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Renewable Energy Sources (RES): An Overview with Indian Context

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Abstract: ***Nowadays Renewable Energy Sources (RES) play an important role in electricity market as the changing climate is placing our planet in peril .So, there is an urgent need for transition from existing fossil fuel based energy system to one based on Renewable Energy Sources(RES) to decrease dependence on depleting reserves of fossil fuels with an objective to assess how Sustainable Development is possible. This paper presents an overview of various renewable energy sources such as solar power, wind power, small hydro power(SHP), Biomass Power(BP), Geothermal Power(GP), Tidal Power(TP), Ocean Thermal Energy Conversion(OTEC), hydrogen fuel cell etc .This paper comprehensively elucidates why we are going towards RES ,their economic, social and environmental impact, challenges associated with RES and also suggests some recommendations in order to promote RES to ensure Sustainable Development.***

Keywords: Renewable Energy Sources (RES), Distributed Generation (DG), MNRE, Sustainable Development , SHP, OTEC

1. Introduction

India is the fourth largest energy consumer in the world after the United States, China, and Russia [1]. Rapid urbanization and improving standards of living for millions of Indian households, the demand is likely to grow significantly. In order to sustain the production, industries have opted for inefficient diesel-fuelled backup power. India's energy planning, which is based on the twin objectives *of high economic growth* and providing *electricity to all*, is failing to meet either. The domestic power demand of India was 918 billion units in 2012. It is expected that at 9.8% annual growth the demand will reach 1,640 billion units by 2020. At this pace, India will require 390 GW in the next eight years which is almost double its current installed capacity. The scarcity of electricity in rural areas in comparison to urban areas seems to be biased in delivery through the centralized system. While the urban-rural difference in energy supply could be reduced through renewable energy, it is more complex to overcome the widening gap between developed and not so developed states [2]. The main concern arises on how to protect the fossil fuel for our coming generation with simultaneously utilizing the different resources of energy for high and sustained economic growth. Pressure to increase its energy supplies and the consequent negative environmental impact of fossil fuels has led India to a conscious policy toward renewable sources [3].

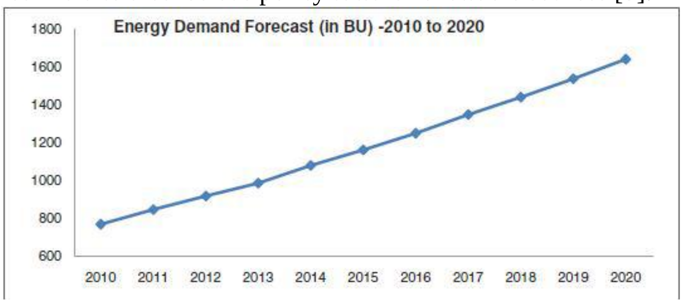

Figure 1: Projected Energy Demand in India
(source:www.greenpeace.org)

2. Indian Power Scenario and Why Renewable Energy?

India has transitioned from being the world's seventh-largest energy consumer in 2000 to fourth-largest one within a decade. The country has the fifth-largest power generation portfolio worldwide [5]. India's energy basket has a mix of all the resources available including renewable (RES). The dominance of coal in the energy mix is likely to continue in near future. At present India's coal dependence is borne out from the fact that ~58 % of the total installed electricity generation capacity is coal based. Out of total thermal installed capacity 86% capacity is coal based [6]. Other renewable such as wind, geothermal, solar, and hydroelectricity represent a 2 percent share of the Indian fuel mix. Nuclear holds a 2% percent share [7].
Total installed capacity in the country stands at ~234 GW of which

(i) Thermal power accounts for 67 %
(ii) Renewable energy accounts for 13% [6]

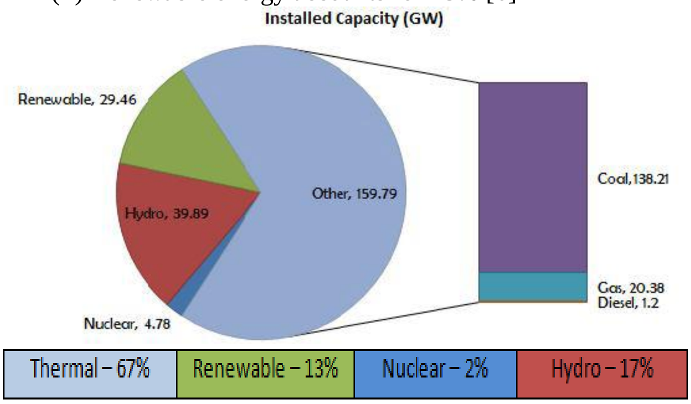

Figure 2: All India installed capacity as on 31st Dec,2013 (source:www.cea.nic.in)

