Several examples are developed which quantify inputs from various land uses and which compare them with environmental inputs including point source and non-point source liquid and atmospheric emissions, land modifications, and resource consumption. Known average values are used and a separate comparison is made in describing the vast differences between the project phases of construction *versus* long-term operation. A hypothetical environmental impact assessment is given for a small residential development in Chambers County, Texas, USA.

Hartje and Dierkes, [57] discussed the role public participation in the siting procedure for two planned nuclear power plants in Wyhl and Ludwigshafen (West Germany) and analyse the factors that led to opposition (Wyhl) and indifference (Ludwigshafen) of the local public towards the project, and it examines the role of citizen groups during this process. It was concluded that the legislative legitimation of siting decisions is not sufficient in view of the dominance of administrative bureaucrative processes. Thus, direct mechanisms for local participation are needed, even at the expense of a delay or change of the federal energy programme. (Author's abstract)

Allende [58] evaluated the siting of nucler power plants in Basque (Spain). The location was proposed for three nuclear power plants with a generation capacity of 10,000 MW along 50 km of the densely populated Spanish State that raised a scenario controversy with strong environmental, planning, and political connotations. It was observed that Basque people reacted against the project due to threat to their health and security, natural resources and their historical identity.

1.7 OBJECTIVES OF THE STUDY

The above literature review shows the development of the impact assessment techniques for impact assessment These methods were developed according to case to case basis and give accurate results give accurate results if the methods applied to related projects. project. Using these basic methods various other methods and software has been developed. Using the advance method RIAM and Network analysis impact of the renewable energy is identified.

The objective of the study is to selsect an study area in desert district of Rajasthan to study the input of renewable energy technology on the environmental aspect of the people of the area Jodhpur and Jaisalmer. The assessment of renewable energy projects in these district are identified and only wind and solar systems are in places.

1.8 ORGANIZATION OF THESIS

This report contains the entire work on the impact assessment in five chapters. The first chapter is the introductory part of the world's energy consumption and the consumption pattern in India. The chapter also contains the renewable energy scenario regarding to the generation is the world's as well as in India. This chapter points toward the position of India in the world in the area of power generation and power consumption. The chapter also discuss toward the literature about the work that has been done previously for the implementation of the work and

In chapter 2 methodology for the impact assessment is described. The chapter also contains the methodology of the various impact assessment methods. Methodology of impact assessment, by Rapid Impact Assessment Matrix and Network method is detailed in this portion. This chapter also has the introduction of the baseline for the clean development mechanism. It is taken from the guideline issued from the central electricity authority.

The next chapter 3 reports the assessment of renewable energy projects like wind and solar energy projects.

Chapter 4 gives the detail of major work done for the impact assessment. And the data collection through the site visit and questioner. For the data collection various methods were applied like meeting with the villagers and the questioner and, the data collected from the Project Officer of the solar and the wind energy project in both the district.

The chapter 5 shows the result and the discussion and chapter 6 conclusion and recommendation.

CHAPTER 2

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

2.1 INTRODUCTION

As the development is taking place it is also affecting the environment. Changing life styles, increasing pace of urbanization, industrialization and infrastructure development have caused environmental pollution and degradation[60]. To stop this type of fearsome development, some legal or scientific measures are necessary. EIA is such a tool that integrates the environment factor with development planning.

Environmental Impact Assessment (EIA) is a techno-managerial process that is based on the Precautionary Principle. In this process the impacts of the development is forecasted before the process is in scientific principle. Then the impact assessment is allowed on the basis of magnitude, nature and duration of impacts.

2.2 GENESIS OF EIA

The term Environmental Impact Assessment (EIA) originated when the National Environmental Policy Act (NEPA) was framed in the United States of America (USA) in November/December 1969 [61]. The EIA was a major success in the USA and the practice slowly spread to other countries such as Singapore (1972), Japan (1972), Canada(1973), Australia(1974), West Germany(1975), France(1976), China(1979), Indonesia(1982), Spain (1986), New Zeland(1991) etc. In 1985, EC Directive (85/337) made EIA mandatory in certain circumstances and more uniformly applied throughout Europe. Countries throughout the world adopted this phenomenon and some agencies like World Bank, Asia Development Bank has their own guidelines for EIA.

In India, the first EIA was ordered, during early 1980s, on the Silent river valley hydroelectric project [62] and [63]. This project, proposed by the Kerala State Electricity Board (KSEB) to build a 130 m high dam across the Kuntipuzha River and a reservoir, was considered a big threat to the biodiversity and forest ecosystem of the Silent valley. Later in 1985, the project was abandoned and Silent Valley was declared as a national park. After this case EIA make a new beginning in India and EIA was extended to other activities. However, EIA was introduced in 1994, when MoEF passed an EIA notification under Environmental Protection Act (EPA), 1986, which made EIA mandatory for 29 highly polluting activities and later on three more activities were added to this list. [64]

The environmental clearances (EC) process is also subjected to the stipulated standards in the Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Noise Pollution (Regulation and Control) Rules, 2000, to provide prescribed limit of the pollutants which a particular activity may release to the environment. The Hazardous Wastes (Management and Handling) Rules, 1989 and Forest (Conservation) Act, 1980, are the other major acts that have bearings on EC practice.

In addition, state governments may have stringent regulations based on their local conditions, but these should be consistent with national laws, regulations and standards.

2.3 CRITERIA FOR CARRING OUT EIA

As per the notification [65] EIA is necessary in India for the following 29 development projects and industries given in the annex 1. These industries should carry out EIA and based on the EIA report (called EIS) would be issued environmental clearance. This list was approved on 27th January 1994 and continued 10 years after the approval. But major amendment was made in 2004. It was added that any building with a cost of construction over 50 crores would need to get environmental clearance after performing EIA. Thus in our country, EIA is necessary for any project whose cost of construction is above Rs. 50 crore and for the above 29 projects, irrespective of their cost [65]. The list of the List of projects requiring environmental clearance from the central government is mentioned in Annex 1

2.4 EIA PROCESS

The whole process of environmental clearance involves many ministries and departments [66].The process starts when project proponent applies for no objection certificate to respective state pollution control boards or other local authorities (i.e., Delhi Pollution Control Committee in Delhi). Site clearance is required for some of the activities i.e., mining, prospecting and exploration of major minerals, pithead thermal power plants, multipurpose river valley projects and major ports and harbours. Consents from airport authority and state forest departments are also considered necessary if any airport is nearby and project involving any forestland respectively. Once the project proponent receives all the approvals, he submits an application to MoEF for environmental clearance.[67]

EIA process in India involves three basic steps—(a) preparation of the EIA report, involving scoping to documentation, (b) review and decision-making and (c) post project monitoring [68]. An EIA process can be divided into 7 distinct stages namely.

2.4.1 Screening

Screening determines whether EIA is required or not. In India, 32 activities listed in schedule Appendix I, any project in ecologically fragile areas4 and any project falling under coastal zone regulation, requires an EIA [69], [70], [71], [72], [73], [74] and [75]. The investment clause has also been formulated to streamline screening process. It specifies that new projects with investment more than 100 crores and modernisation projects involving investment more than 50 crores require EIA. This clause is not applicable to industries involving hazardous chemical processes

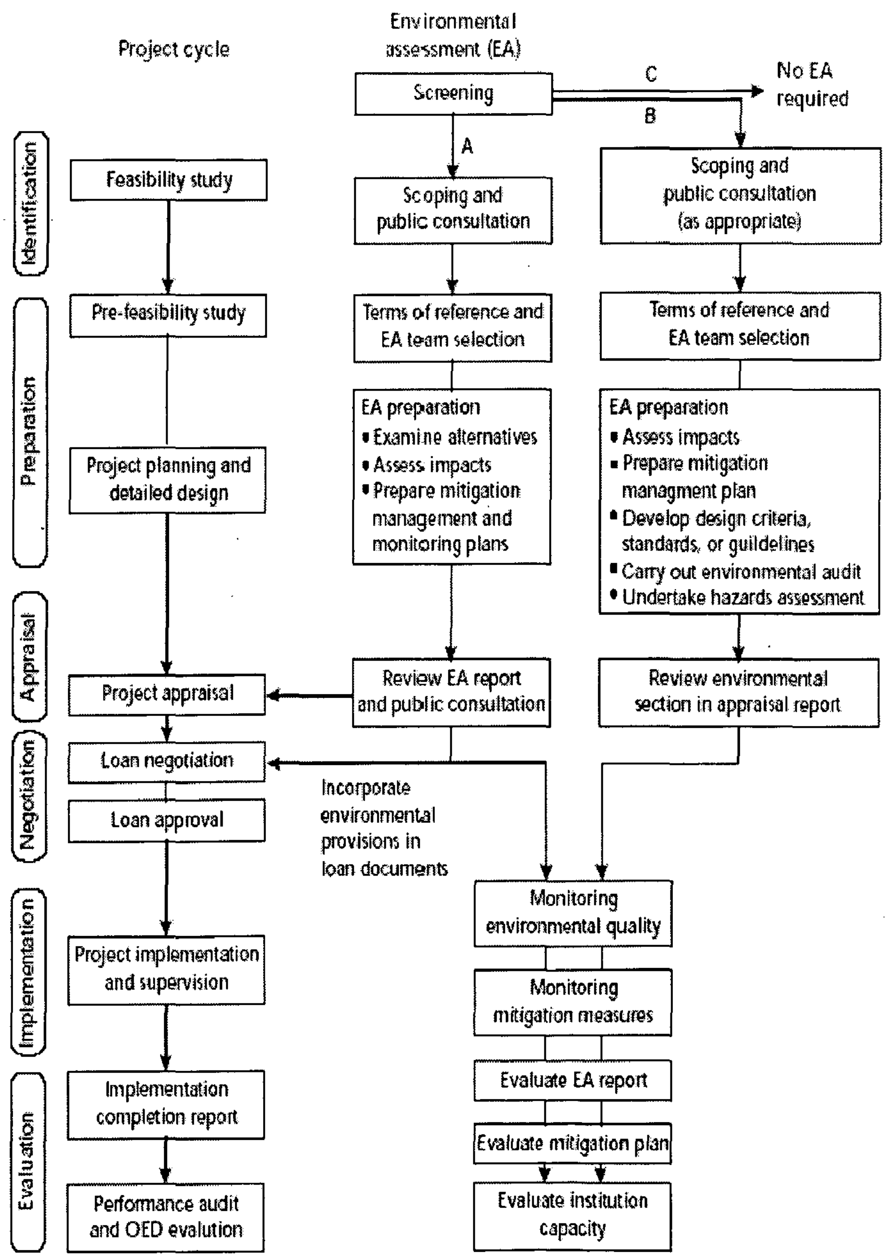


Figure 2.1: EIA Process

2.4.2 Scoping

Scoping identifies the concerns and issues to be addressed for a particular project. MoEF has set guidelines and review checklists for relevant issues for different project types and provides general questionnaires for all the sectors. Study of alternatives and public hearings are undertaken at this stage only. Alternate scenario must account for no project condition along with project scenario employing best-suited technology or processes [76].

2.4.3 Baseline analysis

A comparison of project-induced environmental changes with the expected environmental changes without proposed project is assessed through baseline analysis. The quality of the baseline analysis establishes the viability of the appraisal of the impacts, and therefore of the EIA itself. In India, data is collected on both project engineering and environmental aspects. Project engineering deals with process technology, raw material, water and energy requirements, whereas data on air emissions, wastewater, noise, solid waste and hazardous/toxic waste is required for the environmental study. Project proponent conducts monitoring for various required environmental quality parameters or data available with the local monitoring stations of SPCBs and CBCP may also be used. MoEF provides the detailed guidelines on the procedures of monitoring and analysis of the baseline data.

2.4.4 Impact prediction

Once collecting the relevant environmental information, consequences of the project are outlined. The prediction analysis should forecast the nature and significance of the expected impacts, or explain why no significant impacts are anticipated. Several mathematical models are listed in the manual of MoEF for environmental and socio ecological impacts predictions. Suggestions have also been made on the kind of conditions where they could be used. Socio-economic and ecological impacts are essential to be covered in this analysis.

2.4.5 Impact mitigation measures

In an EIA, mitigation measures are proposed to avoid or reduce environmental and social impacts. Environmental Management Plan (EMP), risk assessment report and disaster management plan (if hazardous substances are involved in the project), rehabilitation plan (if displacement of people is anticipated) are prepared to suggest remedial measures. EMP in particular should entail following aspects. [76]

- Pollution prevention

- Waste minimization
- End-of-pipe treatment
- Mitigation measures
- Protection of the sensitive receptors

In addition to this EMP must be supplied with the work plan, time schedule, place and cost of implementing the mentioned measures.

2.4.6 Documentation

At the end of all the above-mentioned steps, a concise but comprehensive report is prepared. It summarises the description of the project, regional settings, baseline conditions, impact prediction and important findings of the study. Project proponents hire consultants to carry out the EIA and preparation of report for them.

2.4.7 Public hearing

The Indian system provides an opportunity to involve affected people and vulnerable groups to develop terms of references for EIA thus incorporating their concerns into decision-making process. The SPCB is required to publish notices for public hearing in two local newspapers and one of which should be in vernacular language of the concerned locality [77]. The date, time and place of the hearing should be mentioned in the notice; EIA notification also makes provision for access to the executive summary of the project at the offices of district collector, district industry centre, commissioner of the municipal corporation/local body, SPCB [78]. The composition of the public hearing panel has also been specified by the law, which may consist of members of local authorities and representatives of the public nominated by the district collector.

2.4.8 Review and decision-making

The review and decision-making starts as the proponent files an application accompanied by the documents i.e., EIA and EMP report, NOC, risk assessment and emergency preparedness plan, rehabilitation plan, details of public hearing, clearance from airport authority and state forest departments, etc., to IA. The IA reviews the report with reference to the guidelines provided by MoEF in its manual [76]. The IA is free to conduct site visits if considers necessary. Based on the EIA review and other information, the IA either grants or rejects the environment clearance to the project. The assessment has to be completed within a period of 90 days from the receipt of the requisite documents from the project authorities and completion of public hearing. The decision has to be conveyed to the proponent within 30 days thereafter.[78]

2.4.9 Post Project Monitoring (PPM)

The PPM aims to ensure that an action had been implemented in accordance with the measures specified while providing the EC. Thus, it performs a dual task of identifying the actual environmental impacts of the project and checks if the EMP is having the desired mitigation measures. Post-implementation monitoring is the responsibility of MoEF's six regional offices and SPCBs.

2.5 METHODOLOGY

The methodologies employed for these processes are briefly discussed in this section. Some of the important methods developed over the period are discussed below.

2.5.1 Ad Hoc Method

This is the oldest and perhaps the crudest approach to EIA. This method provides qualitative assessment of the total impact while suggesting the broad areas of the possible impacts. It is done by considering each area and predicting the impact. This method lacks in quantification and precision

2.5.2 Checklist Method

Checklists are the lists of environmental attributes. The evaluator needs to tick against each environmental parameter for adverse, beneficial, or no effects due to proposed project activities. The method defines the parameters to be evaluated, but it is usually very large, very subjective, and provides little guidance that can aid in the decision-making process.

2.5.3 Matrix Method

The method was developed by Leopold and also called as Leopold Method. The method uses a matrix format to relate project actions and environmental components. The column of the matrix consists of project actions (normally about 100) against rows of the matrix of environmental components (in the range of 80s project). If a project action is likely to make an impact on environmental components, the appropriate cell is scored for magnitude and importance of the impact (on an arbitrary scale). A +ve or –ve sign is provided for harmful or beneficial nature of the impact. Row totals of the matrix reflect the total impact of all project actions on one environmental component, while the column totals reflect the impact of one project action on all components of the environment. The matrix total gives the total environmental impact.

2.5.4 Networks Method

This approach links the project and its impacts in an easily understandable format. The network method primarily addresses the need by defining a set of possible networks and allowing the user to identify impacts by selecting and tracing appropriate project actions. The network method aims at working from a list of project activities and establishes cause, condition, and effect relationships. Since the environmental system is dynamic and action-impacting, certain environmental parameters can lead to a series of impacts on other environmental parameters and this is taken care by network method. It is also referred to as Impact Tree Diagram

2.5.5 Modelling Approach

Modelling consists of set of structurally inter related variables which are fit into a set of mathematical equations and which are processed with the help of computers to quantify the desired impacts. Modelling techniques give us an extremely powerful means of environmental impact analysis. They are very useful in the quantification of impacts in a highly precise manner. It is no doubt that they are becoming the most popular EIA methodology.

2.5.6 Content Analysis

Content Analysis is an extensive search of related literature in order to enlist activities and their impacts. It can be very useful if the project to be assessed and its setting are similar to cases in the past. However that is very rare.

2.5.7 Expert Opinion

If number of experts is large and properly chosen, the Expert Opinion would provide us with the most qualitative information related to our solutions. Expert Opinion is normally sought through opinion polls, panel discussions and brainstorming sessions. After learning the technical details relating to EIA, it becomes necessary to understand the pros and cons of EIA.

Since the thesis deals with impact analysis of Rajasthan, an assortment This thesis reports the impact assessment of the renewable energy in the desert district of Rajasthan. An assortment of methods can be methods that can be used, are Rapid Impact Assessment Matrix and Network method. These methodologies is being discussed as follow:

2.6 RAPID IMPACT ASSESSMENT MATRIX

RIAM method [79] is based on a standard definition of the important assessment criteria, as well as the means by which semi-quantitative values for each of these criteria can be collected, to provide an accurate and independent score for each condition. The impacts of project activities are evaluated against the environmental components and for each component a score (using the defined criteria) are determined, which provides a measure of the impact expected from the component.

The important assessment criteria fall into two groups:

1. Criteria that are of importance to the condition, that individually can change the score obtained, and
2. Criteria that are of value to the situation, but should not individually be capable of changing the score obtained.

The value ascribed to each of these groups of criteria is determined by the use of a series of simple formulae. These formulae allow the scores for the individual components to be determined on a defined basis. The scoring system requires simple multiplication of the scores given to each of the criteria in group (A). The use of multiplier for group (A) is important, for it immediately ensures that the weight of each score is expressed, whereas simple summation of scores could provide identical results for different conditions.

Scores for the value criteria group (B) are added together to provide a single sum. This ensures that the individual value scores cannot influence the overall score, but that the collective importance of all values group (B) are fully taken into account.

The sum of the group (B) scores are then multiplied by the result of the group (A) scores to provide a final assessment score (ES) for the condition. The process for the RIAM in its present form can be expressed:

$$(a1) \times (a2) = aT \quad (2.1)$$

$$(b1) + (b2) + (b3) = bT \quad (2.2)$$

$$(aT) \times (bT) = ES \quad (2.3)$$

where (a1) and (a2) are the individual criteria scores for group (A); (b1)(b2)(b3) are the individual criteria scores for group (B), aT is the result of multiplication of all (A) scores, bT is the result of summation of all (B) scores, and ES is the environmental score for the condition.

2.6.1 Assessment Criteria

The judgments on each component are made in accordance with the criteria and scales given in Table 2.1.

Table 2.1: Assessment Criteria of RIAM

Criteria	**Scale**	**Description**
A1: Importance of condition		
	4	Important to national/international interests
	3	Important to regional/national interests
	2	Important to areas immediately outside the local condition
	1	Important only to the local condition
	0	No importance
A2: Magnitude of change/effect		
	+3	Major positive benefit
	+2	Significant improvement in status quo
	+1	Improvement in status quo
	0	No change/status quo
	−1	Negative change to status quo
	−2	Significant negative disbenefit or change
	−3	Major disbenefit or change
B1: Permanence		
	1	No change/not applicable
	2	Temporary
	3	Permanent
B2: Reversibility		
	1	No change/not applicable
	2	Reversible
	3	Irreversible
B3: Cumulative		
	1	No change/not applicable
	2	Non-cumulative/single
	3	Cumulative/synergistic

2.6.2 Environmental Components

RIAM requires specific assessment components to be defined through a process of scoping, and these environmental components fall into one of four categories, which are defined as follows:

- Physical/Chemical (PC): Covering all physical and chemical aspects of the environment.
- Biological/Ecological (BE): Covering all biological aspects of the environment.
- Sociological/Cultural (SC): Covering all human aspects of the environment, including cultural aspects.
- Economic/Operational (EO): Qualitatively to identify the economic consequences of environmental change, both temporary and permanent.

To use the evaluation system described, a matrix is produced for each project option, comprising cells showing the criteria used, set against each defined component. Within each cell the individual criteria scores are set down. From the formulae given previously, environmental score number is calculated and recorded.

No claim is made for the sensitivity of any environmental score value. To provide a more certain system of assessment, the individual ES scores are banded together into ranges where they can be compared. Ranges are defined by conditions that act as markers for the change in bands. The full reason for the setting of range bands is described by Pastakia. Table 2.2 gives the ES values and range currently used in RIAM. The final assessment of each component is evaluated according to these range bands.

Table 2.2: Conversion of Environmental Scores to range bands

Environmental Score	Range Bands	Description of Range Bands
+72 to +108	+E	Major positive change/impacts
+36 to +71	+D	Significant positive change/impacts
+19 to +35	+C	Moderately positive change/impacts
+10 to +18	+B	Positive change/impacts
+1 to +9	+A	Slightly positive change/impacts
0	N	No change/status quo/not applicable
−1 to −9	−A	Slightly negative change/impacts

−10 to −18	−B	Negative change/impacts
−19 to −35	−C	Moderately negative change/impacts
−36 to −71	−D	Significant negative change/impacts
−72 to −108	−E	Major negative change/impacts

Once the ES score is set into a range band, these can be shown individually or grouped according to component type and presented in whatever graphical or numerical form.

2.7 COMPARISON OF THE RIAM WITH OTHER EIA METHODS

To compare methods one has to be able to define the criteria against which the value of each method may be judged. For EIA these criteria should include:

- Cost of the method
- Time required for the method
- Accuracy of the results
- Transparency of the results
- Permanence of the record
- Clarity of the results
- Reliability of the method
- Universality of use.

RIAM is cost effective when set against traditional EIA systems. Because of its ordered manner, it is possible to set up the procedures in a planned way, which in turn can often lead to a more accurate forecast of the necessary budget. The method has been computerized (VKI 1998), which allows rapid analysis to take place. Because of its ability to use qualitative data, the method can be pursued at different levels in the development cycle, and so provide guidance on possible positive and negative impacts in a more continuous manner than with other methods.

