

# On the Optimum Utilization and Promotion of Renewable Energy Sources in India

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## ABSTRACT

Renewable energy has had a steady and continuous growth in electric sector worldwide. The need of the hour is to sensitize the general public about the importance of judicious use of energy being generated by conventional sources energy sources and simultaneously shift our dependence on renewable but sustainable energy sources. To mitigate environmental degradation and reduce carbon emission worldwide we have to switch to clean energies. This paper assesses different renewable energy sources, promotion policies adopted by government, and various sectors which influence the energy usage pattern in India. The paper highlights the need of restructuring of the power system, strengthening of the existing transmission system and the importance of improving and incorporating mechanisms to reduce dependence on fossil fuels either by energy saving or by maximization of renewable resources developments.

*Keywords* - Renewable Energy sources, Energy Sectors Electricity Reforms, Demand Side Management, Energy Consumption.

## 1. INTRODUCTION

Energy is the very basic and prime requirement for the mankind. It is one of the major factors on which the economic, social and industrial growth of any country and civilization depends. With 8-9 percent of Gross Domestic Product (GDP) rate and 17 percent of world population, India is one of the biggest consumers of energy. In the population stats India stood in second position after china. In the last decade India has become one of the most favored nations for the investment from the foreign investors. This leads to good economic stability, employment opportunities and overall development of the nation [1]. Demand of energy requirement is directly proportional to the development rate and population growth rate of the country. Presently in 2011-12 the total installed capacity in India is 181.5 GW (including conventional and non conventional sources) with peak load demand of 136 GW. Out of this energy demand only 118 GW is met having a deficit of 13% in energy generation [2][3]. The gap between energy demand and supply is the most serious issues in India. The main reasons for this trend are demographics and economics. India's economy is growing, thereby demanding more energy and electricity. The population is also increasing and causing shortage in energy resources. There is also massive urbanization and modernization, which is putting more pressure on energy resources and the

environment which cannot be neglected. The deficit in energy is also caused by the in-efficient power system structure which includes the generation, transmission and load distribution. In India, the major sources of energy are the fossil fuels. The prime disadvantage of fossil fuel is that they degrade the environment with the pollutant gases and green house gases. These fossil fuel stores, can last only for three to five decade at the most. To meet out the increased energy demand and to reduce the carbon emission, the generation system needs electricity reforms, power system restructuring, demand side management, more renewable energy research and development centre. The main objective of the paper is to emphasis on the current status of energy production, various reforms in power sector with their effects, consumption and tips for energy savings.

## 2. ELECTRICITY REFORMS FOR CONVENTIONAL ENERGY SOURCES

In the past few decades, India is not in a position to meet the peak load demand and normal load demand of energy due to inefficient use of electricity, aggregate technical and commercial (AT&C) losses, which leads to significant energy shortage and energy crises. During the period of heavy loads, the load scheduling is done by the regulatory authorities to make grid stable. These needless power cuts can be avoided by installing new efficient generating stations and by introduction of new reforms and restructuring existing power systems (including generation, transmissions, distribution). The restructuring of Indian power sector formally started in the year 1991 and after that up to 2007 a number of reforms have been introduced by Indian government. These reforms revolutionized the growth in power capacity, reliability in supply, growth in the revenue collection by streamline the working of state electricity boards across the country by unbundling them into separate transmission, generation and distribution sectors, establishment of the central electricity regulatory commission, rationalization of electricity tariff, increase in the oversea investments, increase in private power generating companies, and increase in healthy competition. These reforms are adopted made by government to decrease all the factors which actually degrade the power systems [4][5]. The government succeeded to some extent to achieve the goals set for the power sector reforms. But, still a lot of work has to be done to achieve the ultimate goal. The aggregate technical and commercial losses of India in year 2003-04 were 36.64 percent which have been reduced to 27.15 percent in year 2009-10[6]. So, it is the need of the

hour that these reforms are implemented more rigidly and effectively.

### 2.1 Renewable Energy Integration

Energy crises are more severe in the developing countries. India is more prone to energy crises as the population growth and energy demand requirement rate are faster than the energy generation. The fossil fuels will last for three to five decades more or less and therefore one cannot rely totally on them for energy generation. Renewable energy sources are the best way to meet the increase in the energy demand by integrating them with the already existing systems. In integrated or hybrid energy system conventional energy sources are interconnected with the renewable energy sources to meet the energy demands.