power sector is solely responsible for 30% emission of CO2 throughout the world and this emission from power generation are projected to increase 46% by 2030 [8]. Fossil fuels had for so long been the most convenient and cheapest means of powering the world economy. But now they have been proved worthless to ensure energy security as 1.4 billion people have no access to electricity and world electricity demand is projected to grow by 2.2% per year between 2008 and 2035, from 16,819 TWh to about 30,300 TWh [8]. It's for sure that we cannot sustain a future, powered by a fuel which is rapidly disappearing and causses environmental degradation. Nuclear energy would also not be a sustainable solution as it associates with some fatal risk. Therefore, renewable energy is the only *viable option* to ensure energy security in a sustainable way as India has ample potential of renewable energy sources(Table-1).

Table 1: Renewable energy potential (as on 15th april, 2013)

RESOURCES	ESTIMATED POTENTIAL(MW)
Solar power(30-50 MW/Sq.km)	**100,000**
Wind power(at 80 mtr height)	**100,000**
Small hydro power(upto 25 MW)	**20,000**
Biopower(agro residue)	**17,000**
Bopower(cogeneration and bagasse)	**5,000**
Waste to energy(municipal solid waste)	**2600**
Waste to energy(industrial solid waste)	**1280**
TOTAL	**245880**

(source: data.gov.in)

3. Different Renewable Energy Sources (RES)

India has planned for RES meeting 10% of India's power in future by 2015. For meeting this demand
we need to take a glance on the renewable energy sources such as solar, wind, small hydro power(SHP),Bio mass power(BP), Geothermal, Tidal, OTEC, Hydrogen fuel cell etc.

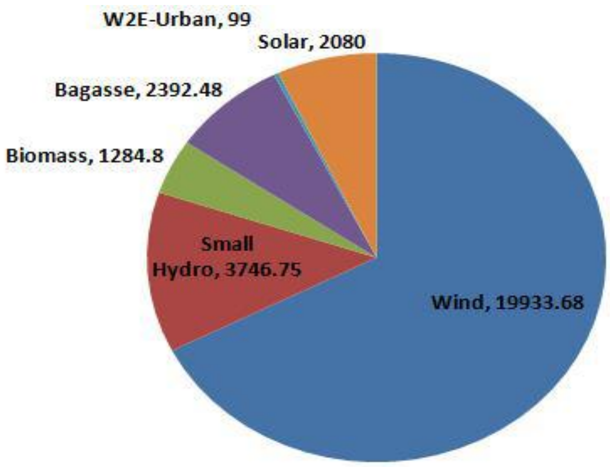

Figure 3: Renewable energy break up in India (source:www.mnre.gov.in)

3.1 Solar Power

Solar energy is clean energy as it produces no hazardous solid, liquid or gas wastes and does not create pollution**.** Solar power can be produced through

- *PV cell* which is made of semiconductor
- *Energy collectors* classified into parabolic trough, parabolic tower and parabolic disc system etc.