The picture built up by the RIAM, in the matrix values and in the resulting histograms, is a true representation of judgments made by the assessors. A further value of RIAM is that the scales used for each criterion are defined. As a result, subjective judgments are understood by the reader of the report, not merely (as in many methods) as "high," "moderate," or "low."

This accuracy is related to, and evident in, the transparency of the RIAM record. Each criterion, for each component, has a judgment recorded by a figure, which in turn is predefined. The reader of any RIAM EIA report can immediately understand, from the RIAM matrix, the exact value ascribed by the assessor to any cell in the matrix.

This record is permanent. It provides at any time in the future a complete statement of the judgments made by the assessor in an EIA. This record of judgments enables procedures in RIAM to be rechecked easily. Work can be redone or the options reappraised with relative ease and a high confidence of accuracy. The replicability of the system is thus very good.

No similar tool has been published, to the authors' knowledge. However, a recent study has used the Delphi approach to identify and evaluate systematically the impacts of effluent control system in Jedda, Saudi Arabia. In this study, a panel consisting of up to 350 respondents with special expertise was requested to give their opinion on 17 different impacts related to this problem in Jedda. The respondents were asked to assess/interpret the impacts and rank them according to the following criteria: importance, magnitude, probability, urgency, type, range and nature of impact (reversible/irreversible). The impacts answered by the respondents were ranked by use of a statistical analysis.

Both studies—although quite different—have shown that systematic ranking possible impacts makes the decision process transparent and open to changes in the rating of the impacts to demonstrate sensitivity effects.

2.8 NETWORK METHOD [79]

Development of the conceptual models that represent potential impact pathways as causal chains is at the essence of the application of the SSA. As illustrated by the examples presented in the previous section, network diagrams are one of the best ways of representing these causal chains. Network Figure 2.2 provides a means for displaying first, secondary, tertiary, and higher order impacts. To develop a network, a series of questions related to each project activity (such as what are the primary impact areas, the primary impacts within these areas, the secondary impact areas, the secondary impacts within these areas, and so on) must be answered. In developing a network diagram, the first step is to identify the first order changes in environmental components. The secondary changes in other environmental components that will result from the first order changes are then identified. In turn, third order charges resulting from secondary changes are identified. This process is continued until the network diagram is completed to the practitioner's satisfaction. The network helps in exploring and understanding the underlying relationships between environmental components that produce higher order changes that are often overlooked by simpler approaches.

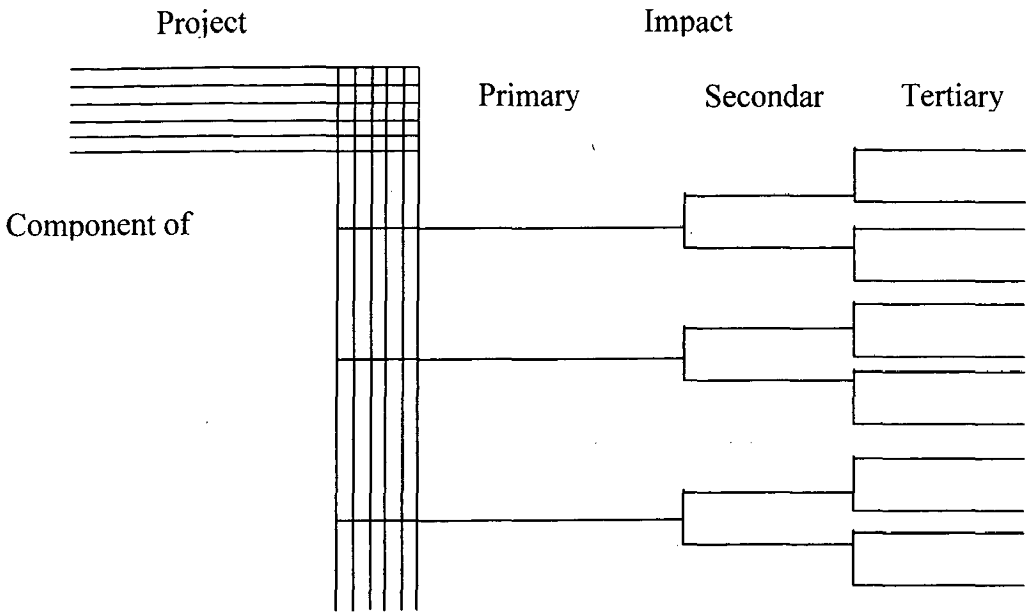


Figure 2.2: Conceptual model of impact networks

In fact, a number of techniques or methodologies are available for EIA which one of the major types is casual network. The network technique developed by Sorensen is regarded as one of the best known methods for investigating higher order impacts [80], [81] and [82]. Networks are diagrams that demonstrate casual relations between their elements. In causal networks, the process of interpreting results is even more complicated. Hence, the significance of the overall impact may be difficult to estimate. Since network method applies a holistic approach to impact assessment, it has the potential to require a slightly higher time or cost input. For this case study, the application of a network method was chosen as an appropriate methodology. It is based on casual networks which come from an EU Guidance Document [0].

In this method, a series of flow diagrams were prepared which illustrated the impact relationships between the effects of various activities of the project and each element of the receiving environment. The network showed a very complex system, which was useful in identifying indirect impacts and also interactions between the impacts as shown in Figure 2.3 This network diagram is a directed graph with elements which are stated textually in various shapes. The network of impacts is initiated by one action of the project process. The process was subsequently repeated with each of the actions on the left of the diagram. As shown in Figure 2.3, primary impacts and secondary impacts are defined respectively by rectangle and circle shapes and also their relationship are marked by unidirectional arrows. The directions with same colour and shape indicate that there are links between individual elements of the environment and activity.

The magnitude of the interaction (extent or scale) is described by assigning a value ranging from 1 (for small magnitudes) to 5 (for large magnitudes). This method could identify beneficial, as well as harmful impacts using appropriate designators. In both cases of primary and secondary impacts, simple shapes (rectangle and circle) show negative impacts of the project while the double shapes represent positive impacts. Also, the activities which cause irretrievable impacts on the environment are shown by colour boxes. When the cause-and-effect impact in feature of chains was prepared, each action and its potential for impacting each environmental item is to be considered. Scoring can be used to give an overall total score for the project or alternative options. The total number of specified actions and environmental items may increase or decrease depending on the nature. Following this approach, a comparison is made between the alternative routes in terms of their degree of impacts in order to select the least impact route. Note that all the interactions between elements are presented in EIA report in both text and diagram formats. The inputs are feed on the basis of the relating parameters of the project activity.

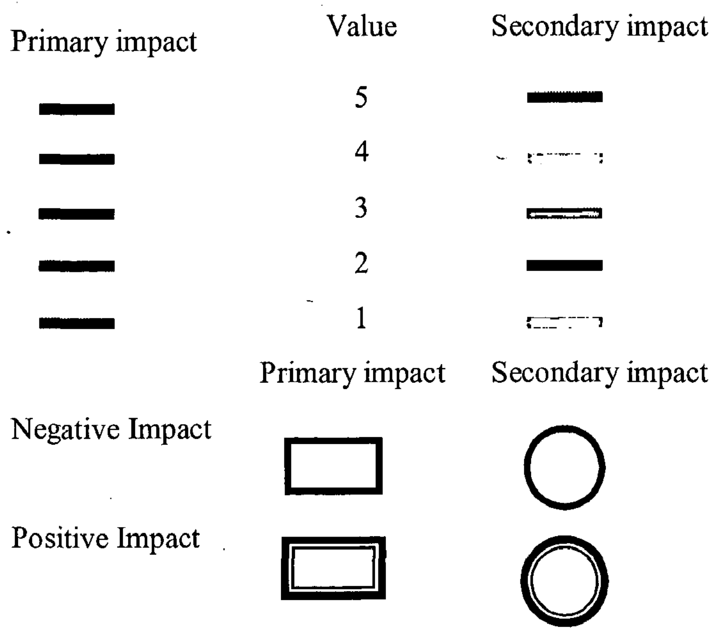


Figure 2.3: Legend of impact score for the network-based method

2.9 BENEFITS OF EIA

EIA is definitely the best environment management tool to have evolved in the 21st century. It offers a wide variety of benefits, which can be grouped into the four major categories:

2.9.1 Consideration of environment effects whilst planning

Before EIA, the economy was the only factor whilst planning a development activity. Now environment is formally and systematically incorporated in the process of development. Thus EIA strikes a balance between environment and development and contributes towards sustainable development.

2.9.2 Assessment of intangible effects

With the absence of a procedure in our way of life to continuously assess our environmental resources, i.e. to form an environmental inventory, we are not aware of any forthcoming impacts. EIA is an opportunity to identify impacts that are not addressed in the normal situations by technical reports

2.9.3 Safeguarding of Natural resources

EIA helps us to safeguard our natural resources like air, water, land, flora and fauna from haphazard development activities.

2.9.4 Facilitation of Public Participation

Public participation is very vital for environmental management in a particular area. In our country, we do not have a mechanism to involve public in natural resources management. However in EIA, it is mandatory to involve the local community.

2.10 LIMITATIONS OF EIA

The introduction of EIA has encountered resistance on the part of many people, who see it as an unwanted change from traditional practice. EIA has been severely criticized, especially so in the developing countries. Some of the limitations of EIA have been

- EIA is a time consuming process
- EIA is a costly process
- EIA requires high scientific analysis
- There is no institutional support base for carrying out EIA
- The political and public awareness regarding EIA is very low

2.11 CRITERIA FOR THE CLEAN DEVELOPMENT MECHANISM

Clean development mechanism is the phenomenon to develop to reduce the green house gases reduction. The developed countries to have to reduce the carbon emission upto the emission level of the 1990's emission. These carbon emission can be solar in the market in the form of certified emission reduction, contains one ton of CO_2.

- Renewable energy generation units, as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity
- If both renewable and non-renewable components the eligibility limit of 15MW for a small-scale CDM project activity applies only to the renewable component.
- Combined heat and co-generation systems are not eligible
- It renewable capacity is added to the existing renewable energy project then the addition by the project should be lower than 15 MW
- Retrofit or modify an existing facility for renewable energy generation shall not exceed the limit of 15 MW.

2.12 DIFFERENT TYPES OF EMISSION FACTORS

The CDM methodologies which have been approved to date by the CDM Executive Board distinguish a range of different emission factors. In the Indian context, the following four are most relevant, and were therefore calculated for each regional grid based on the underlying station data:

2.12.1 Weighted average:

The weighted average emission factor describes the average CO_2emitted per unit of electricity generated in the grid. It is calculated by dividing the absolute CO_2 emissions of all power stations in the region by the region's total net generation. Net generation from so-called low-cost/ must-run sources (hydro and nuclear) is included in the denominator.

2.12.2 Simple operating margin (OM):

The operating margin describes the average CO_2 intensity of the existing stations in the grid which are most likely to reduce their output if a CDM project supplies electricity to the grid (or reduces consumption of grid electricity). "Simple" denotes one out of four possible variants listed in the Grid Tool for calculating the operating margin. The simple operating margin is the weighted average emissions rate of all generation sources in the region except so-called low-cost or must-run sources. In India, hydro and nuclear stations qualify as low-cost / must run sources and are excluded. The operating margin, therefore, can be calculated by dividing the region's total CO_2 emissions by the net generation of all thermal stations. In other words, it represents the weighted average emissions rate of all thermal stations in the regional grid.

2.12.3 Build margin (BM):

The build margin reflects the average CO_2 intensity of newly built power stations that will be (partially) replaced by a CDM project. In accordance with the Grid Tool, the build margin is calculated in this database as the average emissions intensity of the 20% most recent capacity additions in the grid based on net generation. Depending on the region, the build margin covers units commissioned in the last five to ten years.

2.12.4 Combined margin (CM):

The combined margin is a weighted average of the simple operating margin and the build margin. By default, both margins have equal weights (50%). However, CDM project developers may chose to argue for different weights. In particular, for intermittent and non-dispatch able generation types such as wind and solar photovoltaic, the Grid Tool allows to weigh the operating margin and build margin at 75% and 25%, respectively. However, the combined margins shown in the table 2.3 is calculated based on equal weights.

Table 2.3: Weighted average emission factor 2007-08

Grid	Average	OM	BO	CM
NEWNE	0.81	1.00	0.60	0.80
Southern	0.72	0.99	0.71	0.85
India	0.79	1.00	0.63	0.81

The observed variations in the emission factors between the different grids originate from the differing availability and use of coal, gas and hydro resources. Stations fired with other fossil fuels such as diesel as well as nuclear stations play a less significant role.

CHAPTER 3

DESERT DISTRICT IN RAJASTHAN – STUDY AREA

3.1 ABOUT RAJASTHAN STATE

Rajasthan is the largest state of India covering about the area of 342,269km^2 of area which is the 10.4% of the total of the country. Rajasthan has vast verity of climate. It has Aravali Range which has rainfall of about 637 mm and on the other side there is has desert area where has the rainfall less than 25 mm per year. This state is also rich in mineral resources. The major minerals are found here are marble, granite, rock phosphate, zinc, lignite etc

The per capita electricity consumption is 561 units in 2009 compared 545 in year 2008 and 495 in years 2007. In India the largest electricity consumption is in Dadra and Nagar Haveli, (about 12525 units). This data shows that this state has vast potential for the electricity consumption. This consumption is may depend upon the industrial development. And the state Rajasthan has large area for the industrial development and potential for electricity generation. The state is also closer to the national capital which has its on significance. Rajasthan has large scope of renewable energy generation especially for of solar and biomass. [84]

3.2 CURRENT POWER SCENARIO OF RAJASTHAN

The total installed power plant capacity is 6089 MW in year 2007. This is increased by 7716 MW in year 2009. The total renewable energy capacity is 883MW, is about 11% of total installed capacity. The capacity addition plan for remaining period of 11th five year plan is about 4465 MW for conventional sources and 1200 MW for renewable energy sources. The capacity addition during 12th five year plan (2012-2017) for the projects in progress 5730 is the planned addition in the capacity in the duration of the 12th five year plan between years 2012-2017. The project approve in principle in the same duration is 4780Mw and 300MW is capacity addition in renewable energy sector. [84]

3.3 GEOGRAPHICAL CONDITION

The Aravali Range divides the state in into 60% in the northwest of the range and 40% in the southeast. The northwest tract is sandy and unproductive with little water. The area includes the Thar Desert is generally sandy and dry and covers area of 446000 sq kms.

Most of the region is extends into adjoining portions of Pakistan. The Thar Desert is thinly populated having population density of 83 people per square kilometre [85].

This band receives less than 400 mm of rain in an average year. Temperatures can exceed 45 °C in the summer months and drop below freezing in the winter. The Luni River and its tributaries are the major river system. This river is saline in the lower reaches. The Ghaggar River, which originates in Haryana, is an intermittent stream that disappears into the sands of the Thar Desert in the northern corner of the state and is seen as a remnant of the primitive Saraswati River.

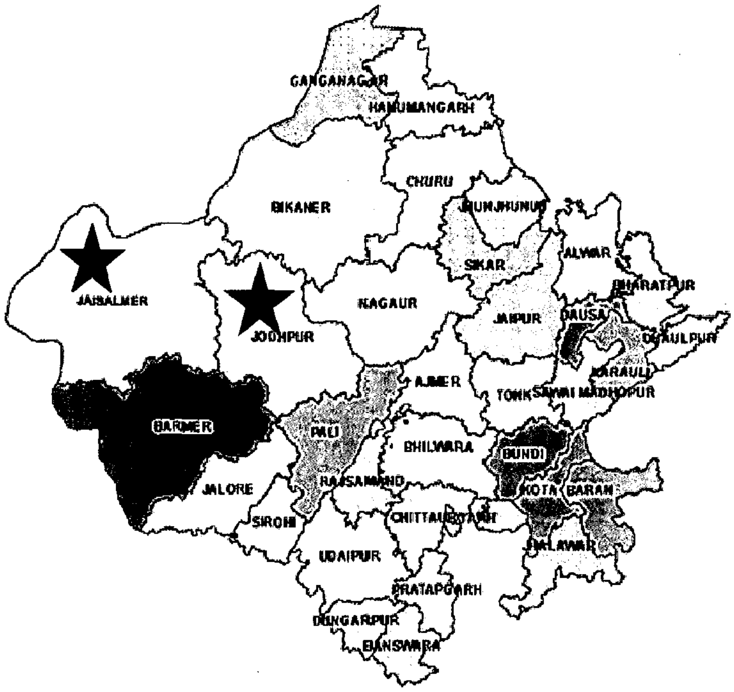


Figure 3.1 Map of Rajasthan state showing districts

Two districts Jaisalmer and Jodhpur are selected as study area because these two districts are the hub for the wind and solar energy generation respectively. Both of the districts don't have the installation capacity of small hydro and biomass as well. The reason is the low rainfall condition and dry climate. But for future work biogas generation can be consider for the alter source of energy.

3.4 PROFILE OF JAISALMER [86]

A part of the Great Thar Desert, largest district of Rajasthan is located within a rectangle lying between 26°4′ to 28°23′ North parallel and 69°20′ to 72°42′ east meridians. It is the largest district of Rajasthan and one of the largest in the country. As shown in the figure 3.1 the Jaisalmer is the border District of the state. The breath (East-West) of the district

District Jaisalmer : Gram Panchayat Samiti & Ward Map

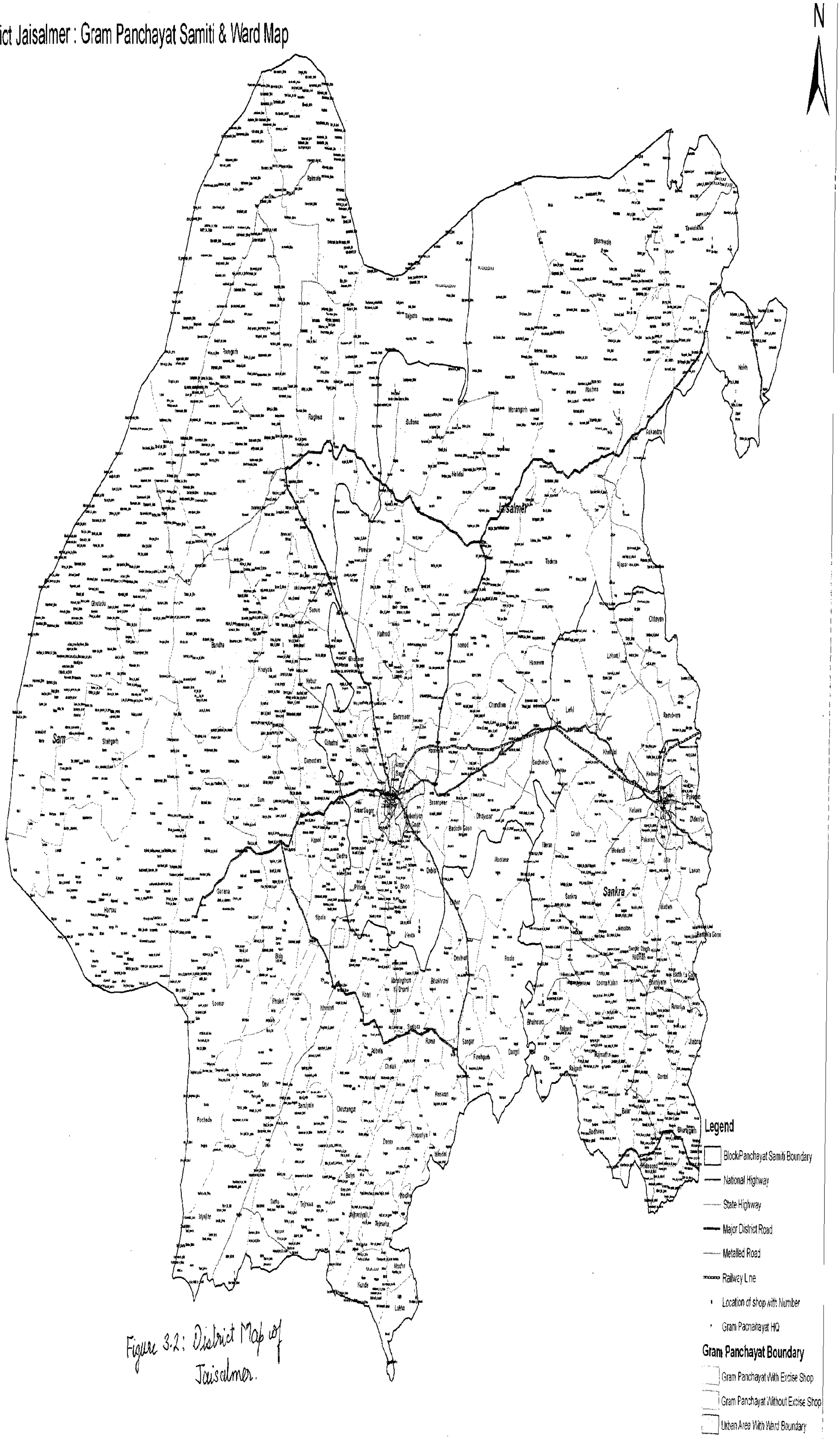


Figure 3.2: District Map of Jaisalmer.