### 2.2 Energy Sources and Energy Resources

A large variety of energy sources are present on the earth which can further be classified as conventional and non conventional sources. Conventional energy sources are coal, oil, gases, wood, radioactive materials. Whereas, Non conventional energy sources generally include solar power, hydroelectric power, wind power, tidal power, ocean wave power, geothermal power, ocean thermal power, biomass, bio-fuel (petroleum) from plants. Some energy sources are utilized to a great extent and some are under utilized or yet to be utilized. Wind, solar, tidal ocean, coal, oil wood energies etc. all are the types of energy sources. These may be energy released during chemical reaction, kinetic energy of gases and water etc. The term energy sources and resources are not the same. The energy resources give an idea about the methods used to extract these energies from their respective sources.

### 2.3 Conventional and Non-Conventional Energy Sources

Most of the population in India resides in the villages which uses conventional sources to meet out their energy requirements. Therefore, the consumption of non renewable (conventional) energy sources in India is very high and it is one of the major causes damaging the environment. By burning these fossil fuels like, petroleum products (petrol, diesel, kerosene), coal, natural gas etc. a great amount of the harmful gases and the particles releases to the atmosphere which causes the acid rain, ozone depletion and global warming problems. This acid rain is harmful to crops, human and the animals.

To overcome these problems and dependency on the conventional energy sources, other alternative sources of energies are to be incorporated to the existing system. These hybrid systems are very important and relevant to the today's situations on the availability of the conventional fuel all over the world. One can use alternate energies from sun, wind, water etc. non conventional energies as hybrid energy sources. This can be achieved by integrating the renewable energy sources more and more in present and near future

with the conventional energy sources. Other advantages with these energy sources, are that they are never exhausted by their extensively usage. They cause less carbon emission and therefore, reduce the chemical, radioactive and thermal pollution. They are also known as clean energy sources. Table 1 shows the region wise installed capacity (in MW) of various energy sources in India till 31-08-2011

**Table 1** All India regions wise generating installed capacity (MW) of power utilities including allocated shares in joint and central sector utilities

Region	Northern	Western	Southern	Eastern	N. Eastern	Islands	All India
Thermal	COAL	24232.50	33105.50	20982.50	21122.88	60.00	99503.38
	GAS	4134.76	7903.81	4690.78	190.00	787.00	17706.35
	DSL	12.99	17.48	939.32	17.20	142.74	1199.75
	TOTAL	28380.25	41026.79	26612.60	21330.08	989.74	118409.48
Nuclear	1620.00	1840.00	1320.00	0.00	0.00	0.00	4780.00
Hydro	14422.75	7447.50	11338.03	3882.12	1116.00	0.00	38206.40
R.E.S (MNRE)	3509.56	5937.60	10128.96	356.42	223.60	6.10	20162.24
Total	47932.56	56251.89	49399.59	25568.62	2329.34	76.12	181558.12

Captive Generating capacity connected to the Grid (MW) = 19509

RES---Renewable Energy Sources includes Small Hydro Project (SHP), Biomass Gas (BG), Biomass Power (BP), Urban & Industrial waste Power (U&I) and Wind Energy.

### 3. RENEWABLE ENERGY SCENARIO IN INDIA

The renewable energy potential in India is very large. India has five regions which favor one or another form of renewable energy sources. India is already emerging as a world leader in renewable energy developer, with the total grid-interactive power installed capacity of 21125.38MW that includes wind- generated electric capacity of 14989.00 MW. India also has 3153.93 MW of small hydro electric power, 1779.03MW of grid connected cogeneration from bagasse, 1083.60 MW of biomass based power, 46.16 MW of solar power and 73.66 MW from waste to energy including industrial (53.46MW) and urban (20.20MW) [8]. Table 2 shows the source wise and state wise estimated potential of renewable power in India on 31-03-2010.