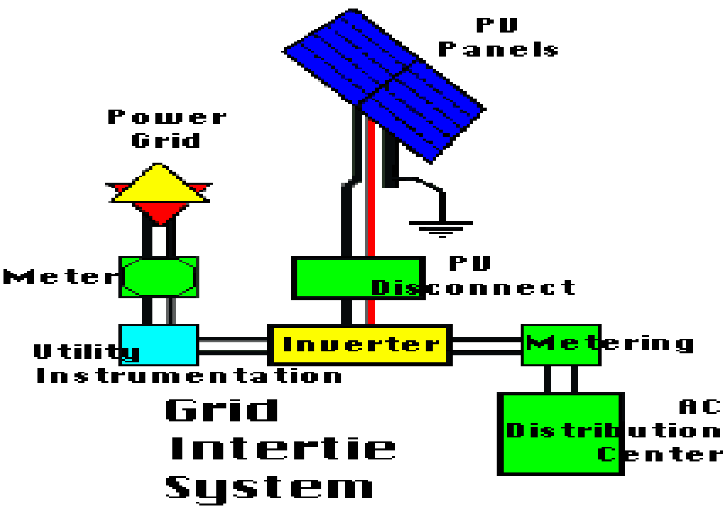

Figure 4: Active solar power generation topolgy

In most parts of India, clear sunny weather is experienced 250 to 300 days a year. India receives nearly 5,000 trillion KWh/year, which is far more than the total energy consumption of the country today.The solar power on the surface of earth is 10^{16}W. The total worldwide power demand of all needs of civilization is 10^{13}W. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require [4]. Some parts of India like western part of Rajasthan (Thar desert) receive solar radiation for use of *Concentrating Solar Power (CSP) Technology*. It is estimated that a 60 Km × 60 Km of area can produce 100000 MW of power using CSP technology. Among the various renewable energy resources, solar energy potential is the highest in the country. The equivalent energy potential is about 6,000 million GWh of energy per year. The National Solar Mission targeting 20,000 MW grid solar Power, 2,000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meters solar thermal collector area by 2022 is under implementation [7].

3.2 Wind Power

Wind energy is one of the most promising alternative energy technologies of the future. During recent years, the amount of energy produced by wind-driven turbines has increased rapidly due to considerable advancement in turbine technologies, making wind power economically compatible with conventional sources of energy. Wind energy makes up the majority about 68 per cent [9] of the total renewable energy capacity installed in India. Initial estimates from Centre for Wind Energy Technology (C-WET) suggest that wind energy potential at 80 metres height (with 2 per cent land availability) would be over 100 GW. Some studies have estimated even higher potential ranges up to 300 GW [9] [10].

Total wind energy flowing through an imaginary area A during the time t is:

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(Avt\rho)v^2 = \frac{1}{2}At\rho v^3,$$

Where,

ρ is the density of air;

v is the wind speed;

Avt is the volume of air passing through A (considered perpendicular to the direction of the wind);

Avtρ is therefore the mass m passing per unit time.

Note that ½ ρv^2 is the kinetic energy of the moving air per unit volume.

Power is energy per unit time, so the wind power incident on A (e.g. equal to the rotor area of a wind turbine) is:

$$P = \frac{E}{t} = \frac{1}{2}A\rho v^3.$$

By the end of October 2013, India had a total installed capacity of 19,933 megawatt (MW) [9], with 1,699 MW installed in 2012-13. The total wind power generation in 2011-12 was 23,399.5 gigawatt hour (GWh), or about three and a half times the output of a new 1,000-MW nuclear reactor. The 12th Five Year Plan aims to install 15,000 MW between 2012 and 2017, which will almost double the total capacity of wind power in India [11]. In order to promote wind power , the government has provided several incentives like 100% accelerated depreciation. Many state governments have provided capital subsidies (Andhra Pradesh, Maharashtra, Karnataka up to 20%), sales tax exemption. Most utilities permit wheeling, banking and buy-back (purchase price of Rs. 2.25/kWh in 1994–1995 with an escalation of 5% per year).