District Jodhpur : Gram Panchayat Samiti & Ward Map

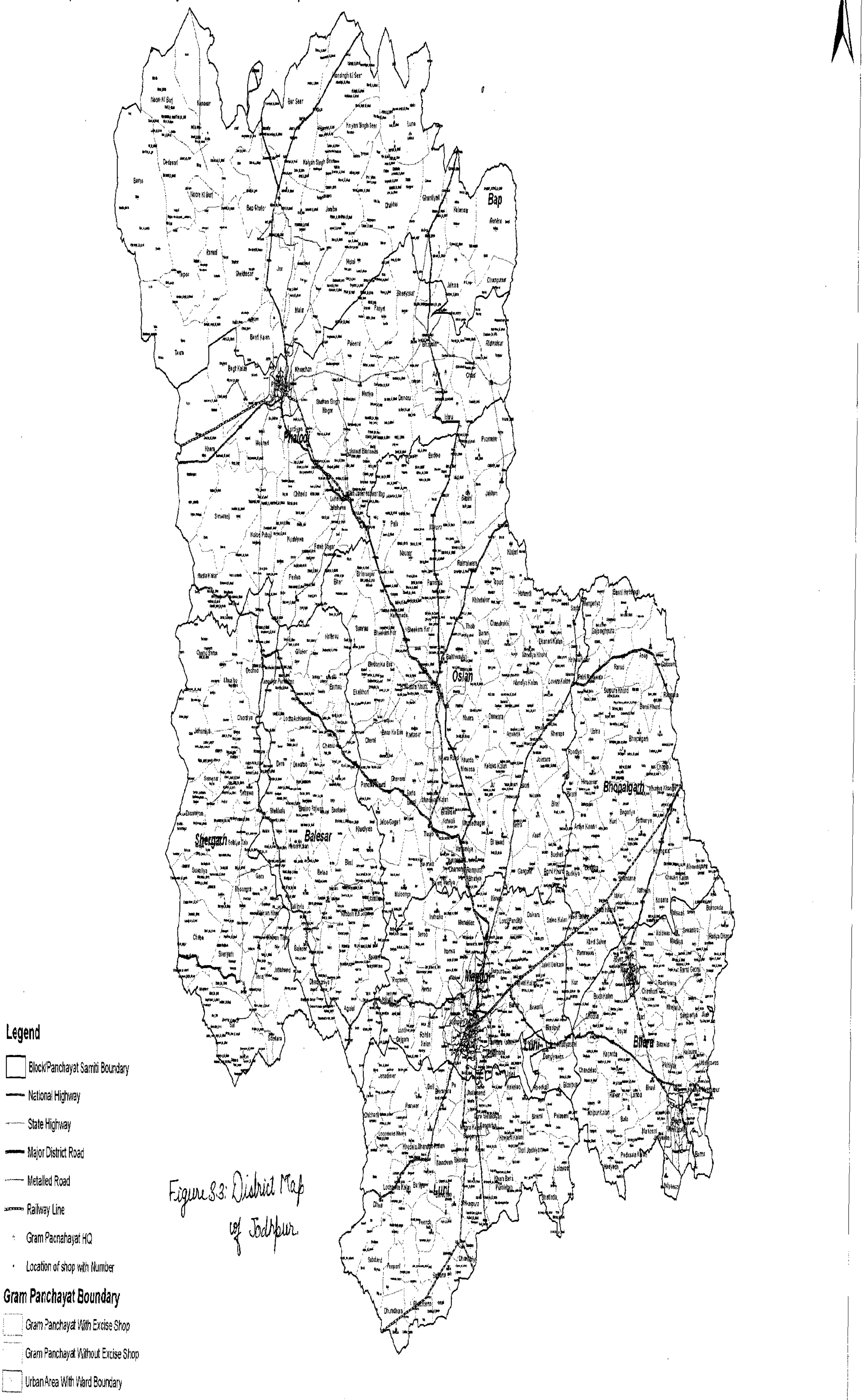
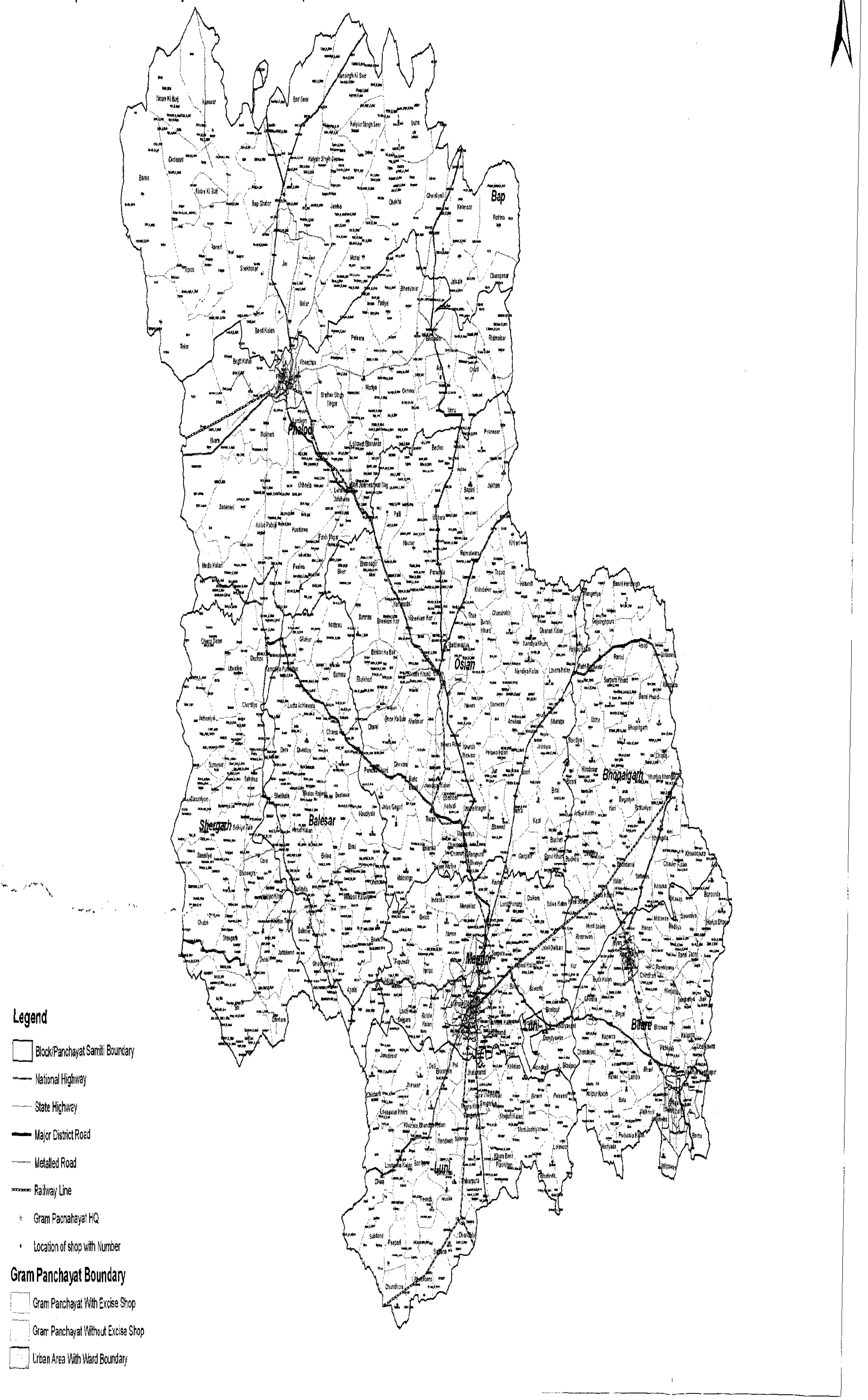


Figure 3.3: District Map of Jodhpur.

District Jodhpur : Gram Panchayat Samiti & Ward Map



is 270 kms and the length (North-South) is 186 kms. The underground water level is very low. Geographically this district is spread over in 38,401 kms^2. The climate is extremely hot during summer with maximum temperature reaching up to 49.2^0C and extremely cold during winder with minimum temperature in the range of 1^0C. The variation in temperature from morning to noon and the late midnight is a sudden phenomenon. The average rainfall is only 16.4 cm as against the state average of 57.51 cm.

3.5 PROFILE OF JODHPUR [87]

As shown in the Figure 3.1 Jodhpur is another one largest district of state and neighbour district of Jaisalmer is centrally situated in Western region of the State, having geographical area of 22850 km^2. It has population of 28.81 laces as per 2001 census. The district stretches between $26^0$0' and $27^0$37' at north Latitude and between $72^0$55' and $73^0$52' at East Longitude. This district is situated at the height between 250-300 meters above sea level. The length of the district from North to South and from East to West is 197 km & 208 km respectively. It covers 11.60% of total area of arid zone of the state.

In this district extreme of heat in summer and cold in winter is the characteristic of the desert. The rainy days are limited to maximum 15 in a year. The average rainfall is 302 mm.

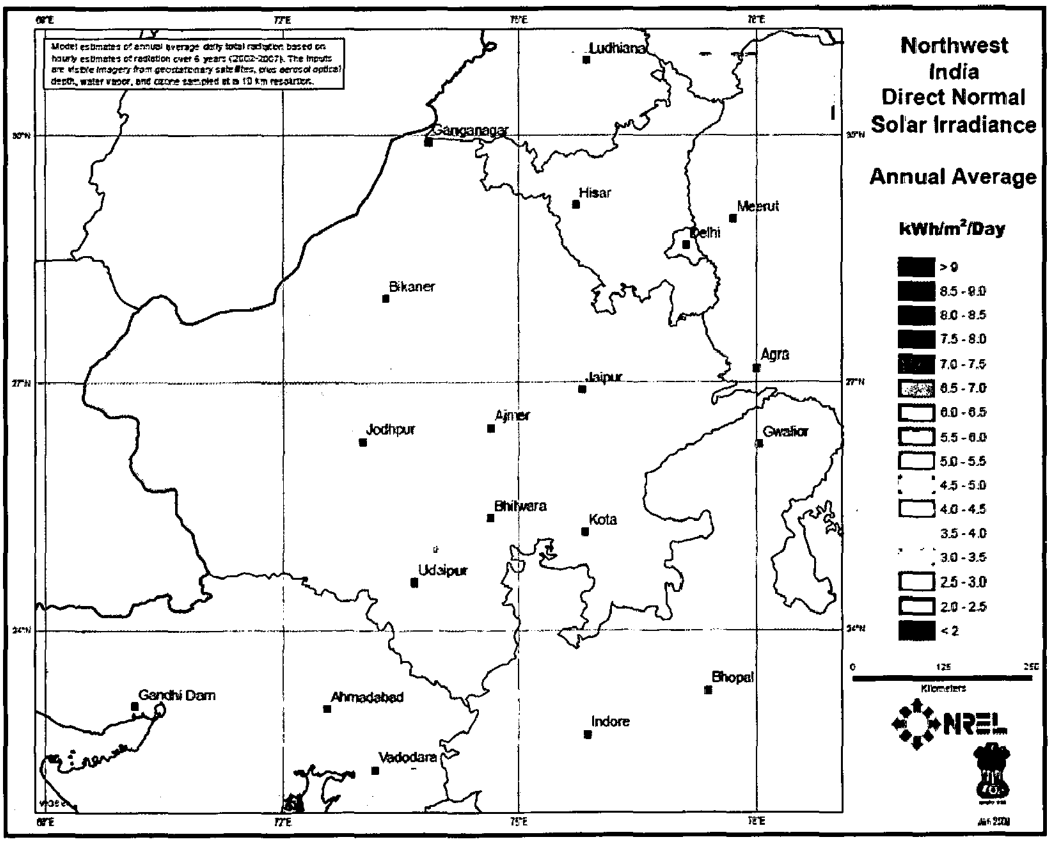


Figure 3.2: Northwest India Direct Normal Solar Irradiance (Annual Average) [88]

3.6 AVAILABILITY OF SOLAR RADIATION OVER WESTERN RAJASTHAN

Although Rajasthan is the largest state in size in the county, covering about 10.4%of the land area the state has limited traditional sources of energy. It has only two perennial rivers, the Chmabal and the Mahi whose hydroelectric potential has been almost fully exploited. However, there are some gas and lignite reserves. None the concentration for the generation is toward is renewable energy. As shown in the Figure 3.2 the in the area of Jodhpura and some of the area from Jaisalmer the solar intensity is in the range of 6-6.5 $kWh/m^2/day$ In Rajasthan with 325 sunny days, large areas of land are barren and sparsely populated, making these areas suitable as locations for large central power stations based on solar energy. Rajasthan has around 208,110 km^2 desert area and the land required for the generation of 100,000MW project is only 3600 km^2 is only 2% of the entire available desert land in Rajasthan.[89]

In order to discuss the potential of solar energy in western Rajasthan it is desirable to examine the climatic conditions of that region the variable of importance from the point of view of generating solar electricity are solar radiation sunshine hours cleanness index and ambient temperature.

Western Rajasthan experiences a hot and dry climatic with severs summer relative clear skies a short mansoon period and cold winter. Table 3.1 present annual and monthly averages of daily values of global solar radiation, sunshine hours, cleanness index for Jaisalmer district. In order to get a comprehensive picture of the spatial distribution of these quantities of annual mean area, a map showing the distribution of the annual mean daily global solar radiation and the clearness index is presented in Table 3.1. It is sending that the solar insulations level is high. In fact the values over western Rajasthan are the highest for the whole country. Further the sunshine hours and values of clearness index for the region are consistently high except for a short mansoon period. This implies an excellent availability of beam radiation. Consequently solar devices which need concentration of radiation would perform much better in this region. Besides these factors, the ambient temperature is high throughout the year touching more than 45^0 C during the summer. Thus the region is the best in the country from the point of view of utilization solar energy.

Table 3.1: Global Solar Potential of Western Rajasthan [91]

Place	Parameter	Jan	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct	Nov.	Dec.
Jaisalmer	G (kWh/m^2)	4.61	5.56	6.49	7.48	8.11	8.24	7.44	7.08	681	6.06	5.00	4.36
	S (hour)	9.0	9.7	10.1	11.2	12.2	12.3	10.0	9.6	10.3	10.5	9.6	8.8
	K_t	0.72	0.73	0.71	0.73	0.74	0.73	0.67	0.67	0.71	0.74	0.74	0.72
Jodhpur	G (kWh/m^2)	4.72	5.57	6.55	7.23	7.55	7.07	5.98	5.54	6.10	5.83	4.90	4.43
	S (hour)	9.1	9.7	8.9	10.0	10.6	9.5	6.7	6.2	7.7	9.5	9.7	9.2
	K_t	0.72	0.72	0.68	0.69	0.68	0.64	0.56	0.57	0.65	0.72	0.74	0.73

This above Table 3.1shows that sunshine hour in the district Jodhpur and Jaisalmer are same during the January and February but as the time spend the sunshine hours in the Jodhpur district decreases and there is the variation increases to about 5 hours in the month of July and August. Again in the parameter of global solar radiation there is not much difference in this parameter and it is maximum in the month of May and June in both of districts. It deceases in the month of August because of the mansoon period. The cleanness index remains constant through out the year for both of the district.

3.7 CURRENT STATUS OF SOLAR ENERGY PROJECTS [92]

To meet the Solar RPO, state has approved 11 Solar Power Projects of 66 MW capacity. For these projects land and Water allotment already done at low rate. The land is making available at the rate of only 10% of the cost of project. In addition to RPO two Solar Power Projects of 5 MW each are under execution under GBI scheme of MNRE. RERC Regulations for promotion of solar energy clears the mandate on providing grid connectivity by State Transmission Utility and there is no grid connectivity charge for Solar Power Project sanctioned under State RPO.

Solar photovoltaic manufactures have also shown overwhelming response. Solar Projects of 5400 MW Capacity already registered by the private project developers and more than 50 solar photovoltaic producer's indentified land and submitted power evacuation plan. To implement these projects the land bank of various districts has already been identified which is about 20,000 hectares. Adequate power evacuation system has dedicated over 400 kV network in Barmer, Jaisalmer, Jodhpur, Bikaner area. These projects also earmarking canal water for power plants in solar potential districts. The government has facilitated the provision of open access for outside sale.

Harnessing solar potential in Rajasthan

There is planning to launch more than 1000 MW solar power plants in next 2-3 years under Phase-1 of National Solar Mission which was launched by prime minister. To activate this solar mission there is provision of meeting of RPO to other states through open access. And there is also planning sell power through RE Solar Certificates to meet RPO of other states. This will give the state economic upliftment and reduce carbon emission. Solar thermal based demonstration project has installed in Mathania– Jodhpur under national solar mission. State government supported and undertakes the plan to set up large scale 'solar parks' of capacity of 3000 MW.

3.7.1 Solar Energy Technology Parks

Clinton Foundation signed MoU with Rajasthan Government in January 2010 for setting up a 3000 MW plus solar energy technology parks. These Solar. Park. have characteristics of ggeneration, manufacturing, R&D centre. These parks will also access to common infrastructure, including water, gas and power transmission system. These parks main feature is innovative low cost financing mechanism. The major processes are utility-scale CSP and PV plants. These will be provided by single window clearance.

According to the current status of the park the sites has been identified in Jodhpur and Jaisalmer. And each site has capacity of more than 8000 hectares of Govt. land. The scope of land survey and soil testing has been finalized. Survey Work has started the month of February 2010. And according to the planning by the end of the March 2010 one site has been earmarked for solar park.

3.8 AVAILABILITY OF WIND OVER WESTERN RAJASTHAN

3.8.1 Surface winds

Generally the winds near the surface have westerly component during major part of the year. They are stronger over the West Rajasthan than over the East Rajasthan. Surface winds reach a value of 25-30 km/h over West Rajasthan during May-June. Such strong winds raise tremendous dust form the loose sandy soil of the region and the dust in transported eastward over neighbouring stated of India.

As listed the Table 3.2 there is 7 Nos. potential sites / locations have been identified for Wind Power Generation in Rajasthan, under Wind Resource Assessment Pprogramme. The data are complied and published in IITM wind data book. The data of the Table 3.2 is related to Rajasthan.

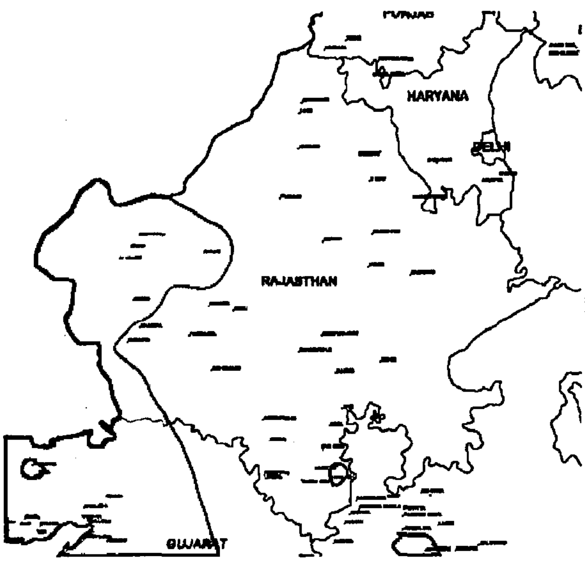
Table 3.2 Wind velocity in Rajasthan [92]

S. No	Wind Mast Site	District	Annual Mean Wind Speed KMPH		Annual Mean Wind Power Density (W/M2)	
			at 20/25 m	Extrapolated at 30 M	at 20/25 M	Extrapolated at 50 M
1	Devgarh	Chittorgarh	19.88	21.38	151	281
2	Harshnath	Sikar	20.62	22.60	206	617
3	Jaisalmer	Jaisalmer	17.80	19.50	159	274
4	Jaisalmer	Jaisalmer	17.80	19.79	182	311
5	Khodal	Barmer	17.00	18.50	135	229
6	Mohangarh	Jaisalmer	15.50	17.50	117	243
7	Phalodi	Jodhpur	17.40	19.20	142	261

The Table 3.2 shows the wind energy potential of the different sites of state. These data are collected from the various monitoring stations from the various time intervals. The major concern of the monitoring station is to assess the potential foremost form the desert area. This graph projects that the average mean wind speed is at 20/25 and at height of 30 m is about same. But the major difference can be seen in the annual mean wind density projection. The maximum wind density is at the height of 50 m at Harshnath in Sikar District and the least we got at the site Kodal at Barmer. But there is huge difference in the data of wind density of the Harshnath at the 50 m height and at 20/25 m height. The wind density is about three time of the density at the of 20/25 m. the wind density at the height of the 20/25 m is moderate all over the sites.

The Figure 3.4 shows that western part of Rajasthan has wind speed of the range of 5.6 to 6.4 and the wind power is lies between 200-300 W/m^2 at the height of 50m. installable power on the assumption that 1% of land becomes available for wind farming. An area required is about 12 hectares/MW assumed

. In Rajasthan renewable energy purchase obligation which was issued in November 2006 displays that the wind tariff will be 6.00% in the year of 2009-10 and in will be 6.75% in next year. In Rajasthan wind energy growth is presented in Figure3.6 where in initial potential is only 176 MW and in the year it comes to 1034.5 Mw and for the future plan it is to be grow upto 1634.5 MW in year 2010-11 and to 2234.5MW in year 2011-12.this growth is of 600MW per year. It represents that the state government is motivation the project installer at low rate



Standard Wind Class definition

CLASS	50 m HEIGHT		INSTALL-ABLE KW*	WIND POWER DENSITY W/sq.m
	WIND SPEED m/s	WIND POWER W/sq.m		
1	< 5.6	< 200		
2	5.6 - 6.4	200 - 300	43106	
3	6.4 - 7.0	300 - 400	4680	
4	7.0 - 7.5	400 - 500	397	
5	7.5 - 8.0	500 - 600	16	
6	8.0 - 8.8	600 - 800	-	
7	8.8 - 11.9	800 - 2000	-	
		TOTAL	48199	

Figure 3.4: Wind energy potential in western Rajasthan [93]

Rajasthan State Regulatory Commission has also declared the different tariff for the wind energy generation. According to the order, the wheeling charge will be 50% of normal charge as applicable for 33 KV, in addition to the transmission charges of 3.6% at 2008 surcharges. The banking will be applicable for Six Months (Apr. to Sept. 8 Oct. to March. Utilization of banking energy not permitted in Dec. to Feb.) by the law for the generation the government will pay Rs. 4.2S/ KWh for Jaisalmer, Barmer and Jodhpur and Rs. 4.50/kWh for all other districts.

The Third party sale will be allowed under Electricity Act 2003 which is subjected to regulation framed by respective SERs. The capital subsidy provided by the government is exemption from electricity duty at about 50% for 7 years. And the other incentives are reactive Power 5.75 paise per kVAh with escalation of 0.25 paise per year.

3.9 FAVOURABLE CONDITIONS IN RAJASTHAN

3.9.1 Policies

Rajasthan Govt. is leader in renewable energy. In the state renewable energy policies has been issued in 1999, 2003 & 2004. Issues of Separate Biomass, Wind & Solar Policies in February-March 2010 come in picture. Rajasthan has maximum solar irradiation in India which gives maximum energy output and best return of investment. In the view of transmission infra structure in desert area, Rajasthan is the only state with six 400 kV GSS associated 400 kV transmission lines and number of 220 kV and 132 kV GSS available.

3.9.2 Climatic Conditions

The state owns dry and calm ambiance. There is no sea cyclone and no sea water corrosion to modules, its frame and outdoor equipments. Rajasthan lies in the lowest earthquake seismic intensity zone (Z-2). Due to all of these above mentioned conditions there is scope of long life of system assured 25 years benefit.