**Table 2** Source wise and state wise estimated potential of

State/UTs	Wind Power	Small Hydro Power	Cogeneration Bagasse	Waste to Energy	Total	
					Estimated Reserve	Distribution %
Andhra Pradesh	8968	560	300	187	10015	11.09
Arunachal Pradesh	0	1329	0	0	1329	1.47
Assam	0	239	0	11	250	0.28
Bihar	0	213	300	117	630	0.70
Chhattisgarh	0	993	0	39	1032	1.14
Goa	0	7	0	0	7	0.01
Gujarat	10645	197	350	172	11364	12.88
Haryana	0	110	350	32	492	0.54
Himachal Pradesh	0	2268	0	2	2270	2.51
Jammu & Kashmir	0	1418	0	-	1418	1.57
Jharkhand	0	209	0	14	223	0.25
Karnataka	11531	748	450	219	12948	14.34
Kerala	1171	704	0	56	1931	2.14
Madhya Pradesh	1019	804	0	119	1942	2.15
Maharashtra	4584	733	1250	438	7005	7.76
Manipur	0	109	0	3	112	0.12
Meghalaya	0	229	0	3	232	0.26
Mizoram	0	167	0	2	169	0.19
Nagaland	0	189	0	0	189	0.21
Orissa	255	295	0	33	583	0.65
Punjab	0	393	300	68	761	0.84
Rajasthan	4858	57	0	93	5008	5.54
Sikkim	0	266	0	0	266	0.29
Tamil Nadu	5530	660	450	240	6880	7.62
Tripura	0	47	0	2	49	0.05
Uttar Pradesh	0	461	1250	270	1981	2.19
Uttaranchal	0	1577	0	7	1584	1.75
West Bengal	0	396	0	221	617	0.68
Andaman & Nicobar	0	7	0	0	7	0.01
Chandigarh	0	0	0	9	9	0.01
Dadar & Nagar Haveli	0	0	0	0	0	0.00
Daman & diu	0	0	0	0	0	0.00
Delhi	0	0	0	194	194	0.22
Lakshadweep	0	0	0	0	0	0.00
Pondicherry	0	0	0	4	4	0.00
Others*	0	0	17536	1281	18817	20.84
All india total	48561	15385	22536	3831	90313	100.00
Distribution %	53.77	17.04	24.95	4.24	100.00	
*Industrial waste						
Source: Ministry of New & renewable energy						

renewable power in India [8]

### 3.1 Advantages of Alternate Energy Sources

Alternative energy sources can be developed by any individual institution to meet out their daily energy requirements of any form. This leads to overall development of the rural area which generally use conventional (non renewable) energy sources for various energy requirement. Now by the use of renewable energy sources they can manage their energy needs to a greater extent. In addition, to use the most efficient devices and to consume energy most efficiently, the alternate energy sources over the convention energy sources can help to improve the overall system in many ways like it reduces our dependency on the conventional energy sources, reduces the carbon emission in the environment, reduces the fuel dependency on forest. This make our power systems more efficient, reliable, environment and people friendly by providing safe, healthy fuel alternatives. Table 3 shows the comparison of alternative fuel and conventional fuel sources.

## 4. INDIAN INITIATIVE IN RENEWABLE ENERGY DEVELOPMENT

The reforms in Indian Power Sector started with the advent of Electricity Act 2003. The Electricity Act 2003, the policies framed under the Act, and also the National Action Plan of climate change (NAPCC) provide a roadmap for increasing the share of renewable in the total generation capacity in the country [9]. With the participation of private sector there is increased competitiveness among the power producers and to meet this challenge and to increase the share of renewable following mentioned provisions and policies have been framed [10]. Many authors have published their work on the status of renewable energy sector and their promotion policies being implemented in India [11] [12] [13].

### 4.1 Electricity Act 2003

The Act has assigned the responsibility of promoting Renewable Energy to State Electricity Regulatory Commission (SERC). Under section 86 (1) (e) –SERC shall promote cogeneration and generation of electricity from renewable sources by providing suitable measures for connectivity with the grid and sale of electricity to any person and also specify, for the purchase of electricity from such sources. Section 61(h) emphasize on tariff rate keeping in mind the cogeneration and electricity generation from renewable sources of energy.

### 4.2 National Electricity Policy (NEP 2005)

The policy focuses on increase in share of non conventional energy sources in the generation mix with participation from private sector. Tariffs rates to be decided by SERC so as to make purchase of power from non conventional sources preferable and thus create competition through bidding process; considering the fact that it will take some time before non-conventional technologies compete, in terms of

cost, with conventional sources, the commission may determine an appropriate deferential in prices to promote these technologies.