3.9.3 Industrial Atmosphere

State's industrial atmosphere is known for peaceful, cordial, cultured behavior due to good law and order situation. This quality enhances the renewable energy scenario. Availability of skilled and unskilled at low cost gives push for the upliftment of the projects.

3.9.4 Ease in Selection of Land

Govt. has made available land bank in 8 districts with RREC for the solar projects. Allotment of land at 10% the installation cost of the project. Water availability for thermal projects is made from Rajasthan Canal within few km to reduce the capital cost of the project. There is direct to connection of the lines of the 132/33 kV or 220/132/33 kV from the RVPNL GSS and assured connectivity for 24 hours with grid to solar photovoltaic power plants.Among all states in India, Rajasthan is first in framing renewable energy regulations and tariff orders and first time in India renewable purchase obligation issued to discoms for solar power in 2008 in Rajasthan only.

3.10 RENEWABLE ENERGY TECHNOLOGIES USED IN SOLAR

3.10.1 Solar Domestic lights

Remote Village Electrification Programme (RVEP) is very ambitious and attractive scheme of Ministry of New & Renewable Energy (MNRE) New Delhi. Under this programme, un electrified Remote Census villages and un electrified dhanis of electrified villages are to be electrified through Solar Photo Voltaic Domestic Lighting System (Model II 37 W). Such villages and dhanis should be remote, revenue and where supply of electricity through Grid is not possible.

3.10.2 SPV Domestic Lighting System:

RREC is providing SPV DLS (Model-2, 37 Wp SPV Module with 2 Light Points of 9W CFL) under Rural Electrification Programme in Rural Rajasthan. Details of approved prices under programme 2006 07 which is extended upto 31/10/2008 are as under:

Unit Cost	Rs. 15075/-
Subsidy (By GOI / GOR)	Rs. 4550/-
Beneficiary Share	Rs. 10525/-

The selected manufacturers / authorised suppliers shall identify beneficiaries to supply, install, commission systems and provide maintenance services for 2 years free of charge and for next three years at the fixed AMC charges (Rs. 300/- per year per Domestic Lighting System) to be charged from beneficiaries. Replacement of CFL is not included in this AMC.

Table 3.3: Achievements of SPV DLS installations in Rajasthan

S.No	Programme Year	Achievements of SPV DLS installations
1	up to 1999-2000	19445
2	2000-2001	9900
3	2001-2002	7000
4	2002-2003	12386
5	2003-2004	12133
6	2004-2005	NIL
7	2005-200	11627
8	2006-2007	8200
9	2007-2008	12168 (Cont up to March, 09)
TOTAL		92859

This Table 3.3 shows the abrupt increment in the installation. In year the data shows the nil installation because the scheme was closed dur to the lack of the public interest.

3.10.3 SPV Street Lighting System:

RREC is providing SPV SLS (74 Wp SPV Module with Light Points of 11 W CFL) under Rural Electrification Programme in Rural Rajasthan. Details of approved prices under Programme 2006-07 which is extended upto 31/10/2008 are as under:

Unit Cost	Rs. 30000/-

Subsidy (By GOI / GOR) Rs. 9600/-

Beneficiary Share Rs. 20400/-

3.10.4 SPV Water Pumping Programme:

RREC is providing SPV Pumping Systems with financial support to beneficiary under programme of MNRE, GOI. The details of approved prices of different capacity Pumping Systems are as under:

Subsidy Support available under SPV Water Pumping Programme of MNRE, GOI : Rs. 30/- per watt of SPV module capacity subject to maximum Rs. 50000/- per Pumping System is being provided by GOI under Programme 2007-08.

3.11 COMPONENTS OF WIND ENERGY TECHNOLOGY-

The description of the major components of the wind energy is being discussed below and there components are shown in the Figure 3.5. Most wind turbines have three blades, though there are some with two blades. Blades are generally 30 to 50 meters (100 to 165 feet) long, with the most common sizes around 40 meters (130 feet). Longer blades are being designed and tested. Blade weights vary, depending on the design and materials—a 40 meter LM Glasfiber blade for a 1.5 MW turbine weighs 5,780 kg (6.4 tons) and one for a 2.0 MW turbine weighs 6,290 kg (6.9 tons). There is a controller in the nacelle and one at the base of the turbine. The controller monitors the condition of the turbine and controls the turbine movement. Many wind turbines have a gearbox that increases the rotational speed of the shaft.

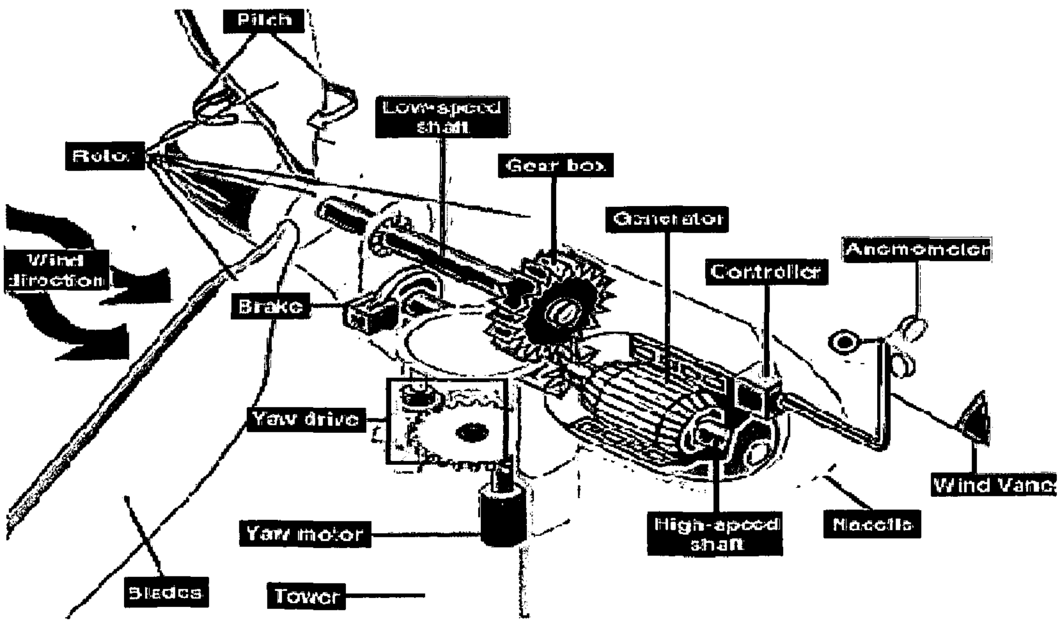


Figure 3.5: Components of wind turbine.

A low-speed shaft feeds into the gearbox and a high-speed shaft feeds from the gearbox into the generator. Some turbines use direct drive generators that are capable of producing electricity at a lower rotational speed. These turbines do not require a gearbox. Wind turbines typically have a single AC generator that converts the mechanical energy from the wind turbine's rotation into electrical energy. The nacelle houses the main components of the wind turbine, such as the controller, gearbox, generator, and shafts. The rotor includes both the blades and the hub (the component to which the blades are attached). Towers are usually tubular steel towers 60 to 80 meters (about 195 to 260 feet) high that consist of three sections of varying heights. (There are some towers with heights around 100 meters (330 feet).

SUZLON	8 x 1500	12	-	
RRB	59 X 230	13.57	-	
ENERCON	124 X 600	74.4		
ENERCON	193 X 800	154.4	73 x 800	58.4
ENERCON	44 X 600	26.4		
		615.22		223.1
Total Installed Capacity				**838.32**

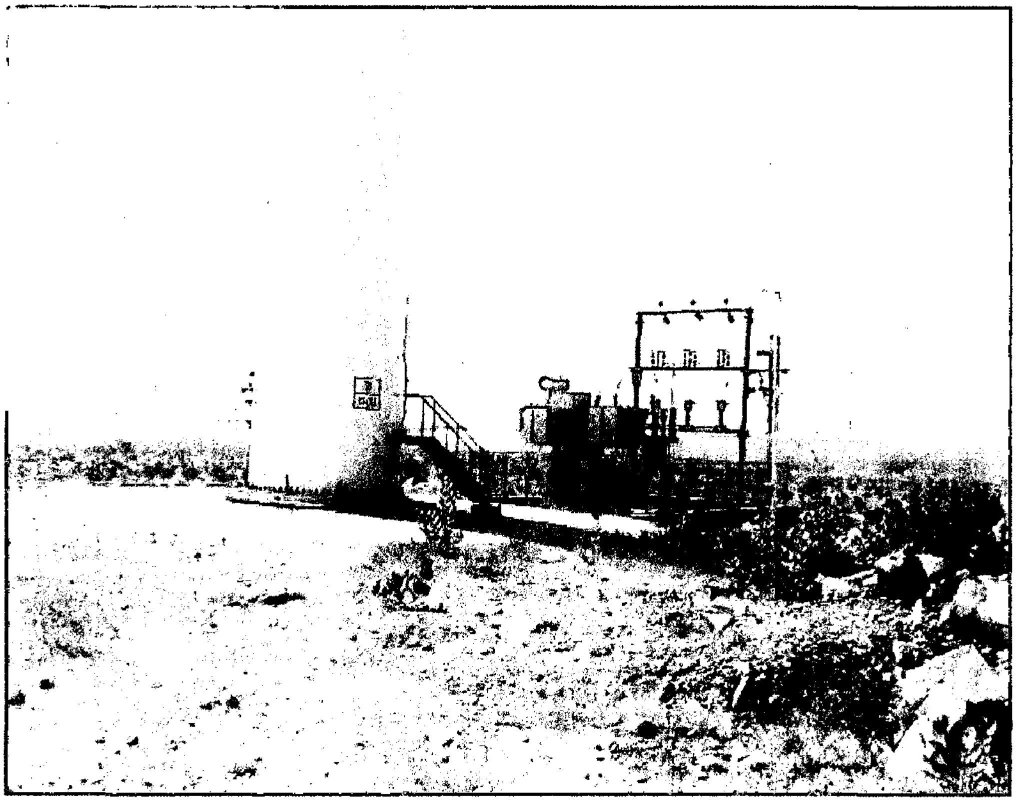


Figure 4.1: Wind projects in Jaisalmer

4.1.2 Solar projects

Solar projects are installed in the form of solar domestic lightning systems, solar street lights, solar direct cooking systems and solar water heaters for community use. The other major way to harness the solar energy is the grid connected power systems. For the national solar mission there is large scope of the solar power generation. Solar domestic lightning is installed to each house of the rural area. If it is no installed in the previous schemes then it will be done in the next schemes.

The PMGY scheme under rural electrification programme covers electrification of remote villages, which are financially unviable due to remote location and far away from grid interactive system requiring long transmission lines for electrification. The villages are

CHAPTER 4

DATA ANALYSIS AND IMPACT PREDICTION

4.1 PRIMARY DATA COLLECTED

The purpose of the site visit is to collect the primary data of related to the renewable energy systems installed. In the desert area major renewable energy systems installed are in the form of solar and wind. These systems are installed in the remote villages or dhani. The system for the installation is only designed for the remote villages.

These data are collected by two ways. The first way was with the help of the project officers of the both wind and solar projects for two of the districts. These data are tells only about the generation and the technological development. The second way was to collect the data on the project site itself. But these data are useful for the study purpose. A questionnaire has been developed for the collection of these data and it is given in the Annex 2. These data tell the story of the actual development due to the project installation. With the help of the local people who lives near the project site answered the question and help for the study of the scenario. These data and the questionnaire is as follow

4.1.1 Wind Projects

Wind project these project are grid connected and the electricity is supply to the Jodhpur Vidhyut Vitran Nigam Limited. These wind turbines are able to generate the electricity at the load factor of 90 in the month of May and June but it reduces to 8 to 9% in the month of November and December due to the cold season. The average plant load factor throughout the year is about 23-25%. The Table 4.1 shows the installation capacity of the wind energy projects in the Jaisalmer and Jodhpur respectively.

Table 4.1: Wind installation capacity in Jaisalmer and Jodhpur District

Make	No. of Machine X Rating of each machine (MW)	Capacity (MW)	No. of Machine X Rating of each machine (MW)	Capacity (MW)
	Jaisalmer		Jodhpur	
BHEL	8 X 250	2	-	
SUZLON	100 X 350	35	6 x 350	2.1
SUZLON	57 X 600	34.2	107 x 1500	160.5
SUZLON	7 X 1000	7	1 x 2100	2.1
SUZLON	205 X 1250	256.25	-	

selected from the list of such un-electrified villages, which has been forwarded by JVVNL, Jaipur. The Ministry of Power, GOI through the Govt. of Rajasthan have allocated funds for the same. RREC has electrified 83 villages PMGY scheme. The average cost of a 10 KW Stand Alone Power Plant with distribution system is around 40 lacs. The plant is capable of supplying electricity to 50 nos. consumers with connected load of 100 Watt. each for 5 to 6 hours in the evening / night. The Figure 4.2 shows the line diagram of the centralised power generation.

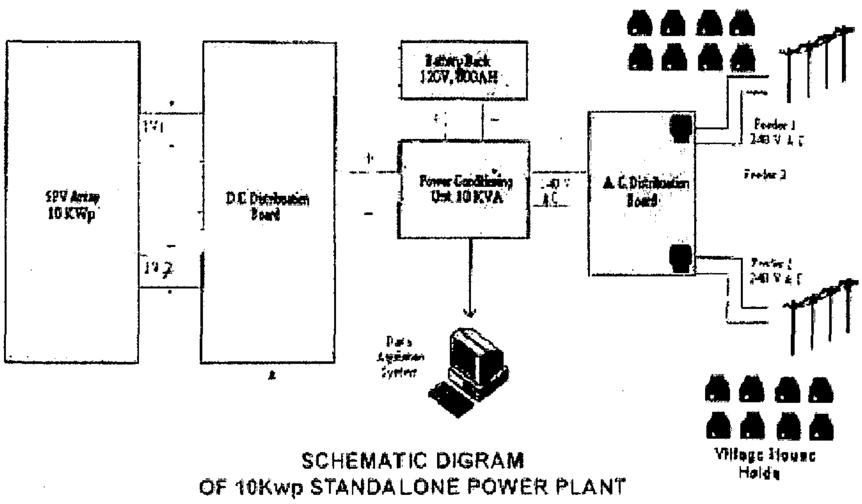


Figure 4.2: Centralized solar power plant

The data given in the Table 4.2 is showing the installation capacity of the solar energy for solar street lightning. Data are showing the installation capacity of the solar projects in the Jaisalmer and Jodhpur Districts. The total capacity of the solar system is calculated around 3.12 MW for Jaisalmer and 13.5 ME for Jodhpur district.

Table 4.2: Solar street lighting systems

Details	Jaisalmer	Jodhpur
Total villages in the district	750	1058
no of solar light to each village	5	5
street light installed are	3750	5290
Power rating of the solar lights	11W	11 W

Table 4.3: Grid connected solar projects

Jodhpur	Jaisalmer	Capacity (kW)
Village Lumbansar Panchayat Samiti Jodhpur	Village Soda G/P Kotadi Panchayat Samiti Jaisalmer	10 + 10
Village Meerpur Panchayat Samiti Jodhpur	Village Ghantiyali G/P Satayaya Panchayat Samiti Jaisalmer	10 + 10
Dungurpura Panchayat Samiti Jodhpur	Moharanwala G/P Akal Ka Tala Panchayat Samiti Jaisalmer	10 + 10
Bhomsagar Panchayat Samiti Jodhpur	Tanot G/P Ramgarh Panchayat Samiti Jaisalmer	10 + 10
Total Capacity in kW		**40 + 40= 80**

Table 4.41: Solar domestic lightning

Details	Jaisalmer	Jodhpur
Total Household	71975.5	318237.1667
unelectrified villages	693	423
electrified villages (DLS)	57	63
DLS installed	655	1038
DLS required to be installed	71320.5	317199.1667
Rating of the solar light	37 W	37 W

Table 4.5: Solar water heaters

Detail	Jaisalmer	Jodhpur
Total villages in the district	750	1058
Total house hold	71975.5	318237.1667
Water heater/50 household	1	1
Solar water heaters installed	1440	6365
Rating of the heaters	1500 units annual	1500 units annual

Figure 4.3: Direct Solar cooking System

Except these projects there is another solar utilization unit is there. It is solar direct cooking system. These cooking systems are installed in only 2 in the Sarva Shiksha Abhiyan in the Jaisalmer district. The specification for the utilization of the system is that the collector size is $12m^2$. The capacity of the system is around 39.6 kWh/day if the incident solar radiation is of the range of 6 kWh/m^2 / day and the efficiency is taken as 55%. It is used to cook the meal for the 100 girl's student who lives in the residential school. The breakfast and the lunch are prepared using this method. The following figure shows the installation of the system.

4.2 LAND USE PATTERN IN JAISALMER

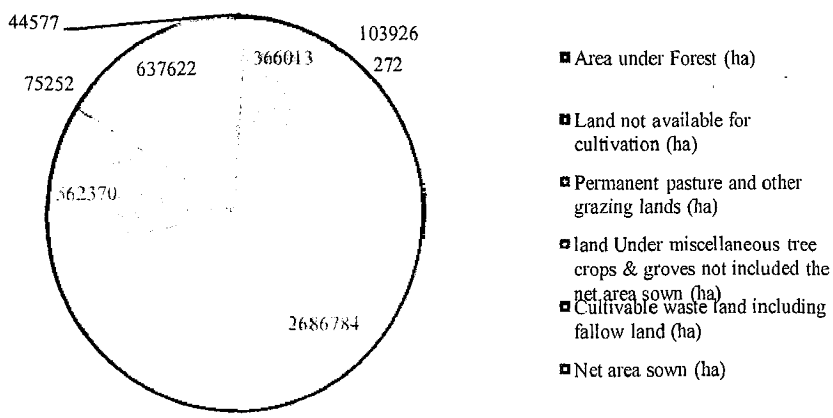


Figure 4.4: Land Use Pattern in Jaisalmer

The Jaisalmer district is the largest district of the state whose area is more then the Kerala. This district holds about 3839154 hectare land. From these total holding around 60 % of the area is under cultivable land. The reason may be the Rajasthan canal. Due to this canal irrigation facility is provided to the farmers and this make the land able to cultivation. The next maximum type of the holding is under gross cropped. This holds around 14% of the total land. The barren and uncultivated land is only 8% which is due to housing and military are. The least land holding is under miscellaneous tree, crop and groves. The area under the forest is only 1% which is very less. The forest area is now converted to the cultivable land and cropping land. This can be seen in the Figure 4.4.

4.3 ELECTRICITY CONSUMPTION PATTERN JAISALMER

The supply to the Jaisalmer district is through the Jodhpur Vidhyut vitran Nigam Ltd. The generation of this electricity is from the Suratgarh district where the thermal power generation station located. In Jaisalmer the other source of the generation is wind and solar. But till the date the generation is very low and uncertain. As shown in the Figure 4.5 the maximum electricity in consumed in the irrigation purpose. The irrigation consumption is high because to draw water from the irrigation canal.

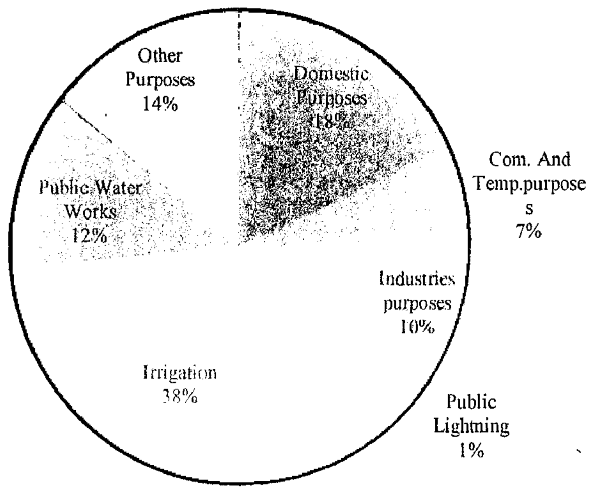


Figure 4.5: Electricity Consumption pattern

Also seen in the previous figure the maximum land use is in cultivation and cropping. So that also gives rough estimation of the electricity consumption. the next electricity consumption is in domestic purpose and public water work. The public water work is a big user of electricity because there is low water table and to supply water in the remote and interior villages. The industrial sector uses only 10% of the electricity. This indicates there is large scope of the industrial revolution. There is vast land and good to implement industry.

4.4 LAND USE PATTERN IN JODHPUR

The Figure 46 is indicating the total reporting area of the Jodhpur district is 2256405 hectare. The least land holding is under miscellaneous tree crops and groves not included in the net area planted. The forests are in again very less about 1% of the total area. There is again no specific land that can be called as forest. Now the maximum land is under non-cultivation about 64 % and 23% of the land in under agriculture use. Due to more urbanization there is less land is under the pasture and grazing purpose.

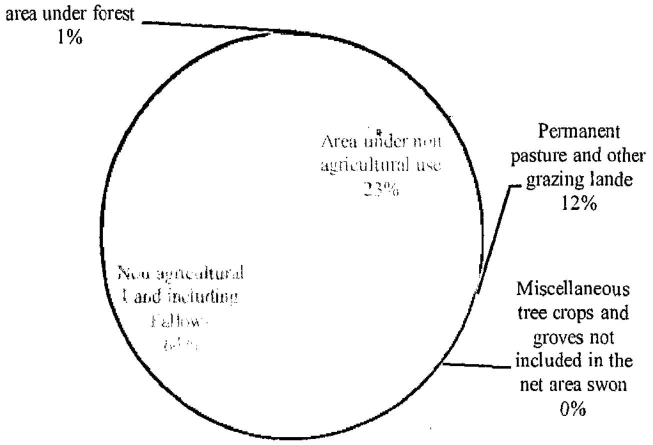


Figure 4.61: Land use in Jodhpur

4.5 ELECTRICITY CONSUMPTION PATTERN IN JODHPUR

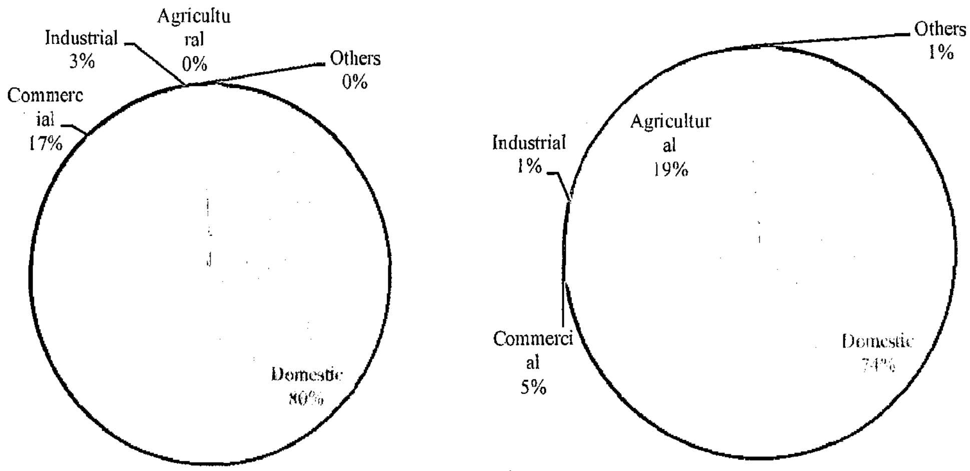


Figure 4.72: Electricity consumption in Urban area and rural area

The first figure 4.7 (a) demonstrate the electricity consumption pattern in the Jodhpur urban area and the second Figure 4.7 (b) shows consumption in rural area. The major difference is noticeable in the consumption in agriculture sector. The different is of about

19% of the total consumption. The data shows that the urban area uses the 1.02 times more electricity than the rural area. This is not the major difference. The industrial use of the electricity in both areas is very less is 3% in urban and 1% in rural area. The commercial use of electricity in urban sector is around 17% and in only 5% of electricity is used in urban sector. This much less amount of electricity consumption in industrial sector shows chance to promote the industrial development. This promotion will lead to employment and revenue generation. Govt. should take steps for the schemes for the promotion of the industries.

The other data for the impact analysis is collected from the local people living near the power plants or who are the benefiters'. The selected questions related to the changes in the living style and environment effect. Some questions are not to be required to answer. These questions are based on the visual inspections. The question's major points are related to environment and social upliftment.

4.6 DATA COMPILATION

Compilations of a various type of data collected by different means are as follow:

4.7 DATA FROM JAISALMER

4.7.1 Domestic Lightning Systems in Jaisalmer

The total villages are 750 whose population is around 431853 using 6 inhabitants per household. So that there are total households are 71975. Out of these 750 villages 495 villages are electrified and from these 495 only 57 villages have solar domestic lights. Left behind 655 villages are the targets of at least one solar domestic light per housel hold. Total domestic light has been installed till date is only 655 and according to the target close to 70 thousand lights are more required. In near future if all houses install solar domestic lights of capacity 37W and 12 volt and 40AH rating then it will save about 39MW/year. This saving will take place with different consuming pattern. This burning up will be consumed if the ratio is in 2:2:1 form. The lightning hours will be 6 hours for the light and 7hours for the fan and it any house hold has TV then it will run for 4 hours per days. The rating of the TV is 20W and rating of the fan is again 20 W. This utilization patterns saves on 0.4 million liters of the diesel. The total CER generated from this system is around 3218.41. The calculation is given in Table 4.6.

Table 4.6: Domestic Lightening System Installation Details in Jaisalmer District

Domestic Lightening System Installation Details in Jaisalmer District			
total villages	750		
total rural population	431853		
Population per house hold	6		
Total Household	71975.5		
electrified villages	495		
unelectrified villages	693		
electrified villages (DLS)	57		
DLS installed	655		
DLS required to be installed	71320.5		
Specification of DLS 37 W (12V and 40 AH)	2 lightening point of 9W	1 lightening point 9W + 1 point for fan 20 W	1 lightening point 9W + 1 point for portable TV 20 W
Lightening hours	6 hours of lightening	6 hours for light and 7 hours fan	6 hours for light and 4 hours for TV
Electricity comsumed (Wh/year)	39420	70810	48910
Percentage of house hold using this pattern	40%	40%	20%
No of house	28790.2	28790.2	14395.1
Total power consumption (Wh/year)	1134909684	2038634062	704064341
total power to be saved through this pattern (Wh/year)	3877608087		
Saving of diesel through Solar lightening system (million liters)	0.383499743		
CER generated	3218.414712		

4.7.2 Centralized Solar power plant

The Table 4.7shows that there are 4 projects of the 10 centralized solar power plants. The plants are designed to work for 7 hours per day. There is a battery bank is also available to make the electricity available during off sunshine hours. If the average working hour of the solar panel is 7 hours per day then it will be able to save round of 10 thousand liters of the diesel if replaced by the diesel generator set. The total CER generated from the grid connected systems is around 72 thousands.

Table 4.7: Secondary data from the grid connected Solar projects (Jodhpur)

Description of the project	Capacity (kW)
Village Soda G/P Kotadi Panchayat Samiti Jaisalmer	10
Village Ghantiyali G/P Satayaya Panchayat Samiti Jaisalmer	10
Moharanwala G/P Akal Ka Tala Panchayat Samiti Jaisalmer	10
Tanot G/P Ramgarh Panchayat Samiti Jaisalmer	10
Total Capacity in kW	40
Working Hours per day	7
Days in year	365
Total yearly Electricity generated from plant kWh	102200
Saving of diesel from this pattern (litres)	10107.7
CER Generated	8482.6

4.7.3 Direct Cooking System

Keen on the sarva shiksh abhiyan the Govt. of the state has provided the facility of the direct cooking system. This cooking system scheme is launched only in two schools. Both of the schools are in Jaisalmer district. These schools are residential girl's schools. The strength of the school is 100 students. The breakfast and the meal are cooked under this scheme. The size of the receiver is 12 m^2. Its orientation can be change according to the season. Because the lack of the solar radiation in the winter season. For the breakfast the can prepare tea and make one dish like daliya. For the lunch time the perpetration hours are around 2 hours. It can make dhal, rice and halwa for lunch time. Before this cooking system the food was used to cook on the wood and some time on the LPG. If the entire system was based on the fire wood then this systems replaces around 16 lacs kg of the wood per year. And it saves 6 lacs kg of wood.

4.7.4 Centralized Solar power plant

The Table 4.8shows that there are 4 projects of the 10 centralized solar power plants. The plants are designed to work for 7 hours per day. There is a battery bank is also available to make the electricity available during off sunshine hours. If the average working hour of the solar panel is 7 hours per day then it will be able to save round of 10 thousand liters of the diesel if replaced by the diesel generator set. The total CER generated from the grid connected systems is around 72 thousands.

Table 4.8: Secondary data from the grid connected solar projects

Description of the project	**Capacity (kW)**
Village Soda G/P Kotadi Panchayat Samiti Jaisalmer	10
Village Ghantiyali G/P Satayaya Panchayat Samiti Jaisalmer	10
Moharanwala G/P Akal Ka Tala Panchayat Samiti Jaisalmer	10
Tanot G/P Ramgarh Panchayat Samiti Jaisalmer	10
Total Capacity in kW	40
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Days in year	365
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Table 4.9: Direct Cooking systems under Sarva Shiksha Abhiyan

No of students in the school		100
Time Taking (min)		
Breakfast	tea	30
	daliya	40
Lunch	dal	45
	rice	40
	chapati	45
Total Cooking Time/day		200
Cooking item I hours		3.33
Working days in year		250
Radiation Intensity (Wh/m2/ day)		6400
Total Working Hours		833.33
Working days		104.16
Area of Receiver m2		12
Total energy saved (Wh)		8000000
Calorific value of Cooking Gas (kWh/kg)		13.14
Saving of cooking gas (kg)		608750.79
Calorific value of Kerosene (kWh/liter)		9.72
Saving of kerosene		62 thousand liter
Calorific value of fuel wood (kWh/kg)		5
Saving of Fuel wood (kg)		16 lacs
CER generated		6.64

4.7.6 Solar Water heater system

Government has promoted the program for solar water heating system for the community use. This system can save the consumption of the wood from the lavishly flaming. The CER generated from the projects are 7168760 which are due to the saving of 86 lacs units from heaters. The table of the calculation is given below Table 4.10.

Table 4.102: CER generation from the solar water heating system

Total villages	750
Rural population	431853
one heater per person	75
heater required	5758.04
saving from one heater in the year (kWh)	1500
Saving from all water heaters (MWh)	8637060
CER generated	7168760

4.7.7 Solar street lighting system

The Table 4.11 is indicating that for 750 villages it is planned that minimum 5 solar street lights has to be install for a village. This will save 1500 units per year and 12 CER.

Table 4.11: CER generated from the solar street lightning systems

Total villages	750
target for the solar street light per village	5
total lights to be install	3750
rating of the solar light (W)	11
working hours in year	4015
power saved (MWh)	15.05625
CER generated	12.4966875

4.7.8 Wind energy plants (Grid Connected)

Rajasthan Govt. has made various plans for the promotion of the wind energy. Many national and multinational companies are there to install there projects. The major companies are BHEL, SUZLON, ENERCON etc. the total installation capacity till the end of the march 2010 is 615.22 MW in Jaisalmer district. As shown in the table 4.12 the plant load factor is considered as 0.8 then in a year the total generation will be 43 lacs MWh. The wind energy has a lot of uncertainty. Due to these uncertainties the plant load factor is that much low. All the wind energy power plants are grid connected. If it replaces the diesel generator system in that case it can save approximately 4 lacks liters of the diesel fuel. Furthur the CDM benefits can be calculated as in the Table 4.13.

Table 4.12: Saving of Diesel using grid connected wind projects

Grid Connected Wind Energy Plants		
Make	Capacity (MW)	No. of M/c X Rating
BHEL	2	8 X 250
SUZLON	35	100 X 350
SUZLON	34.2	57 X 600
SUZLON	7	7 X 1000
SUZLON	256.25	205 X 1250
SUZLON	12	8 x 1500
ENERCON INDIA Pvt. Ltd.	13.57	59 X 230
ENERCON INDIA Pvt. Ltd.	74.4	124 X 600
ENERCON INDIA Pvt. Ltd.	154.4	193 X 800
M/s RRB	26.4	44 X 600
Total Capacity (MW)		615.22
Plant load factor		0.8
Working hours		8760
Total electricity generated (MWh)		4311461.8
Saving of diesel fuel (million liter)		426408.31
Reduction in carbon emission		3578513

Table 4.13: CDM Benefits from Jaisalmer wind energy projects

CDM Methodology applied	ACM002/version07
calculation method	Combined margin
Operating margin	75%
Build margin	25%
Values for Combine margin	
Operating margin	1
Build margin	0.71
Combines margin	0.93
Project generation net (MWh/yr)	431146.176
Projected Emission Reduction (tCO2/year)	400965.9437
Cost of 1 tonn of carbon in market	661.2
Total CDM cost from the project (Rs.)	26.5118682

4.2.7 Improved Chulha

There are roughly 71975 houses in the Jaisalmer district. Out of these houses only 60% of the households are using the conventional chulha for cooking the food and other chores. The wood requirement for the conventional channel is 345480 kg if the wood consumption is 8 kg per household per day. If the presented systems are altered by the improved chulha then the wood consumption will be reduced by 10000 kg. It will replace 1.06 kg of the LPG and 1.13 kg of kerosene. The carbon reduction using this technology is only 0.011. The calculation is in Table 4.14.

Table 4.14: Saving of wood by using improved chullah in Jaisalmer

Total household in Jaisalmer	71975
60% household using conventional chulha	43185
Wood required per household (kg/day)	8
Wood consumption (kg)	345480
Total wood requirement (per year)	28070.25
Calorific value of wood (Wh/kg)	0.5
Energy generated (kWh/year)	14.035125
Improved Chulha Efficiency	35%
Wood required for improved chulha (kg)	18245.663
Reduction of wood quantity in improved chulha (kg)	9824.5875
Replacement of Kerosene (kg)	1.13
Replacement of LPG (kg)	1.0680409
Reduction in Carbon Emission	0.0116492

4.7.9 Biodiesel

There is an outsized area not used for the agriculture. Again due to the Rajasthan canal there is no lack of the water. Using the non-cultivating area by growing Jatropha as the crop and produce the biodiesel will save large amount of the diesel. The entire un-cultivated area is used for Jatropha cultivation then approximate 1000 lacs liters of biodiesel can be produced. This biodiesel can save 922 lacs liters of the diesel. The calorific value of the biodiesel is 10 times less than the calorific value of the diesel fuel. Reduction in the carbon emission is around 8 lacs. The calculation is given in the Table 4.15.

Table 4.15: Carbon emission reduction using biodiesel

Area under non agriculture use (hectare)	224713
Production of Jatropha seeds (liters/hectare)	400
Total oil production of oil (liters)	89885200
Calorific value of Jatropha biodiesel (kWh/liter)	11.01
Total power generated (yearly) (kWh)	989636052
Calorific value of Diesel (kWh/liter)	10.722
Replacement of Diesel fuel (liters/year)	92299575.83
CER Generated	821397.9232

4.7.10 Biomass Production

Large amount of the land is used for the cultivation. And the other two classification of the land use is also gross cropped area and area sown more than once. These all types of the area are able to generate the crop residue of around 10000 kg per hectare. If the entire crop residue is used for the production of the producer gas then the production will be 14665 million m^3. This will guide the saving of the diesel fuel around 1173 million liters. But the problem with the producer gas production it's smoke generation. And this make the environment polluted. The reduction in the carbon emission is 1crore. The Table 4.16 is showing calculation.

Table 4.16: Energy saving using biomass

Net area sown (ha)	562370
Area sown more than once (ha)	75252
Gross Cropped Area (ha)	637622
Average Crop residue per hectare (kg/hectare)	10000
Total residue production (million tonnes)	6.37
Producer gas production per kg of residue (m^3)	2.3
Total Gas production (m^3)	14665306000
Energy generated from gas (kWh/year)	12570980627
Saving of Diesel fuel (liters/year)	1172447363
CER generated	10433913.92

4.7.11 Biogas Production

Biogas is mainly produced with the aerobic and anaerobic fermentation of the dung and animal waste. Each kind of the animal has its own capacity for the dung generation. Local population has tendency to keep livestock. A large population of livestock is live here. Cattle, cow, buffalo, camel and sheep are in majority. The biogas plants can be implemented for the community use. The community based biogas plant can use the waste generated from all the livestock. The total efficiency is considered for the designing of the plant is 55%. As per the waste collection according to the efficiency the total gas generated is about 40 million liters per year. This amount of the biogas can replace the 23 million liters of kerosene. This mount of the gas production will save large amount of the price regarding to the transportation cost and cost of expensive fossil fuel. Using this system there is reduction in the carbon emission us upto 18500. Table 4.17 is showing the calculation of the biogas generation

Table 4.17: Calculation of diesel saving using biogas

Item	Particulars	Dund Produced per animal	Dung produced per day (kg)	No of days in year	Yearly dung production (kg)
Cattle	359360	10	3593600	365	1311664000
Buffaloes	2653	15	39795	365	14525175
Pigs	713	0.8	570.4	365	208196
Camel	38969	4.5	175361	365	64006582.5
Sheep	1291243	0.435	561691	365	205017107.3
Goats	1132856	0.54	611742	365	223285917.6
Horses & Ponies	728	5.6	4076.8	365	1488032
Dogs and Bitches	11093	0.64	7099.52	365	2591324.8
Total poultry	20834	0.18	3750.12	365	1368793.8
Total dung produced through out the year (kg)					1824155129
Efficiency in dung collection					55.00%
Dung available for energy generation (kg)					1003285321
Biogas produced (litres/kg)					0.04
Total biogas production (m3)					40131412.84

Calorific value of biogas (kWh/m3)	5.55
Total energy generated/year (kWh)	222729341.3
Saving of Kerosene per year (million liter)	22.9
Saving of Diesel per year (million liter)	20.77
CER generated	18486.53532

4.8 DATA FROM JODHPUR

4.8.1 Domestic Lightning Systems in Jodhpur

The total villages are 1058 whose population is around 1909423 using 6 inhabitants per household. So that there are total households are 318238. Out of these 1058 villages only 423 villages are un-electrified and only 63 villages have solar domestic lights. Left behind 360 villages are the targets of at least one solar domestic light per housel hold. Total domestic light has been installed till date is only 1038.and according to the target close to 3.17 laces lights are more required. In near future if all houses install solar domestic lights of capacity 37W and 12 volt and 40AH rating then it will save about 17088 MWh/year. This saving will take place with different consuming pattern. This burning up will be consumed if the ration of 2:2:1 in number of consumers. The lightning hours will be 6 hours for the light and 7hours for the fan and it any house hold has TV then it will run for 4 hours per days. The rating of the TV is 20W and rating of the fan is again 20 W. This utilization patterns saves on 0.4 million liters of the diesel. The reduction in the carbon emission is reduced by 14183 CER. The Table 4.18 is containing calculation.

4.8.2 Solar Water Heater

The same as made known in the table 4.5 , 75 citizens requires one solar water heater of capacity of 100 liters. As a result the installation requirement of the water heaters is 25460 approximately. One heater saves 1500 units per year then the total units saved will be 38188.46 and emission reduction will be 31696 from the installed projects. The calculation of energy saving is shown in Table 4.19.

Table 4.18: Domestic Lightening System Installation Details in Jodhpur District

Total villages	1058		
Total rural population	1909423		
Population per house hold	6		
Total house hold	318237.1667		
Unelectrified villages (connections)	423		
electrified villages (DLS)	63		
Remaining unelectrified villages	360		
DLS installed	1038		
DLS required to be installed	317199.1667		
Specification of DLS 37 W (12V and 40 AH)	2 lightening point of 9W	1 lightening point 9W + 1 point for fan 20 W	1 lightening point 9W + 1 point for TV 20 W
Lightening hours	6 hours	6 hours for light and 7 hours for fan	6 hours for light and 4 hours for TV
Electricity Consumed (Wh/year)	39420	70810	48910
Percentage of house hold using this pattern	40%	40%	20%
No of household using this pattern	126879.6667	126879.6667	63439.83333
Total power consumption(Wh/year)	5001596460	8984349197	3102842248
Total power will be saved through this pattern (Wh/year)	17088787905		
Total amount of diesel will be saved (million liters)	1.690100088		
CDM benefit	14183.69396		

Table 4.19: CER generated from water heating system

Total villages	1058
Total rural population	1909423
one heater per person	75
heater required	25458.97333
saving from one heater in the year (kWh)	1500
Saving from all water heaters (MWh)	38188.46
CER generated	31696.4218

4.8.3 Solar street lightning system

The Table 4.20 indicating the target of the government is to install at least 5 solar street lights in each village. The power rating of the light is 11W and the blazing hours are 11 in a day and 365 days in a year. As a result the CER generated are 17.62.

Table 4.20: Power saved from solar street lightning system

Total villages	1058
target for the solar street light per village	5
total lights to be install	5290
rating of the solar light (W)	11
working hours in year	4015
power saved (MWh)	21.23935
CER generated	17.6286605

4.8.4 Centralized Solar power plant

The Table 4.21 shows that there are 4 projects of the 10 centralized solar power plants. The plants are designed to work for 7 hours per day. There is a battery bank is also available to make the electricity available during off sunshine hours. If the average working hour of the solar panel is 7 hours per day then it will be able to save round of 10 thousand liters of the diesel if replaced by the diesel generator set.

Table 4.21: Diesel saving from the grid connected solar projects

Description of the project	Capacity (kW)
Village Soda G/P Kotadi Panchayat Samiti Jaisalmer	10
Village Ghantiyali G/P Satayaya Panchayat Samiti Jaisalmer	10
Moharanwala G/P Akal Ka Tala Panchayat Samiti Jaisalmer	10
Tanot G/P Ramgarh Panchayat Samiti Jaisalmer	10
Total Capacity in kW	**40**
Working Hours per day	7
Days in year	365
Total yearly Electricity generated from plant kWh	102200
Saving of diesel from this pattern (liters)	10107.7
Carbon Reduction in CER	8482.6

4.8.5 Wind energy plants (Grid Connected)

Rajasthan Govt. has made various plans for the promotion of the wind energy. Many national and multinational companies are there to install there projects. The major companies are BHEL, SUZLON, ENERCON etc. The Table 4.22 is indicating towards the total installation capacity till the end of the march 2010 is 223.1 MW in Jodhpur district. The plant load factor is considered as 0.08 then in a year the total generation will be 15 lacs MWh. The wind energy has a lot of uncertainty. Due to these uncertainties the plant load factor is that much low. All the wind energy power plants are grid connected. If it replaces the diesel generator system then it can save around 1.5 lacs liters of the diesel fuel. Table 4.22 is showing the amount of diesel fuel replaced from wind energy project

Table 4.22: Amount of the diesels fuel replaced

Make	Capacity (MW)	No. of M/c X Rating
Suzlon	2.1	6 x 350
Suzlon	160.5	107 x 1500
Suzlon	2.1	1 x 2100
ENERCON	58.4	73 x 800
Total Installed capacity		223.1
Plant load factor		0.8
Working hours per day		24

Working days	365
Total power generated (MWh)	1563484.8
Saving of diesel	154630.53
CER generated	1297692.4

Table 4.23: CDM benefits of wind energy generation in Jodhpur District

CDM Benefits	
CDM Methodology applied	ACM002/version07
calculation method	Combined margin
Operatin margin	75%
Build margin	25%
Values for Comine margin	
Operating margin	1'
Build margin	0.71
combines margin	0.93
Project generation net (MWh/yr)	1563484.8
Projected Emission Reduction (tCO2/year)	1454040.864
Cost of 1 tonn of carbon in market	661.2
Total CDM cost from the project (crore Rs.)	961411819.3
CDM revenue from wind project in Crore Rs.	96.14118193
Per MWh/year CDM revenue	614.916

4.3.6 Improved Chulha

There are approximately 318237 household in the Jodhpur district. Out of these houses only 35% of the households are using the conventional chulha for cooking the food and other chores. The wood requirement for the conventional chulha is 891064 kg if the wood consumption is 8 kg per household per day. If the presented systems are altered by the improved chulha then the wood consumption will be reduced by 113.8 million kg. it will replace 12000 liters of LPG or 10000 liters of kerosene. The reduction in the carbon emission is very less upto 0.000135. The calculation Table 4.24 can be referring.