Energy Source	Application	Efficiency	Cost effective	Ability to meet base load demand	Source reliability and availability	Back-up power required	Greenhouse gas emission	Other wastes	Other environmental impacts
<b>Non renewable energy sources</b>									
Thermal Energy	To generate electricity	40-45%	yes	yes	Good	No	Yes	Ash fly-ash	Acid rains. Air pollution
Nuclear Energy	To generate electricity	35-40%	yes	yes	Good	No	No	Radioactive waste	limited mining and associated tailings storage facilities
Gas Energy	To generate electricity	38-42%	yes	yes	Good	No	yes	Nil	Air pollution, acid rain
<b>Renewable energy sources</b>									
Solar Energy	Photovoltaic (PV) cells to produce electricity  Solar thermal system for heating water	15-20%	Initial cost is too large	No	Less reliable  More dependant on weather conditions on daily bases	yes	No	Toxic waste left after production of solar panels	reduce the working space on roof
Wind Energy	Wind turbine: single turbines or a number of turbines in a wind farm.  Conventional windmill to pump water.	32-38%	Not on continuous pattern	No	Less reliable  More dependant on weather conditions on daily bases	yes	No	nil	Dangerous to the birds
Water Energy	Hydro electric, wave and tidal systems to produce electricity	90-95% for large hydro plants.  85-90% for small Hydro plants	yes	Yes	Season dependent	yes	No	nil	May cause floods in nearby areas, submerge the agricultural land.
Bio-mass Energy	Direct combustion of gas produced from biomass, or biogas, to generate electricity and/or heat - e.g. wood stoves or larger commercial operations	32-38%	In Local areas	No	Good for locality dependent mainly on the bio waste	yes	No	Bio manure	No ill affects on environment
Geo-thermal Energy	Using the temperature of the earth to produce electricity and/or heat, e.g. ground source heat pumps	12-16%	in a few localities	No	Less suitable sites	No	No	nil	No ill affects on environment

Table 3 Comparison of various energy sources



**Table 4** Energy consumption levels of some commonly used appliances

Appliance	Capacity	Consumption
Instant geyser	3000 W	3 units/hour
Immersion rod	1000 W	1 unit/hour
Air conditioner	1500–2500 W	8.5–14.5 units/day
Air cooler	170 W	1.7 units/day
Fan	60 W	0.6 unit/day
Refrigerator	200 W	2 units/day
Electric kettle	1000–2000 W	1–2 units/hour
Hot plate	1000–1500 W	1–1.5 units/hour
Oven	1000 W	1 unit/hour
Toaster	800 W	0.8 unit/hour
Iron	750 W	0.65–0.75 unit/hour
Incandescent bulb	100/60/40 W	0.5/0.3/0.2 unit/day
Fluorescent lamp	40/20 W	0.28/0.15 unit/day
Slim tube	36 W	0.26 unit/day
Compact fluorescent lamp	7/9/11/13 W	0.06–0.09 unit/day
<b>Source</b> Energy Management Centre, Ministry of Power, Government of India		

## 6.2 Industrial Sector

Other prime consumer of the energy is the industrial sector of any country. The energy requirement of India is increasing day by day, as it is in its developing stage. In the developing countries like India, the main sources of energy consumption are to install new industries like manufacturing (petroleum refineries, steel, aluminum, air craft, ship, paper, chemical, cement, medicine, defense appliances, daily use appliances etc.), Construction (roads, building, shopping malls and rail tracks etc.) research-development industries and many more. The energy requirement in this sector is also very large.

## 6.3 Transportation Sector

Other sector which consumes energy is the transportation sector of the country. Big country like India has a huge network of roads, trains tracks and air routes along with the shipping routes. In the transportation sector a very high percentage of the energy is consumed to move people and goods from one place to another. The transportation is mainly done by the commercial vehicles like trucks, buses, utility vehicles, airplanes, cargo ships, trains, personal vehicles. Country like India requires a large transport system due the large population. In the recent past due to the economic growth in India the buying and affordability capacity of the people is increased many a fold. The numbers of personal vehicles also goes on increase many a fold.

As the energy consumption is directly proportional to the number of vehicle. The number of vehicles goes on increasing day by day and consumes a large amount of energy. The main sources of energy for transportations are petrol, diesel, coal, LPG, CNG. The availabilities of these fuels are limited. Generally all sectors consume one and another form of energy which are directly or indirectly derived from the fossil fuels. As we all know that availability of these sources is limited. They may not last for next 30 to 50 years. Some of these fuels also make environment polluted. So it is the right time to avail the new sources of energy which are renewable and environment friendly. Along with that we must improve the older technologies and the processes to make various equipments.