Table 4.24: Saving of wood by using improved chullah

Saving of wood by using improved chulha	
Total household in Jodhpur	318237
35% household using conventional chulha	111383
wood required per household (kg/day)	8
Wood consumption	891064
Total wood requirement (million ton per year)	325.238
calorific value of wood (Wh/kg)	0.5
Energy generated (kWh/year)	0.16262
Improved Chulha Efficiency	35%
Wood required for improved chulha (kg)	211.405
Reduction of wood quantity in improved chulha	113.833
Replacement of Keroscene (kg)	0.01
Replacement of LPG (kg)	0.01237
CER generated	0.00013

4.8.6 Biodiesel

There is an outsized area not used for the agriculture purpose. Again due to the Rajasthan canal there is no lack of the water. Using the non-cultivating area by growing Jatropha as the crop and produce the biodiesel will save large amount of the diesel. From the 2686784 hectare land about 1074.7 million liters of the biodiesel can be generated. This much generation of the biodiesel will save 1103 million liters of fossil diesel. Using this system the reduction in the carbon emission is upto the level of the 9821055. The calculation is given in Table 4.25.

Table 4.25: Energy saving from the use of Jatropha biodiesel (Jodhpur)

Area under non agriculture use (hectare)	2686784
Production of Jatropha seeds (liters/hectare)	400
Total oil production of oil (liters)	1074713600
Calorific value of Jatropha biodiesel (kWh/liter)	11.01
Total power generated (yearly) (kWh)	11832596736
Calorific value of Diesel (kWh/liter)	10.722
Replacement of Diesel fuel (liters/year)	1103581117

CER generated	9821055.291

4.8.7 Biomass Production

Jodhpur land has good cropping capacity. The major crops grown here are maize, guar, bajra, wheat etc. Large amount of the land is used for the cultivation. These all types of crops give good production and produce large amount of residue. These residues are able to produce biomass. After processing of this biomass produced gas can be generate. This producer gas can be burn like LPG. If the entire crop residue is used for the production of the producer gas then the production will be million 1613 million m^3. This will guide the saving of the diesel fuel around 1754 million liters. But the problem with the producer gas production it's smoke generation. And this make the environment polluted. Biomass production will reduce the carob emission upto 1516500 CER's. Refer Table 4.26.

Table 4.26: Reduction in carbon emission with the help of biomass-generated

Crop	Area (ha)	Production (MT.)	Production kg	Residues per kg of production	Total residue production (MT)
Maize	0	0	0	2.3	0
Guar	82821	4969	4969000	2	9938000
Bajra	570594	34236	34236000	2.63	90040680
Moth	450442	6770	6770000	1.8	12186000
Moong	81862	2783	2783000	1.26	3506580
Chanwla	0	0	0	1.1	0
Till	44996	1350	1350000	1.47	1984500
Groundnut	20968	37742	37742000	2.3	86806600
Chilli	10000	120000	120000000	1.5	180000000
Cotton	8132	3253	3253000	2.2	7156600
Wheat	34000	74800	74800000	1.8	134640000
Barley	1500	3150	3150000	1.3	4095000
Chana	0	0	0	1.3	0
Isabgol	7300	1095	1095000	2.2	2409000
Rap (Sarso)	0	0	0	1.8	0

Mustard(Raida)	71500	92950	92950000	1.8	167310000
Taramira	2000	600	600000	1.8	1080000
Total residue produced from all the crops					701152960
Producer gas from per kg of dry residue (m3)					2.3
Total gas produced from residues (m3)					1612651808
Energy generated from the gas (kWh/year)					1881319599
Net diesel fuel will be replaced (liters)					175460223
CER generated					1561495.27

4.8.8 Biogas Production

Aerobic and anaerobic fermentation changes animal waste and dung into a useful thing. This process makes biogas. This gas can be use instead of the LPG. Local population has tendency to keep livestock. And there is a good business of the poultry also. Cattle, cow, buffalo, camel and sheep are in majority. The biogas plants are able to be implemented for the community use. The community based biogas plant can use the waste generated from the all the livestock. The total efficiency is considered for the designing of the plant is 55%. As per the waste collection according to the efficiency the total gas generated is about 40 million liters per year. This amount of the biogas can replace the 23 million liters of kerosene. This mount of the gas production will save large amount of the price regarding to the transportation cost and cost of expensive fossil fuel. This process is reducing the carbon emission in the environment upto the level of 405251.25 CER Table 4.27 is containing the calculation part.

Table 4.27: Calculation for the reduction in using diesel fuel using cattle dung

Description	Number (Lacs)	dung (kg/ day/head)	Total Dung Produced per day	No of days in year	Total yearly dung Produnction (Lacs kgs)
Cattle	5.19	10	51.9	365	18943.5
Buffaloes	2.16	15	32.4	365	11826
Goats	10.36	0.54	5.5944	365	2041.956
Sheep	8.84	0.435	3.8454	365	1403.571

Camel	0.3	4.5	1.35	365	492.75
Poultry	0.37	0.18	0.0666	365	24.309
Others	1.44	10	14.4	365	5256
Total	28.66				**39988.086**
efficiency in dun collection					55%
Dung collected (lakhs kg)					21993.4473
Biogas from dung (m3/kg)					0:04
Total gas production (lakhs m3)					879.737892
Calorific Value kWh/m3					5.55
Total energy generated/year (million units)					488.2545301
Saving of Keroscene (million liters)					50.22161387
Saving of diesel (million liters)					45.53763571
CER generated					405251.2599

4.9 IMPACT PREDICTION

Impact assessment is followed by the impact prediction. At this time prediction of the impact has to be carried out so that it can give impression of the project, impacting the various factors in a manner. The impact predictions of the solar energy and wind energy projects are given described below:

4.10 PHYSICAL AND CHEMICAL IMPACT

4.10.1 Ground cover and land use-

For low/medium heat systems it is the characteristics of the chosen system, which define the land use. For instance, in the case of single-dwelling hot water or space heating/cooling, no land will be required since the system will usually be added to the roof of the existing building. Communal low-temperature systems might use some land, though again the collection surfaces might well be added on already existing buildings. The principal additional use of land might be for heat storage. For high temperature systems, the land-use requirements of concentrating collectors providing process heat are more problematical. Concerning the loss of habitat and changes to the ecosystem due to land use in the case of large-scale systems, provided that predevelopment assessments are carried out and ecologically important sites are avoided, these are unlikely to be significant. These large land use carries toward the vegetation loss because of the increasing the temperature and makes the land unfit for the living.

But as the project installed some amount of the trees are cut so it shows negative impact on the ground cover. There is no permanent impact on the ground cover of the project. After the removal of the project the vegetation will be as before. The wind turbines are installed at the distance of the 10 to 15 m so that blades do not strike each other. The projects use only 1% of the land taken by the user

4.10.2 Air/ Wind

There are no direct air emissions from operating a solar facility. Depending on the solar technology used, some power block emissions are possible from process boilers (combustion-related criteria pollutants and hazardous air pollutants) and cooling towers (small amounts of particulate matter. Transport emissions were still only 0.1– 1% of manufacturing related emissions. In the case of poly- and mono-crystalline modules, the estimated emissions are 2.757–3.845 kg CO2/kWp, 5.049– 5.524 kg SO2/kWp and 4.507–5.273 NOx/kWp. In urban environment, modern PV systems, which are architecturally integrated into buildings, are able to provide a direct supply of clean electricity that is well matched to the demand of the building, but can also contribute to day-lighting, and the control of shading and ventilation.

Also, PV panels can be used instead of mirrors directly into the facade of a building. PV systems also assist to create a supportive environment within which to encourage other means of energy saving by the building promoters, owner s and users. PV energy services are particularly obvious where only low levels of power are needed, such as in rural electrification applications, and where the users are able to benefit directly from the very high reliability of having their own PV generator. In the former case, to install a PV generator is frequently cheaper than to extend the mains grid over long distances.

The wind has the impact on the generation. So the magnitude of the impact related to the region. If the wind speed is disturbed or become less then it directly reduces generation. And all the wind projects are grid connected impacts the regional generation. So the magnitude of the change is negative. But the change is not permanent. Impact is reversible and if the project is removed then the original state will be restore. These impacts are non cumulative.

4.10.3 Elevation

Solar energy does not impact on the elevation.

The wind has the impact on the generation. If the wind speed is disturbed or become less then it directly reduces generation. And all the wind projects are grid connected impacts the regional generation. There is not any sort of impact is imposed on the elevation from the wind generating plants.

4.10.4 Water Quality

Except for the normal use, there may be the risk of accidental water pollution through leaks of heat transfer fluid. In parallel, so large converters can achieve relatively high temperatures if their coolant is lost (up to 200^0C). Consequently, at this temperature, there is a fire risk, with the additional problem of out-gassing from panel components (insulant, plastic components, epoxys) and the release of heat transfer fluids in gaseous state or following combustion (e.g. burnt freon).The solar power plants not directly impact the water. But in case of the disposal of the life ended batteries the liquid is disposed in the water and it makes water polluted. The water is considered RCRA K065 hazardous waste due to the lead content.

Wind energy is not directly coming into the contact of water. So there is not any major emission in the water. But at the construction phase water may contaminate water. But when the wind farms are installed in the ocean the oil spill harms the aquatic life and sea water. During the upgrading works a number of potential pollutants may be present on site, including oil, fuels, chemicals, unset cement and concrete. Any pollution incident occurring on the site may detrimentally affect the water quality of the nearby surface waters and groundwater. Where there are fisheries and water supply interests this may have a significant impact.

4.10.5 Ground water table-

As mentioned previously there is not impact on the ground water in the case of solar energy. The emission into surface water is able to spoil the ground water. But the manufacturing is not upto this level that is not able to ground water.

Water would be used for dust control when clearing vegetation and grading, and for road traffic; for making concrete for foundations of towers, substations, and other buildings; and for consumptive use by the construction crew. Water could be trucked in from off-site or obtained from local groundwater wells or nearby surface water bodies, depending on availability.

Surface and groundwater flow systems could be affected by withdrawals made for water use, wastewater and storm water discharges, and the diversion of surface water flow for access road construction or storm water control systems. Excavation activities and the extraction of geological materials could affect surface and groundwater flow. The interaction between surface water and groundwater could also be affected if the surface water and groundwater were hydrologically connected, potentially resulting in unwanted dewatering or recharging of water resources.

4.10.6 Soil Structure –

Soil structure is an important issue for the local habitants. It changes if there is large scale of excavation is there but in solar projects there is very less excavation will be required only to plant the solar panel. The large area is covered due to the installation of the solar panels but it does not show any impact on the soil structure.

Wind is impacting the soil structure in the manner of soil erosion. The excavation for the implanting the wind turbine is leading toward the soil erosion. The implanting the wind turbine loose the land and the wind speed take away the soil far away. This will lead towards the erosion.

4.10.7 Temperature-

Solar power generation is increases the temperature of the surrounding. Solar thermal installation rise the temperature. Growth of vegetations is reduces and it make tough to live near by places. The rise in temperature also increases the fire hazards.

Wind energy is not impacting the temperature.

4.10.8 Noise-

There is not any sort of noise generation from the solar project during the operation period. The disturbing noise is generated when the construction period in going on. But that period is very short so it does not harm the wildlife. A bit of noise comes from the solar parabolic trough but it is avoidable in the day time and for the night time the system is does not work.

Wind power plant cause very much noise on the. The major problem with the wind projects is noise. The noise produced by wind turbine has a thumping, pulsing, character, especially at night, when it is more audible. The noise observing location depends on the turbine construction, its operation and the following situational factors:

- The distance between residential area and the wind turbine
- Operating conditions of the wind turbine
- Wind turbine components

- Characteristics of the noise source, i.e. tonality and impulsive character etc.

There are two potential noise sources from the wind power plant; one is mechanical and other from aerodynamic noise. Mechanical Noise- the mechanical noise is emitted from the wind turbine due to relative rotation of drive train, components like gearbox, generator, yaw motors, cooling fans, hydraulic pumps and other accessories. The noise from these components frequently contains more or less prominent tones, whose amplitude and also frequency fluctuates slightly in rhythm with the blade passing frequency of the rotor. Occasionally low levels of mechanical noise also arise from pitch control motors. All mechanical noise sources are contained within the wind turbine nacelle. Several techniques are used to mitigate this noise source. These include special isolating mounts and the use of acoustic isolation to dampen noise.

4.11 BIOLOGICAL AND ECOLOGICAL IMPACT

4.11.1 Flora and Fauna

Small solar power generation units are not affecting the flora and fauna but solar farms are affecting the flora as well as fauna. The temperature is increased dur to heating of the solar panel. This temperature is leads towards the damage of local vegetation. The dumping of the emitted chemical may harm the flora and fauna. If the large area is under the influence of the emission then food chain will also get affected of this.

Wind energy is in impacting the flora and fauns in some negative and in some positive manner. The negative manner is that it kills the flying bird by the rotating blades. Lot of study has been carried out for this phenomenon. Unfortunately, these areas are also good corridors for migration or habitat for birds and other wild life. The possible impact of the project on birds is called ornithological impact assessment. There are three main ways in which a wind farm development could affect bird populations:

Direct habitat loss - Through displacement from an area around the wind turbines that can be bird's typical feeding or nesting area.

Collision – The magnitude of the predicted collision rate should be determined in the context of the background mortality rate for that species. A 'negligible' magnitude impact would be predicted if the collision mortality was to represent an increase of less than 1% on the background mortality rate. The birds most likely to suffer mortality are small nocturnal migrants, flying in large numbers, especially when poor flying conditions of fog and rain are they more susceptible to strikes at tall structures.

Disturbance – Mostly because of extensive disturbance to the surroundings, or the continued presence of people and vehicles than the turbines themselves. Disturbance would have a real ecological impact if it resulted in reduced resource use by the birds and hence a reduction in carrying capacity. The impact on flora and fauna is irreversible on the environment and it will remain permanent after the project also.

4.11.2 Aesthetic impact

Till recently ''integration'' used to be synonymous with ''invisibility''. It was actually considered desirable to hide the fact that the solar elements were different than other building elements. This trend unfortunately changed. Architects have discovered that solar elements can be used to enhance the aesthetic appeal of a building, and their clients have discovered the positive effects of advertising the fact that they are using solar energy. The solar elements are used as architectural elements in attractive and visible ways. The aesthetic impact of solar panels is evidently a matter of taste, though flat panels usually are designed in such a way as to fit closely to the existing roofline and produce little glare. Modern solar thermal Systems allow for the manufacturing of collectors that can be easily integrated in buildings in an aesthetically pleasant manner.

One frequently voiced objection to wind farms is their aesthetic impact. Wind farms consist of one to sometimes dozens of wind turbines. For best efficiency, they are typically very tall, conspicuous structures, which can detract from their effectiveness for humans. Humans may view them as obtrusive as oftentimes the turbines will be taller than any other existing structures. Some object to the industrial look it may give an area.

Along with the low-frequency sound, wind turbines produce a low-grade seismic or vibrating effect that can produce feelings of motion sickness in sensitive individuals. A 2006 French National Academy of Medicine report concluded that the effects are a risk for exposed individuals, especially those who live in close proximity to turbines.

4.12 SOCIAL AND CULTURAL IMPACT

The important study of the impact is the social and cultural factors of the project. Any project is implementing only if it shows sustainable development. Recently European commission stated that the "substantial part of the public benefits pursued by policies supporting renewable relate to employment and social policies, and rural development while other national policy goals should be respected and duly take into account".

4.12.1 Education

There is no literature is available on the educational impact of the solar and wind energy. This is more or less depending upon the location and planning of project

4.12.2 Employment

Solar power plants majorly creating the job for maintenance and operation purpose. Then the other sector for the employment is maintenance of the solar power generating units. Manufacturing of the solar panel is a good opportunity for the employment. Large number of labour works for the construction time also. The same opportunities are also available for the wind energy generating projects. Transportation and communication in the form of roads to the site where the units has to be installed, provides employment.

4.12.3 Industry

In the solar and wind energy projects industrial upliftment is also a foremost concern point. The solar panels and the wind turbine manufacturing have taken a form of small industry.

4.12.4 Health

The accidental release of heat transfer fluids (water and oil) from parabolic trough and central receiver systems could form a health hazard. The hazard could be substantial in some central tower systems, which use liquid sodium or molten salts as a heat-transfer medium. Indeed a fatal accident has occurred in a system using liquid sodium. These dangers will be avoided by moving to volumetric systems that use air as a heat-transfer medium. Central tower systems have the potential to concentrate light to intensities that could damage eyesight. Under normal operating conditions this should not pose any danger to operators, but failure of the tracking systems could result in straying beams that might pose an occupational safety risk on site. The wind turbine is impacting the health of the inhabitant. Due to the noise generation the local people are suffering for the problem of headache, irritation and less sleep.

4.12.5 Ease of Operation

Wind and solar power units make the ease of the operation and routine work easy because of the electricity time consumption is reduced and workability is increases.

4.12.6 Agriculture

The solar energy implementation requires more space for implementation. So the land where the solar power plant is installed the land cannot be use for the agriculture purpose. This way solar energy shows the negative impact on the agriculture. The temperature of the land is increases and this make the land unable for the agriculture practices.

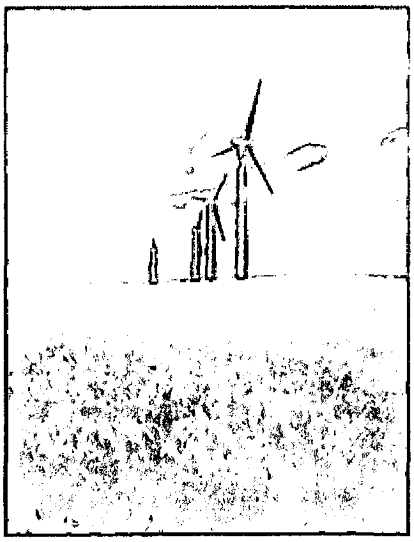


Figure 4.8 Location of wind and solar projects in Jodhpur.

As visible in the Figure 4.8 the space between the wind turbines can be use for the farming and animal grazing. Wind turbines used only 1% of the land occupy. The solar radiation, wind and rain are easily approach the farm. If the turbines are installed at hight then the small trees can also planted. This way wind energy helps for the agric

4.12.7 Recreation

In India solar and wind farms attracts the tourists.

4.12.8 Urbanization

The solar energy is not directly impacting the urbanization because in the area where the solar farms are installed is not able to live. But the employment opportunities, communication, roads are taking towards the urbanization. In the same manner wind farms are also promoting the urbanization. The localities developed near by farms are leading towards the urbanization.

4.12.9 Communication

Solar power dose no support the communication at a good level. In the form of communication there is only road is developed to reach the site location. In case of wind farms, roads, better traffic, buses is leading towards the communication.

4.12.10Population density

The solar projects has reduce the population density because of the heat generated from the solar panel rinsed the temperature of the atmosphere so that the place are not good to live. But wind farms are supporting agriculture and other small industry so the population density increases.

4.12.11Public Acceptance

This is the major factor of the installation of any project. If the public does not support the project, cannot install. It is the major step for the impact assessment. Public hearings are also the important for the project implementation. The project cannot be viable till all the clearances form the local people is taken.

4.13 ECONOMIC AND OPERATION

The economic return from project is another major step. If the project is not economically viable then even the planning of project will not be happen.

4.13.1 Operation failure

In case of solar project the operation failure is not happen. There is less moving parts in system. But there is need of the cleaning of the solar panel in some duration. So the regular power generation can be happen. In case of the wind power generation the operation failure happens due to the wear and tear of the rotating parts.

4.13.2 Intermittent power generation

The power generation is intermittent because the solar power cannot be generated in the night time and in case of wind turbine the generation is always same. The power generation is intermittent because the wind speed varies according to the season and the generation is not same.

4.13.3 Mishap

Fire hazard due to the high temperature is result of the solar energy generation and harm to the labours at the time of maintenance work and loss of body part is bad result from the wind power generation.

CHAPTER 5

RESULT AND CONCLUSION

5.1 ENVIRONMENTAL ASSESSMENT USING RIAM

The EIA of the renewable energy projects installed in the two definite district of Rajasthan is carried out using the RIAM and Network method. Both the methods have their own marks regarding to the impact of the projects implemented. Here we will discuses the from RIAM method for the impact assessment of the solar energy.

As discussed earlier the first step in the RIAM is to set up a number of different assessment in question, and these number are individually process in the method. Option is required to mention in case if available. Then, the component screen records the results of the scoping of the assessment. All four types of components in the RIAM system are catered, and each component is individually coded. These four components are physical/chemical (PC), biological/ecological (BE), sociological/cultural (SC) and last is economic/operational (EC) component. The component list displays all the elected components for each option. These components are shown in the Table 5.1. Under these components RIAM allows the criteria to evaluate for each component. The scales for each cell are displayed to allow rapid and easy checking of qualified values. After completing the RIAM analysis, the RIAM report shows the actual values qualified to each component, as well as a summary of the scores. Moreover, from the RIAM report it is possible to view the result of the analysis as a histogram for each option and corresponding components. The ranges were not expressed as ±5, but as ± A to E (with *N* representing the zero range).

5.2 RAPID IMPACT ASSESSMENT MATRIX FOR WIND ENERGY PROJECTS

Table 5.1 Rapid Impact Assessment Matrix of wind projects

		Environmental Score	Range Value	A1	A2	B1	B2	B3
PHYSICAL /CHEMICAL								
PC1	Ground Cover	-4	-A	1	-1	1	1	2
PC2	Wind	-28	-C	2	-2	3	2	2
PC3.	elevation	0	N	3	0	1	1	2
PC4	Water Quality	0	N	2	0	1	1	1

PC5	Ground water table	0	N	2	0	1	1	1
PC6	topography	0	B	3	0	3	1	1
PC7	soil structure	-3	A	1	-1	1	1	1
PC8	Temperature	0	N	1	0	3	2	1
PC9	Noise	-14	-B	1	-2	3	2	2
BIOLOGICAL/ ECOLOGICAL								
BE1	Fauna condition	-16	-B	1	-2	3	3	2
BE2	Flora condition	-18	-B	1	-2	3	3	3
BE3	Aesthetic Impact	-36	-D	2	-2	3	3	3
SOCIOLOGICAL/CULTURAL								
SC1	Education	14	B	1	2	3	1	3
SC2	Employment	27	C	1	3	3	3	3
SC3	Industry	27	C	1	3	3	3	3
SC4	Health	12	A	1	2	3	1	2
SC5	Ease of operation	6	A	1	1	1	3	2
SC6	Agriculture	14	B	1	2	2	3	2
SC7	Recreation	5	A	1	1	2	1	2
SC8	Urbanization	10	B	2	1	3	1	1
SC9	Awareness	4	A	1	1	2	1	1
SC10	Communication	5	B	1	1	3	1	1
SC11	Population Density	10	B	2	1	3	1	1
SC12	Public Acceptability	4	A	1	1	2	1	1
ECONOMIC/OPERATIONAL								
EO1	operational failure	-42	-D	3	-2	2	3	2
EO2	intermittent power generation	-42	-D	3	-2	2	3	2
EO3	Mishap	-8	-A	1	-1	3	3	2

Table 5.2: Resultant and environmental scores.

Range	Class	Physical/ Chemical	Biological/ Ecological	Social/ Cultural	Economic/ Operational
-108 to -72	-E	0	0	0	0
-71 to -36	-D	0	1	0	2
-35 to -19	-C	1	0	0	0
-18 to -10	-B	1	2	0	0
-9 to -1	-A	1	0	0	1
0 to 0	N	4	0	0	0
1 to 9	A	1	0	5	0
10 to 18	B	1	0	5	0
19 to35	C	0	0	2	0
36 to 71	D	0	0	0	0
72 to 108	E	0	0	0	0

The histograms provide comparative pictures of positive/ negative impacts between options, to identify important negative components. In the beginning this impact from the wind power plants will be discussed. Later on the solar power utilization impact will be discussed.

The following components are introduced in the present study: nine components of Physical/Chemical changes, three components of Biological/Ecological, twelve components of Social/Cultural, and three components of Economic/Operational. Table 5.2 summarizes the scoping components and the results of the RIAM in a matrix form for the renewable energy project. Accordingly, these matrices are represented graphically by histograms as in various figures. As listed in table 5.1 and seen in Figure 5.1, the Physical/Chemical changes are spreading over the wide range but having the most null effect. The components lies in the range of null effect are ground watertable; elevation, topography and temperature. Reason being the wind farms does not affect all these components.

5.3 PHYSICAL AND CHEMICAL

Although these components are of the significance of national level but the projects are not affecting so they falls into null effect. The factors get affected are ground water cover, wind, soil structure and noise. The ground cover in not much gets affected because of the less vegetation in the region. And the land is not having much undulation. So ground cover is not much affected. The next component is wind which has negative impacts. The negative impact the wind speed is reduced after the installation of the wind turbine. But the turbines are installed on such height that the wind speed is not much get affected. Soil structure is bit disturbed due to the excavation for the installation of wind turbine and implementation of the machines.

The major negative effect is shown by the noise. The habitant's are distress from the noise problem. The rotating part's wear and tear makes noise. The wind turbine itself makes noise in the time of rotation. This makes noise pollution and habitant get headache problem. The sound is creating much disturbance in night time.

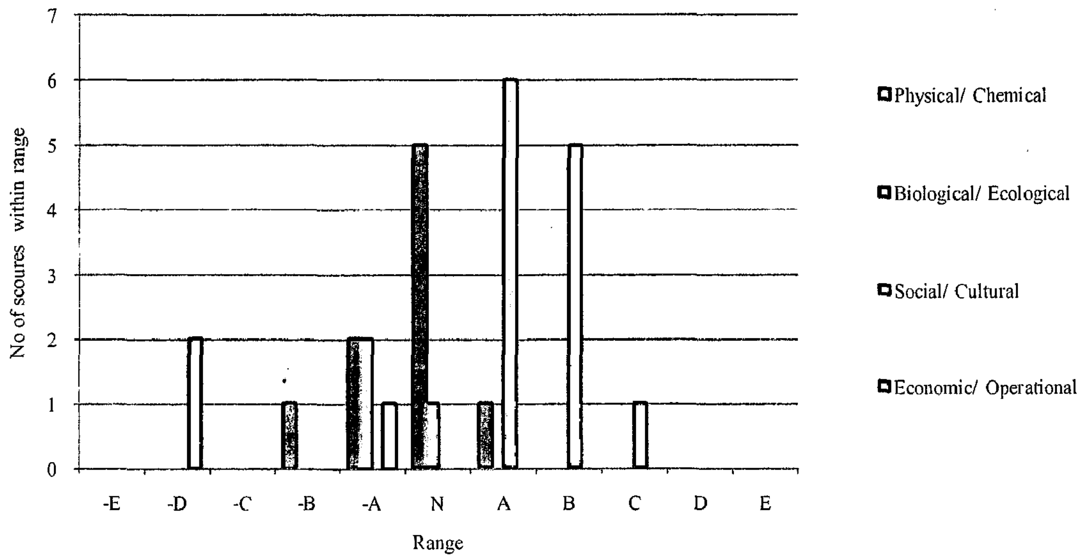


Figure 5.1 Histogram of the result from table 5.1

5.4 BIOLOGICAL AND ECOLOGICAL IMPACT

As shown in the above figure the biological and ecological change lies in the negative range only. The biological and ecological features consists only flora, fauna and aesthetic impacts. The desert area is having very less flora condition. The land covers with only small shrubs and very less amount of trees. So the flora is not much impacted. In a particular season the migrants comes to the desert area. And these migrants some ties stuck to the rotating blades of the turbine. This is happened to the local birds also. This way the wind farms are harming the fauna condition. The height of the wind turbine is also impacting the visibility and reducing the view of the tourist place as shown in the Figure 5.1

5.5 SOCIAL AND CULTURAL IMPACT

As seen in the Figure 5.1 all the result lies in the positive range. But there is not any extreme effect of the project which can be in range of D and E. Education has the good positive impact of the project implemented. At the big power plant there is small community is developed where a small school is also started. This school is upto the 8^{th} standard and about 100 students are studying and 7 teachers are working for these students. The project owned also organizes health camps for the students and giving some economic support to the school students. This creates interest towards the study.

There is currently 15 jobs related to maintenance activities, in addition to 5 Junior Engineer and 2 Assistant Engineer and one Executive Engineer. Except these there are about

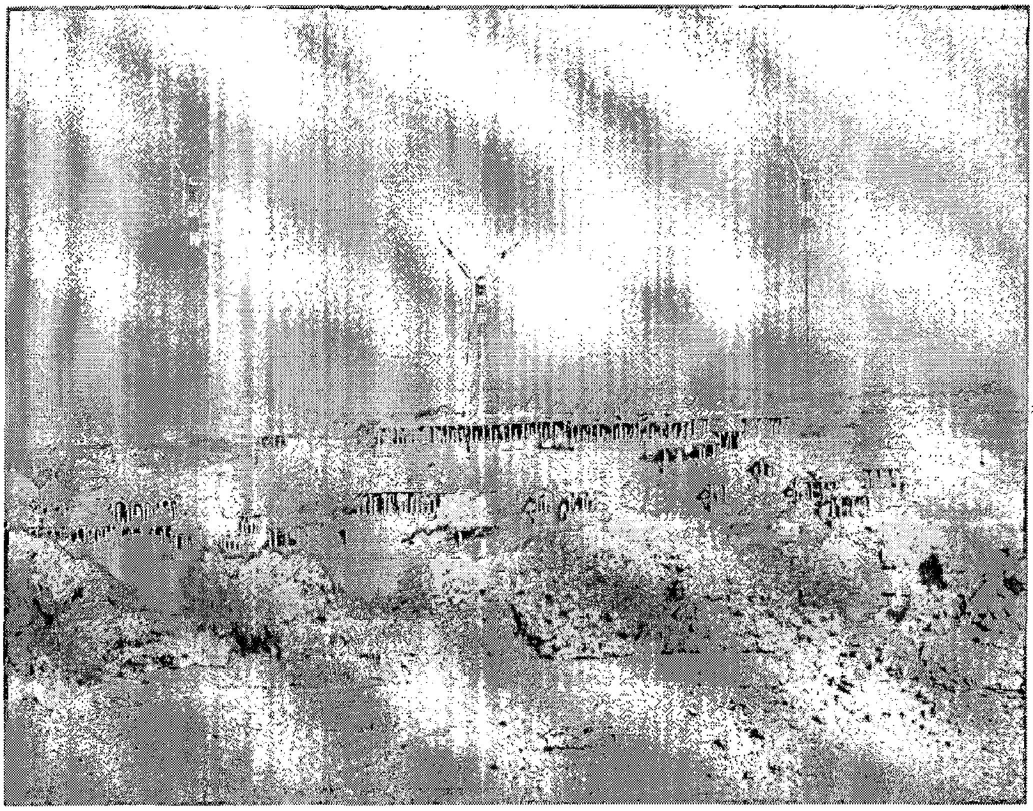


Figure 5.2: Reducing Aesthetic View of the historical place

20 security guards for the project site. Some peoples are also working in the manufacturing of the wind mills. But there is no idea about the people who are working for the manufacturing industry. There are the jobs directly related to the project but some indirect jobs and employment is also there. These are not countable that how many people are working in indirect employment. Many other activities are coming in the indirect employment like small tea stall, small general store, milk business, cycle shop etc. The company whose projects are installed are also has there offices in the district. Like in the office of Suzlon there is staff strength of 10. In these there is 1 branch manager, 2 site engineer and then other working staff.

Small industries are also developed due to the project activity. There is large land holding in the district and wind farms are remotely located. So it makes the easy supply of electricity to the small workshop or to the small industry locates at remote area.

Directly any health impact is not visible but there is small dispensary is make available for the bigger projects. This is able to solve small health problems of the local. The project owner also provides facility for the free health check-up of the employee. Project holder organizes the health camp for the livestock. And due to these project no negative impact on the health of the local habitants. There is neither any sort of emission in air nor in water and land. According to the habitants problem induced by the noise is also nullify due to this dispensary.

Setting of the wind project makes the daily operation easy. The development of the local market make the thing easy available and reduce the time of the operation.

The land occupied by the project owner for the wind mills, utilises only 1% of the land holding so the remaining land can be use for the agriculture practices. And the development of the locality helps the farmer for more production.

The tourist people who come for viewing the desert are also comes for the scenic view for the wind farms.

Due to the proper supply of the electricity and development of the small colony the living standard of the people is also improved. There were previously illiterate people were residing but due the installation of the wind farm and living of the working people has increase the living standard of the people. This leads the region to the urbanization.

This awareness is related to the working culture or relate to the living style and new technology. Now a day's communication is the basic need of the human being. Urbanization and awareness are leading toward the mode of communication. Residing people are using various modes for communication like mobile, roads, telephone etc.

There is good growth in the population density at the places where there the projects are installed. These projects installation is leading the place towards the providing the basic need of the habitants.

The project has to be publicly accepted. Before the implementation of the project there were always some problem what the villagers will get after to implementation of the project but the companies has provided lots of facilities to the villagers. Some times eye check-up camp, literacy programme and animal husbandry camp had been installed with the support of the company. The above description shows that the wind energy projects are totally social and cultural viable.

5.6 ECONOMIC AND OPERATION

There is more chance of operation failure in wind energy project. The wear and tear in the rotating parts causes operation failure. The dust or sand accumulation is also harms the wind turbine.

The generation of the power in the renewable energy systems is not consistent. There are large chances of intermittent power generation in wind energy projects. In the season of December there is less wind speed so the generation is less and plant load factor is only 8 to 9% and in the month of July the plant load factor is around 90% so the average plant load factor through out the year is only 20 to 25%.

There are less chances of mishap in the renewable energy projects but some major accidents had happened. During the time of repairing machine the machine man has fallen or he got electric shock during the maintenance work are the major mishap happened.

5.7 RAPID IMPACT ASSESSMENT MATRIX FOR SOLAR ENERGY PROJECTS

Since solar power systems generate no air pollution during operation, the primary environmental, health, and safety issues involve how they are manufactured, installed, and ultimately disposed of. Energy is required to manufacture and install solar components, and any fossil fuels used for this purpose will generate emissions. Thus, an important question is how much fossil energy input is required for solar systems compared to the fossil energy consumed by comparable conventional energy systems. Although this varies depending upon the technology and climate, the energy balance is generally favourable to solar systems in applications where they are cost effective, and it is improving with each successive generation of technology. According to some studies, for example, solar water heaters increase the amount of hot water generated per unit of fossil energy invested by at least a factor of two compared to natural gas water heating and by at least a factor of eight compared to electric water heating.

Table 5.3 Rapid Impact Assessment Matrix of the Solar projects

		Environmental Score	Range Value	A1	A2	B1	B2	B3
PHYSICAL /CHEMICAL								
PC1	Ground Cover	-12	-B	1	-2	1	3	2
PC2	Air	-18	-B	1	-2	3	3	3
PC3	elevation	0	N	0	-1	1	1	1

PC4	Water	-3	-A	1	-1	1	1	1
PC5	Ground water table	0	N	1	0	1	1	1
PC6	topography	0	N	2	0	3	3	2
PC7	soil structure	-27	-C	1	-3	3	3	3
PC8	Temperature	-42	-D	2	-3	3	2	2
PC9	Noise	-10	-B	1	-2	2	2	1
BIOLOGICAL/ ECOLOGICAL								
BE1	Fauna condition	-9	-A	1	-1	3	3	3
BE2	Flora condition	-9	-A	1	-1	3	3	3
BE3	Aesthetic Impact	0	N	1	0	3	3	3
SOCIOLOGICAL/CULTURAL								
SC1	Education	14	B	1	2	3	1	3
SC2	Employment	18	B	1	2	3	3	3
SC3	Industry	18	B	2	1	3	3	3
SC4	Health	-6	-A	1	-1	3	1	2
SC5	Ease of operation	6	A	1	1	1	3	2
SC6	Agriculture	-14	-B	1	-2	3	2	2
SC7	Recreation	0	N	1	0	2	1	1
SC8	urbanization	0	N	2	0	3	1	1
SC9	Awareness	0	N	1	0	2	1	1
SC10	Communication	5	A	1	1	3	1	1
SC11	Population Density	-10	-B	2	-1	3	1	1
SC12	Public Acceptability	16	B	1	4	2	1	1
ECONOMIC/OPERATIONAL								
EO1	operational failure	-5	-A	1	-1	2	2	1
EO2	intermittent power generation	-14	-B	1	-2	2	3	2
EO3	Mishap	-8	-A	1	-1	3	3	2

Table 5.4 Resultant impact and environmental scores

Range	Class	Physical /Chemical	Biological/ Ecological	Social / Cultural	Economic / Operational
-108 to -72	-E	0	0	0	0
-71 to -36	-D	1	0	0	0
-35 to -19	-C	1	0	0	0
-18 to -10	-B	3	0	2	1
-9 to -1	-A	1	2	1	2
0	N	3	1	3	0
1to 9	A	0	0	2	0
10 to18	B	0	0	4	0
19 to35	C	0	0	0	0
36 to71	D	0	0	0	0
72 to108	E	0	0	0	0

5.8 PHYSICAL AND CHEMICAL CHANGES

As shown in Figure 5.2 the physical and chemical change lies in the range from null affect to –D. it shows that there is large negative impact. impact on the ground cove is negative because solar systems destroys the land cover and vegetation. The emission from the solar panels and from the batteries harms the surrounding air upto some extend. There is no impact on the elevation. The water availability is very less and for cleaning of the solar panels may be of solar farms or house oriented needs water for cleaning. This way it impacts water in negative manner. The ground water and topography are not affected from solar farms. The soil structure gets affected badly because of two reasons. The temperature of the surrounding increases and it harms soil. The soil is not be able to generate the crop and the rubbish of the batteries are dump carelessly also destroy soil properties. The temperature of the immediate atmosphere also grows due to heat absorption of the panel. The rotation of the solar parabolic trough creates sound but this is not much disturbing in day time and in night solar systems does not work

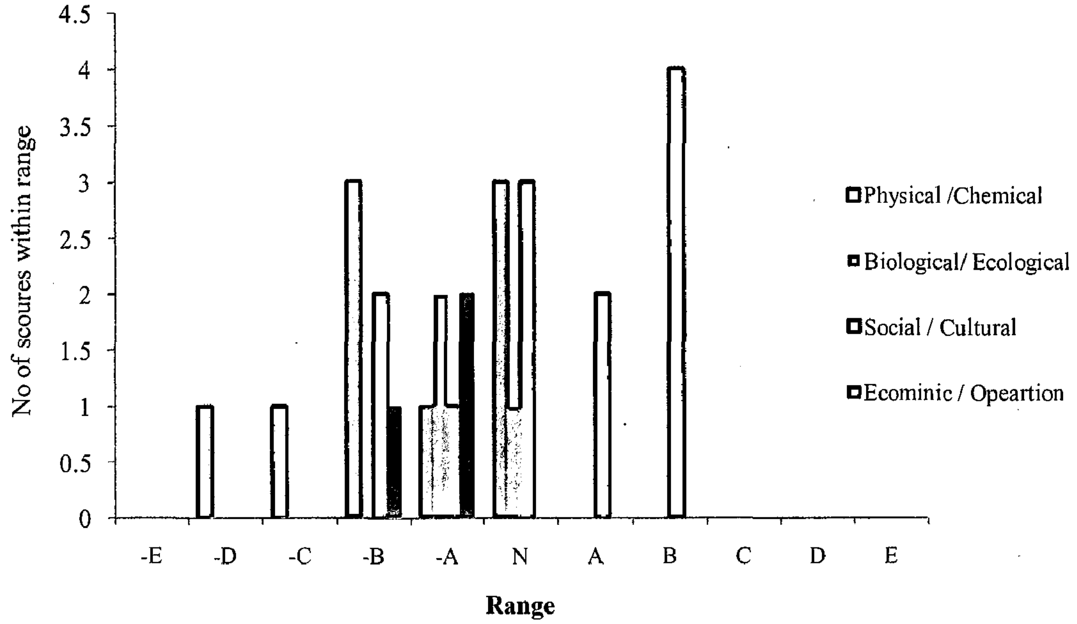


Figure 5.3: Histogram of the environmental score calculated in Table 5.4

5.9 BIOLOGICAL AND ECOLOGICAL CHANGES

The range of the biological and ecological changes lies in the range from–A to no effect. The negative effect is on the fauna and flora. The reason is growth in the temperature. This temperature makes place terrible to live. The reptiles and small insects migrated from the solar farms. But here the installation capacity less so the impacts are not visible. Same it is for fauna conditions. It can be seen in the figure 5.2. There is no aesthetic impact lies.

5.10 SOCIAL AND CULTURAL IMPACT

The important study of the impact is the social and cultural factors of the project. Any project is implementing only if it shows sustainable development.

Projects have positive impact on education of the project implemented. The domestic lightening system makes the life of the student bit easier. It increases the time for working and studying also. Due to solar lightning system government also able to conduct the 2 literacy programmes. This literacy programme organized by TATA BP makes around 40 people literate. As per the collected data direct solar cooking system, implemented in two villages of Jaisalmer District also increased effectiveness of the system.

Solar power plants majorly create the job for maintenance and operation purpose. For the maintenance of the solar domestic light local skilled labour is trained by the company. For each village there is one trained person is there. And this person is also paid for this work. The solar power plant is also requiring maintenance. For the maintenance there is one Junior engineer is appointed under there is 5 labours are working. For one district there is one Executive Engineer. There is one labour each for direct solar cooking system. For solar power plants security government also appointed 3 security guards.

Manufacturing of the solar panel is a good opportunity for the employment. There are many manufacturing companies in the zone, providing employment. Solar panel manufacturing is providing employment to around 7000 people at various levels.

Solar power plant and solar photovoltaic installation increased the industrial demand. De-centralised solar power generation has also increased the chances of the implementing small industry in the remote area where the owner can get land at low price this can reduce the capital cost of the industry

Directly any health impact is not visible but there is small dispensary is make available for the bigger projects. This is able to solve small health problems of the local. The project owner also provides facility for the free health check-up of the employee. Project holder organizes the health camp for the livestock. And due to these project no negative impact on the health of the local habitants. There is neither any sort of emission in air nor in water and land.

Setting of the solar project makes the daily operation easy. Enough electricity is provided to the remote area and this make the routine work easy for the local. Like direct cooking system make the cooking system smoke free. De-centralised system makes the more utilizable for the remote area residing people. So the easiness of the work has taken place.

The solar energy implementation requires more space for implementation. So the land where the solar power plant is installed the land cannot be use for the agriculture purpose. The heat generated from the solar system also does not support the agriculture practices.

The solar farms are installed in the interior parts of the district so it does not create recreation. There is no impact on the urbanization due to solar energy implementation. Awareness is not being enhanced due to the solar power generation. Solar power dose no support the communication at a good level. In the form of communication there is only road is developed to reach the site location. Population density is not impacted from the solar farms but it impacts the people living there.

Public accepted the projects implemented and also accepted the project of domestic lightning system. They are taking interest for the implementation of the small solar energy generation systems. Here the interesting thing is that the solar domestic lightning system was implemented previously which was free of cost. No maintenance and installation cost has to be given by the consumer. But this scheme was failed because people didn't take interest in the thing which was easily affordable for them. Now again the scheme was started and beneficiaries were to give around Rs. 5500/- for the implementation and operation and maintenance purpose. Not the scheme is working at it's best.

5.11 ECONOMIC AND OPERATION

The project is only viable when it is giving enough return. And local people will also accept this. There is less chances of the operation failure because of less moving pasts in the solar system. These solar systems are not working in the night time, to solve this problem there is provision of the battery bank. So overall there is no chance of failure of the operation.

The power generation from the solar systems are not 24 X 7. In the night time it is not possible to generate power. To solve this problem there is provision of the battery bank. Thus the intermittent power generation problem is solved. Some times the repair and maintenance of the power systems can interrupt the power generation

Flying birds can be harmed due to the reflection from the solar panels at the solar power station. There are chances of fire hazards from the solar power systems. Because of the increase in the temperature may burn the fodder or other things, can easily catch the fire. Till now not any serious hazard has happened but it has seen at small level. The fencing has been made around the farm so the roaming animals cannot enter into.