## 7. ENERGY CONSERVATION

In modern era, the people have become machine dependant. They prefer to do everything with the help of machine, as machines do the work more precisely, efficiently and within no time as compared to the human being. Each machine whether it a small machine (like grinder, air conditioner, washing machine), large machines (like lifts, elevators, other three phase machines, AC generators, DC generator, industrial machines, transporting machines (like trains, buses, trucks, airplanes etc) all require energy in one form or another. These energies must be consumed in a most efficient manner. For that new efficient techniques are to be designed and manufactured. Beside that one can help in reducing the wastage of useful power by just taking care of some of the points in daily life in all energy sectors. The following section discusses the important recommendations which if implemented efficiently can help conservation and optimum utilization of energy available.

### 7.1 Recommendations for Various Energy Consuming Sectors

#### 7.1.1 Residential and Commercial Sector

- Switch off light, fan and other electrical loads whenever not required.
- Replace all existing bulbs with CFLs (compact fluorescent lamps) and Conventional chocks by the electronic chocks which actually consume less power and have longer life.
- Use higher star rated air conditioner. Either used the auto cut off air conditioner or run them for few hours to cool the room and then switch it off.
- Make eco friendly buildings by using maximum day light.
- Every light load must be cleaned regularly.
- Fridge must not be opened very frequently.
- All appliances having moving parts must be lubricated so that to reduce friction losses and less power.

- While cooking, use wide bottom vessels with lids. Allow food articles taken out of the refrigerators to attain room temperature before cooking them.
- Soak cereals and pulses for some time before cooking them to reduce the cooking time as well as the fuel consumption. Use just sufficient water for cooking.
- Pressure cookers used with separators lead to substantial fuel saving. Reduce flame by bringing the burner knob to the simmer position as soon as the water starts boiling.
- Try to eat together to avoid repeated warming of food. This not only saves fuel but also preserves the nutritional value of food.
- Solar water heaters can be employed for heating and cooking in the day time and solar cells can be employed for lighting the corridors in the night.
- Put your desktops/laptops in the sleeping mode when ever not in use, otherwise shut it down.
- All electrical appliances must be properly maintained and used more efficiently. So that they consume less power etc.

Whenever one save energy by switching unjustified loads off or using them more efficiently then one actually reducing the demand for gasoline, coal, natural gas, nuclear fuel, oil etc which are used to generate the electricity. Less demand of these fuels reduces the emission of toxic gases like carbon mono-oxide, carbon dioxide, methane, ethane and many more which are the main causes of the global warming, acid-rain, ozone depletion etc. One can save at least 30-40 percent electricity from residential and commercial sectors.

### 7.1.2 Transportation Sector

The fuel used in this sectors are petrol, diesel and CNG etc. if by any means we are able to reduce the fuel consumption in this sector then we can save energy and environment as well. Some of the points that can be followed for the same are as follows:

- Drive route must have fewer stoppages so that you can take best average from your transport.
- Public transport must be used instead of personal transport in long and short journeys, if possible.
- Transport pooling system must be used by those people who have the same working localities.
- Shut down the vehicle at the red light whenever light time is more than 30 seconds irrespective of the fuel used (Petrol or Diesel). It will save fuel and money both.
- Traffic lights must be followed to avoid the traffic jams which leads to increased fuel consumption.
- Time to time maintenance of the vehicle make the transport system more fuel efficient.

- The speed of the vehicle should be as per the rules so that to avoid frequent braking and frequent speeding. It will also help in reducing the fuel consumption.
- Avoid over speeding, clutch riding, overloading because all these conditions consumes more fuel than normal conditions.
- Good lubricants must be used to avoid friction and deposition of carbon in the various parts of the vehicle. It makes sure the long life of the vehicle. Therefore less fuel consumption.
- Pollution check must be done regularly without any compulsion from the authorities.
- Parts used in the vehicles should be genuine. Because genuine parts gives the best fuel efficiency.
- Air and air pressure in tyres must be checked regularly. It must help in saving the fuel and money New dual fuel systems are introduced in the vehicles in last decade like petrol and natural gas, petrol and CNG. Other alternative fuels are under development stage. One may develop some new cheaper fuels for transportation which are eco friendly also which is the need of the hour. The most prominent fuel can be the electricity because that can be generated from the renewable energy sources. For that one has to design some new methods to generate electricity which are more economical.

### 7.1.3 Industry Sector

Industry is one of the biggest power consuming sectors in the developing countries. For economical growth one must develop materials, equipments and all necessary items required in day to day life by ourselves. For that one requires more and more industries. To meet out the requirement of increased population of India, these sectors also grow at a faster rate. With the help of the govt. policies the multinational companies making their product here in India and set up their offices here. The energy requirement goes on increase day by day in India. India in 2011 has shortage of 20 % electricity as on record.

Generally in industrial loads are inductive (Low power factor) in nature, which consumes more power as compared to resistive load. Due to that there is more power requirement in the industries. The industries can also help in saving electricity by taking care of some of the points listed below.

- Older less efficient machines/techniques can be replaced by the new efficient machines/techniques to enhance the production and to increase efficiency of the system.
- Older machines must regularly undergo the pollution check by the competent authority.
- They must undergo the energy auditing regularly once in one year. So that they must use electricity more efficiently.

- They can use power factor improvement devices like capacitor banks and synchronous condensers (overexcited synchronous motor).
- They must use the better methods of cooling the machines installed so that wastage can be reduced.
- Housekeeping methods must be improved by maintaining the systems as per the norms design for them.
- They can generate their own electricity using the waste/residual materials they produce. Examples like sugar industry can use cane residue to produce electricity, similarly the rice industry can also use the Rice straw, leaves and stems, rice husk, dust and other wastes to produce electricity.
- They can reduce their dependency on the power from the electricity market by taking care of renewable energy sources.
- They must install voltage stabilizer to take care of voltage fluctuations in power system. Because these fluctuations can cause wastage of the energy by drawing more current from power system.
- The type of light system must depend upon the need not on the availability of the system etc.
- Maintenance of the equipments, machines and other necessary parts is must to ensure that the overall efficiency increases and it reduces the energy wastage either in form of heat or more current drawn by the loads.

## 8. CONCLUSION

The demand of energy is increasing day by day. The ever increasing use of modern means of transport systems, changing lifestyles and mechanization of labor have led to sudden and very large spurt in the energy requirements. There are several choices available in selecting an alternate source, but the cost factor is high and each is suitable only in a particular area. Since the renewable sources of energy have inbuilt constraints of use. Almost 90 percent of the energy requirements have to for now be met from the finite sources available on this planet. With the impending energy crisis facing mankind, saving 'every bit of energy' is of great importance. This saved energy can then be put to same useful 'use' in future. One must remember 'energy saved is energy produced'. Therefore one needs to practice sustainable sources of energy for consumption.

## REFERENCES:

- [1] Overview of Renewable Energy Potential of India GENI (*global energy network institute*) 2006.
- [2] Central Electricity Authority, Government of India Ministry of Power,; [www.cea.nic.in](http://www.cea.nic.in)
- [3] "Load Generation Balance Report 2011-12". Central Electricity Authority, Government of India Ministry of Power. May 2011. Retrieved 2011-11-26.

- [4] Vinod Kumar Yadav, N.P. Padhy and H.O. Gupta. "Assessment of Indian Power Sector Reforms Through Productivity Analysis: Pre and Post Electricity Act, 2003" *IEEE PES Transmission and Distribution Conference*. pp.1-8, 2010.
- [5] Overview of Sustainable Renewable Energy Potential of India GENI (*global energy network institute*) 2010.
- [6] Ministry of Power, Government of India: [powermin.gov.in](http://powermin.gov.in)
- [7] Ministry of New and Renewable Energy, Government of India: [www.mnre.gov.in](http://www.mnre.gov.in).
- [8] "Energy Statistics 2011" national statistical organization ministry of statistics and programme implementation government of India.
- [9] Report on Development of Conceptual Framework for Renewable Energy. Available on: [www.mnre.gov.in/pdf/MNREREC\\_Report.pdf](http://www.mnre.gov.in/pdf/MNREREC_Report.pdf).
- [10] Khaparde, S.A.et.al,"Indian initiatives in the development of Renewable Sources of Energy" *NPSC 2010*.
- [11] Goyal, M. and Jha, R.,"Introduction of Renewable Energy Certificate in the Indian Scenario", *Renewable and Sustainable Energy Reviews*, Vol.13 (2009), pp.1395-1405, 2009.
- [12] Yajvender Pal Verma" Renewable Energy Certificate and Growth of Renewable Energy Sources in India" *CHASCON-2011*.
- [13] Singh, A., "A market for renewable energy credits in the Indian power sector", *Renewable and Sustainable Energy Reviews*, Vol. 13 (2009), pp. 643-652.
- [14] Mukhopadhyay, S and Rajput, A.K., "Demand side management and load control—an Indian experience", *IEEE power and Energy Society General meeting*, pp-1-5, 2010.
- [15] U.S. Department of Energy: *Intermediate Energy Infobook*, 2011-12.