5.12 IMPACT OF SOLAR ENERGY PROJECTS USING NETWORK METHOD

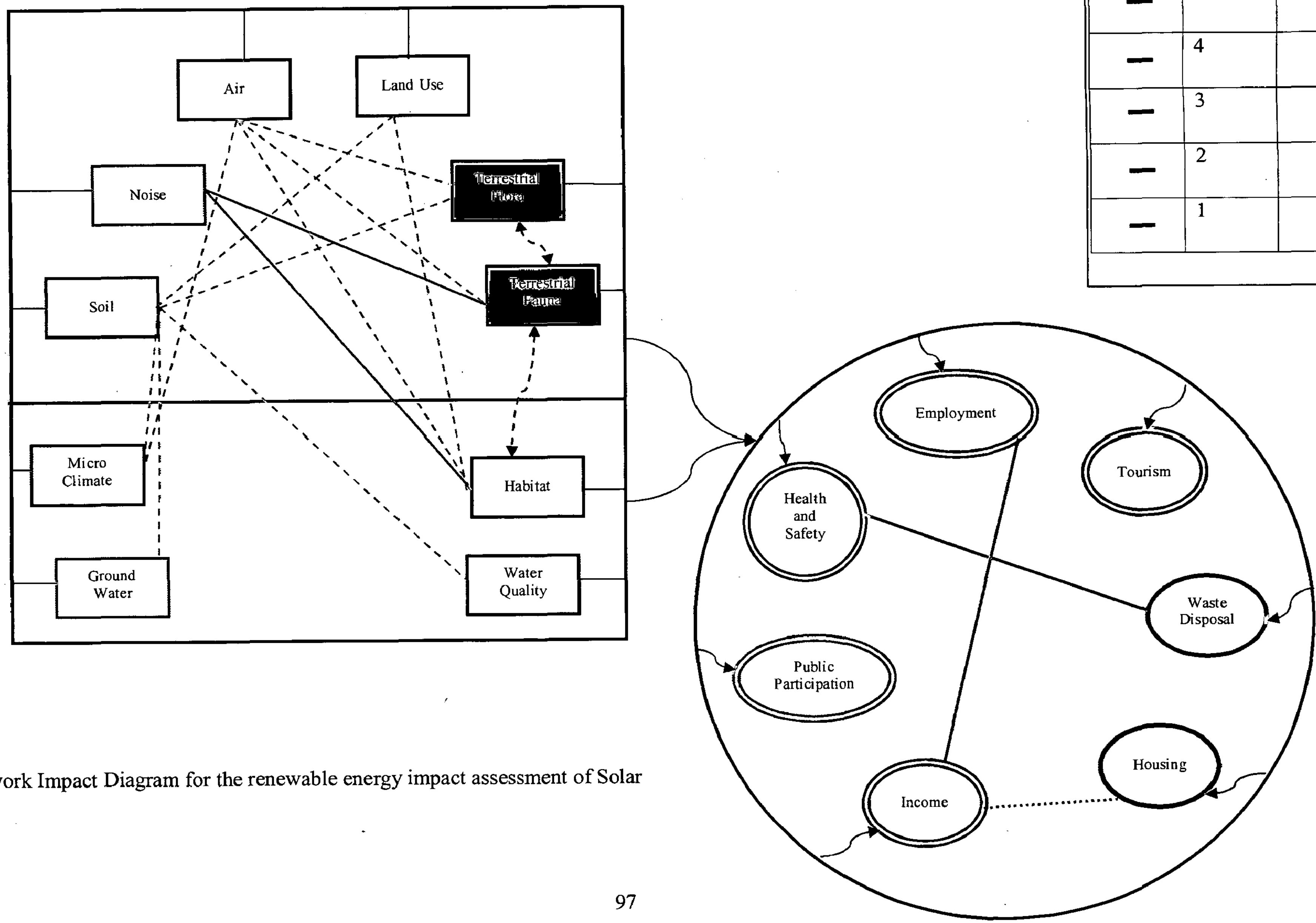
As discussed in the chapter 3 the network method in shows the relation of the various component by using colour. In the shown diagram there is various component has been shown. As per the discussion the primary components are soil, noise, air. Land use etc. the impact on there components has been discussed earlier. But the network diagram shows the interrelation between there factors. The network diagram is divided into two portions first one is primary impacts and second one is secondary impact. The impact on one other is discussed as below as shown in the figure:

1. **Soil** is showing impact on the land use, terrestrial flora, terrestrial fauna, water quality, ground water and micro climate. Sol is directly related to the land use and flora. Here flora is get disturbed then the flora is also disturbed. The temperature of the soil is also increased due to the installation of the solar panels.
2. Noise is impacting the habitat and fauna. But the level of the noise is very low so it so not disturbing.

3. **Air-** as discussed earlier the there is large and bad impact of air on the terrestrial flora, fauna. But upto a level of extend. It is impacting local habitat at very less level. It is for the people who close to the solar system. But it in not impacting the water and ground water. Air quality is also impacting the micro climate because of the emission of the gases.
4. **Land use- Land** use is impacting the agricultural factor. Land use is also impacting the micro climate and flora and flora up to a level. Land use is also impacting the local population and reducing population density.
5. **Housing** small solar systems are not impacting the housing but surrounding of the big solar power plants is not able to live. Because the atmosphere temperature increases. The house will be in well condition if the income is good. It can be seen in the Figure 5.4 network analysis of solar projects.
6. **Waste Disposal-** the waste from the solar power plants is dumped in careless manner. This leads to the environmental pollution. The various toxic agents release from the batteries is harming the surroundings.

Now coming to the secondary impact as in the network diagram:

1. **Health-** health is the major factor which is impacting from the solar panels. At the time of manufacturing the harmful chemicals are disturbing the health of the labours.
   And the various emissions in the air and water are impacting health very badly. Health is also
2. **Public Participation:** initially the public is not very much aware and not participating to such activities. Because the policy and government are providing these things free of cost. Bu when the government has started taking money for the implementation local participants took interest and the scheme is working properly.
3. **Income-** the solar energy is not able to generate the much income generation source. But due to more implementation of the systems like decentralised systems, there is chance for the implementation of the small industry at the remote area. It is also promoting the solar manufacturing companies.
4. **Tourism-** Tourism is not much impacted. But the on road solar power plants attract the tourists.
5. **Employment-** as mentioned in the part of impact assessment from RIAM is showing that in small manner but solar power generation is affecting the employment in encouraging way. So the solar power is an income generating unit. As shown in the network diagram of solar energy generating units.



Primary Impact	Value	Secondary Impact
—	5	—
—	4	—
—	3	—
—	2	—
—	1	—

5.4
Figure: Network Impact Diagram for the renewable energy impact assessment of Solar Energy

Primary Impact	Value	Secondary Impact
—	5	—
—	4	—
—	3	—
—	2	—
—	1	—

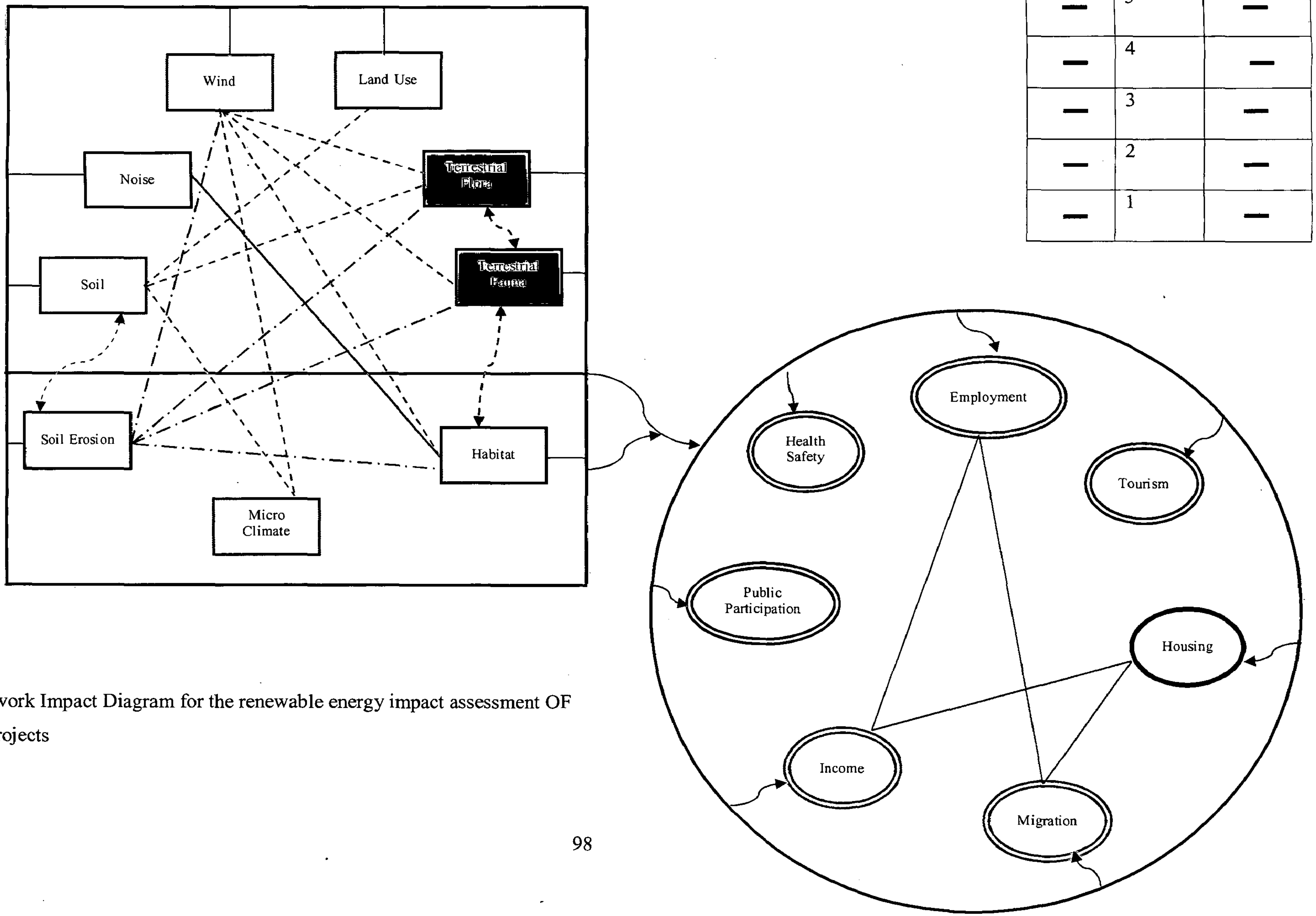


Figure 5.5: Network Impact Diagram for the renewable energy impact assessment OF Wind Energy Projects

5.13 IMPACT OF WIND ENERGY PROJECTS USING NETWORK METHOD

As mentioned earlier in the network diagram of solar energy here the impact of wind energy is detailed. The Figure 5.4 shows the network diagram of the wind energy impact. The description below details the network diagram.

1. **Fauna-** local fauna is not under much impact of wind energy. But during the season when the migrations period comes then the mortality rate of the birds increases. Because at the time of flying they stuck to the turbine blades.
2. **Flora-** in not impact from the wind power installation because the desert area has small vegetation in the form of shrubs and less numbers of trees.
3. **Soil-** Soil showing impact on the land use, terrestrial flora, terrestrial fauna, water quality, ground water and micro climate. Soil is directly related to the land use and flora. But the land use only 1% of the total land holding. But wind turbines are introducing the problem of soil erosion.
4. **Noise-** This is major drawback of the wind energy. The noise coming from the rotating parts disturbs the local habitants. But till now the problem is not so serious.
5. **Wind-** The installation of wind turbine reduces the wind speed for the further places. So the wind energy potential is not much impacted because there is large land holding and in large area project can be install.
6. **Land use-** only 1% of the total land holding is used for the wind turbine installation. And the space between the wind turbines can be use for the cultivation purpose.
7. **Housing-** Housing is not greatly impacted from the project installation. But the project as made the better housing facility near by the wind farm Figure 5.5 is indicating the same.

Now coming to the secondary impact as in the network diagram:

1. **Health-** various health camps has been organised by the installation company. These health camps are for eye check up camp, animal husbandry camp etc. a small dispensary is also running from the fund from company and Government.
2. **Public Participation:** initially the public is not very much aware and not participating to such activities. Because the policy and government are providing these things free of cost. Bu when the government has started taking money for the implementation local participants took interest and the scheme is working properly.
3. **Income-** The income generating sources is provided from wind energy projects. These are the manufacturing, security, and small business developed for the local community. Income is impacting the housing also.

4. **Tourism-** Tourism is not much impacted. But the on road wind power plants attract the tourists. Because wind farms are not famous in India.
5. **Employment-** as mentioned in the part of impact assessment from RIAM is showing that in small manner but solar power generation is affecting the employment in encouraging way. So the wind power is an income generating unit. As shown in the network diagram of wind energy generating units. This employment reduced the migration.

CHAPTER 6

CONCLUSION

6.1 CONCLUSION OF RIAM METHOD

RIAM is a very powerful tool to use in an EIA, especially with very complex options as demonstrated in this study. It is transparent, able to test different options easily, and still able to obtain an overview of the solutions. It is easy to visualise the results of different options, which makes the tool useful for decision makers.

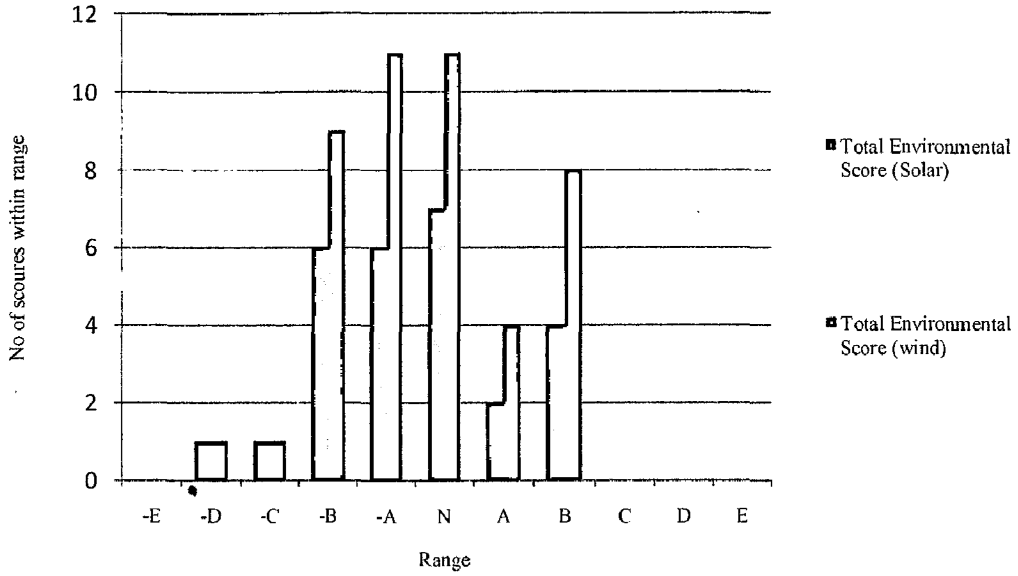


Figure 6.1 Comparison of the environmental score of wind and solar projects.

The study of wind and solar projects tested RIAM in desert district of Rajasthan, and it has shown that RIAM is a very useful and transparent tool to apply EIA. It also demonstrates the efficiency of the RIAM tool in handling cases with large quantities of data, which can make it difficult to obtain an overview of the results. The ability of RIAM to provide a clear, transparent, and permanent record of the judgments made in an EIA is a major advance in improving the use of EIA. It is hoped that the RIAM concept, and the ease of use of the method, may lead to a wider acceptance of impact assessment in all stages of development planning and management.

As shown in Figure 6.1 the environmental score of wind project is always higher than the solar energy generating units. Reason may be the wind energy in more viable and beneficial comparison to solar energy. The wind projects are socially and culturally supportive. Wind project has no negative effect in social factor. But in case of the null effect the wind energy is showing higher score than solar reason is wind is not impacting the physical and chemical factors. Again the wind energy is topper in the negative range the reason is the mortality rate of the migrating birds and the mishap happened. These mishap leas toward the human lost.

The generation cost of the wind energy is less than the unit cost of solar energy generation. There is large scope of the renewable energy in the Rajasthan. The large land holding and availability of land at low cost is influencing the implementation of there projects. This is major scope of development in solar and wind sector. The barrens land and less vegetation are influencing the project activities.

The demand of the time is to generate the green energy for fulfil the requirement of energy. Implementation of the renewable energy projects are is reducing the carbon emission. Renewable energy projects are also producing some amount of emission in the air and water. But the amount is very less and if the emitted parts are disposed properly then it can reduce the negative impacts of solar energy. The noise generated from the wind projects is also harming the public health but there is only one project near to the locality. Education and employments is also supported from these projects. The agriculture is not much impacted because of the barren land and less availability of water. The infrastructure like road, power house is leading toward the social upliftment. The RIAM is less time consuming and quantities method.

The entire study concluded that the wind is better than the solar power generation if the some drawbacks can be eliminate

6.2 CONCLUSION OF RIAM METHOD

The network method is the best one to assess the impacts. A wide variety of information must be used in a network method, and it is also time-consuming and costly method, but simple and comprehensible representation of project impacts makes it functional. Generally, a disadvantage of network analysis is that it may not be quantitative. However, as shown in the figure, it is possible to include irretrievable, direct, Environment Monitoring Assessment and indirect impacts in the network diagram using quantitative measurements. Consequently, the results of the scenario analysis reveal that renewable energy projects are more desirable. Upto large extend they reduce green house gases reduction and uplift the local people living standard.

SUGGESTION FOR FUTURE WORK

1. Another methods for the impact assessment can be employ

2. Network method in a qualitative approach but if linked to other method then it can be quantities. Neural network is also can apply for the network analysis.

3. Impact assessment for the projects of other regions and in other renewable energy sector can be done.

ANNEX I

LIST OF PROJECTS REQUIRING ENVIRONMENTAL CLEARANCE

1. Nuclear power and related projects such as heavy water plants, nuclear fuel complex, rare earths.
2. River valley projects including hydel power, major irrigation and their combination including flood control (even if investment is less than 100 crores but command area is more than 10,000 ha).
3. Ports, harbours and airports (except minor ports and harbours).
4. Petroleum refineries including crude and product pipelines.
5. Chemical fertilizers (nitrogenous and phosphatic other than single super phosphate).
6. Pesticides (technical) and intermediates.
7. Petrochemical complexes (both Olefinic and Aromatic) and petro-chemical intermediates such as DMT, Caprolactam, LAB, etc., and production of basic plastics such as LLDPE, HDPE, PP, PVC.
8. Bulk drugs and pharmaceuticals and intermediates.
9. Exploration for oil and gas and their production, transportation and storage.
10. Synthetic rubber.
11. Asbestos and asbestos products.
12. Hydrocyanic acid and its derivatives.
13. Primary metallurgical industries (such as production of Iron and Steel, Aluminium, Copper, Zinc, Lead and Ferro Alloys), (b) Electric arc furnaces (Mini steel plants).
14. Chlor alkali industry.
15. Integrated paint complex including manufacture of resins and basic raw materials required in the manufacture of paints.
16. Viscose staple fibre and filament yarn.
17. Storage batteries integrated with manufacture of oxides of Lead and Lead Antimony alloys.
18. All tourism projects between 200 m and 500 m of high water line and at locations with an elevation of more than 1000 m with investment of more than Rs. 5 crores.
19. Thermal power plants.
20. Mining projects (major minerals) with leases more than 5 ha.

21. Highway projects (except projects relating to improvement work including widening and strengthening of roads with marginal land acquisition along the existing alignments provided it does not pass through ecologically sensitive areas such as national parks, sanctuaries, tiger reserves and reserve forests)
22. Tarred roads in the Himalayas and or forest areas.
23. Distilleries.
24. Raw skins and hides
25. Pulp, paper and newsprint.
26. Dyes and intermediates.
27. Cement.
28. Foundries (individual).
29. Electroplating.
30. Meta amino phenol (added in 2000).
31. New townships, industrial townships, settlement colonies, commercial complexes, hotel complexes, hospitals, office complexes for 1000 persons and above or discharging sewage of 50,000 l/day and above or with an investment of Rs. 50 crores and above (added in 2004).
32. New industrial estates having an area of 50 ha and above and the industrial estates

ANNEX II

QUESTIONER

This questioner has been developed with the help of the beneficiaries and with the help of project officers of both of the district, Jaisalmer and Jodhpur and visual inspection of the site and the branch office of Suzlon in Jaisalmer District..

S. No.		Wind	Solar
1.	Damage to fauna and flora	not considerable	less
2.	Damage is recoverable	yes	no
3.	Harm to fauna	yes (migrated birds)	no
4.	Modification in the life style	yes	moderate
5.	What kind of modification	departmental shop, transport, bus service, grains, food, water supply	lightning, smoke free cooking,
6	Impact in vision	reduced view of historical place,	not considerable, due to less installation capacity
7	Soil	no change	temperature increases in day time
8	Temperature	no	yes
9	Noise	yes, headache	not disturbing
10	Education	Middle school, 100 students and 7teachers + staff	yes, positive, literacy camp from TATA BP, 40 people make literate, direct solar cooking system healthier cooking
11	Employment	manufacturing, security, shops in locality, construction, operation and maintenance	manufacturing, construction, operation and maintenance,

12	Industry	gird connected but helps the industry to locate in remote area	stone cutting plant
13	Health	eye camp organized by Suzlon for 60 people, animal husbandry camp for 20 animals, dispensary running under government's add	not much impacting, but gas from batteries is harms
14	Ease of operation	makes thing easily available in local market	lightning, studying time,
15	Agriculture	not harms	reduces
16	Recreation	for tourists	not considerable
17	Communication	mobile shop, roads, transport	not much, but small TV
18	Public Acceptability	accepted, now public supporting	accepted, at large level
19	Operational Failure	impacting because grid connected	impacts the local people
20	Intermittent power generation	yes	yes but very less
21	Mishap	one line labour died at time of maintenance, 2-3 person fall from height	Caught the fire, cattle died.
22	Ground water level	ground water is not available to use	ground water is not available to use
23	Wind turbine affect wind velocity	reduces the wind velocity but no much due to large area	not applicable
24	Cut and Fill	no	no
25	Surface excavation	not much, because of height	yes for orientation
26	Soil erosion	yes a bit	no

27	Forest or any scentury	no	no
28	Soil structure is disturbed	Not considerable	yes, adding temperature
29	Cutting of tree	Not much	no
30	Impact on migrating birds	yes, mortality rate increases	no
31	Activity of the land animals get disturbed due to the project?	no	yes
32	disturbance to animal grazing	no	yes
33	Food chain	no	a bit
34	Irrigation	no	no
35	Fencing is required	no	yes
36	Rehabilitation	no	no
37	Frequency of operation failure	moderate	not considerable
38	Cultural loss	no	no
39	Archaeological factors	one project	no
40	Project activity helps in the educational Upliftment of the local people?	yes	yes
41	Lightning problem is solved	no impact	yes, solar domestic lighting
42	Working Hours is increased	no impact	yes

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