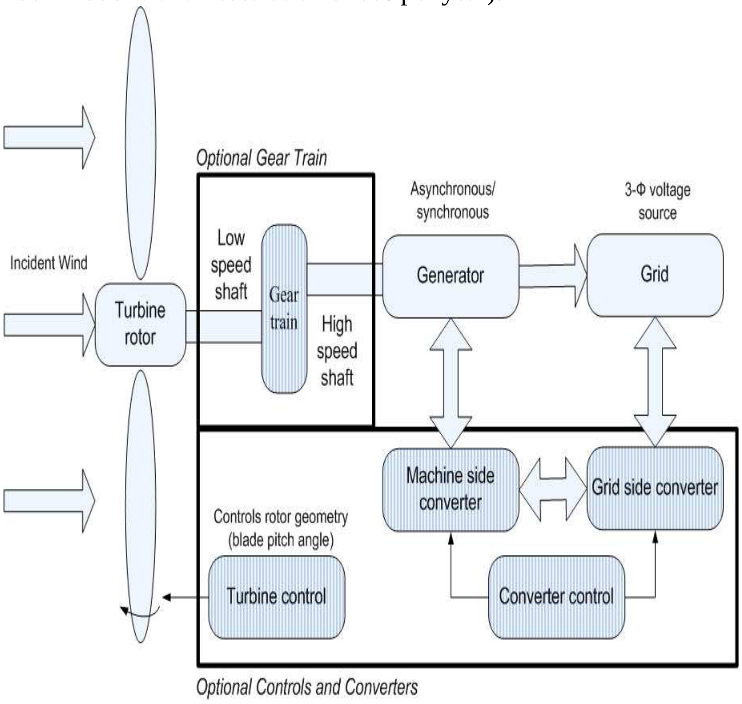

Figure 5: Modern wind turbine diagram

3.3 Small Hydro Power (SHP)

India was the 7th largest producer of hydroelectric power in 2008 after Norway. The potential for hydroelectric power in India is one of the greatest in the world. Hydro projects in India, which are under 25 MW in capacity, are classified as "small hydropower" and considered as a "renewable" energy source. India's first SHP plant come up in 1987. The total installed capacity of SHP projects in India was 3,632 MW in March 2013. This is spread over 950 projects, hence, the average SHP project capacity is 3.8 MW. This does not include micro-hydel plants. The draft 12th Five Year Plan (2012-17) has, as its target, 2,100 MW of SHP capacity [11]. The total potential country-wide capacity is estimated at 19,749 MW, of which about 1,250 MW is under development [12]. The current total installed capacity of small hydro power plants is 3746.75 MW [10]. National Hydroelectric Power Corporation (NHPC), Northeast Electric Power Company (NEEPCO), Satluj jal vidyut nigam (SJVNL), Tehri Hydro Development Corporation, NTPC-Hydro are a few public sector companies engaged in development of Hydroelectric Power in India.

3.4 Bio Energy

Bio energy refers to bio mass power, bagasse cogeneration, waste to energy, biomass gasifier, bio ethanol, bio diesel etc. Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. Biomass takes carbon out of the atmosphere while it is growing, and returns it as it is burned. If it is managed on a sustainable basis, biomass is harvested as part of a constantly replenished crop. Municipal solid wastes, animal and poultry wastes are also referred to as biomass as they are biodegradable in nature. The main biomass sources are as listed below.

- *Wood and wood waste*: forest wood, wood from energy plantations, saw dust, tree branches and leaves etc.
- *Agricultural residues*: rice husk, bagasse, groundnut shells, coffee husk, straws, coconut shells, coconut husk, arhar stalks, jute sticks etc.
- *Aquatic and marine biomass*: algae, water hyacinth, aquatic weeds and plants, sea grass beds, kelp, coral reef etc.
- *Wastes*: municipal solid waste, municipal sewage sludge, animal waste, paper waste, industrial waste etc[13].

Bio Diesel fuel and can be produced from oilseed plants such as *rape seeds, sunflower, canola and or* ***JATROPHA CURCAS.*** Jatropha circus the wonder plant produces seeds with an oil content of 37%. The oil can be combusted as fuel without being refined. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. Bio Diesel is environmental friendly , provides a 90% reduction in cancer risks , extends the life of diesel engines and ideal for heavily polluted cities.

Bagasse is the fibrous matter that remains after sugarcane or sorghum stalks are crushed to extract their juice. It is currently used as a bio fuel and in the manufacture of pulp and building materials. Bagasse based Cogeneration gained momentum in 1993, subsequent to the report submitted by the committee constituted by MNES. In Tamil Nadu, full-fledged Cogeneration plants have been commissioned in Four sugar plants. The first of these plants with the installed capacity of 18.68 MW, was commissioned and synchronized in November 1995, and the biggest of these plants with 30 MW capacity was commissioned in May 97.In India, a total of 4,449 MW has been installed under bio energy, including both in grid connected and off-grid capacities.

Table-2: Installation break up of various bio-energy (as on june 30,2013)

Type	Grid connected	Capacity installed (MW)
Biomass Power	On-grid	1,265
Bagasse Cogeneration	On-grid	2,337
Waste to Power (urban)	On-grid	96
	Off-grid	116
Biomass (non-bagasse) cogeneration	Off-grid	475
Biomass gasifiers (rural)	Off-grid	17
Biomass gasifiers (industrial)	Off-grid	143
Total		4,449

Source: MNRE achievements

3.5 Geothermal Energy

Geothermal power taps the Earth's internal heat, which comes from a combination of residual heat from planetary accretion (about 20%) and heat produced through radioactive decay (80%). The geothermal gradient, which is the difference in temperature between the core of the planet and its surface, drives a continuous conduction of thermal energy in the form of heat from the core to the surface. At the core of the Earth, temperatures may reach over 5000 degrees Celsius [14]. Geothermal energy comes from the natural heat of the Earth primarily due to the decay of the naturally radioactive isotopes of uranium, thorium and potassium. Geothermal power plants have minimal land and freshwater requirements unlike for instance solar energy which needs large area and plenty of water for cooling. Geothermal plants use only 3.5 square kilometers (1.4 sq mi) per GW of electrical production and require just 20 liters of freshwater per MW/h.

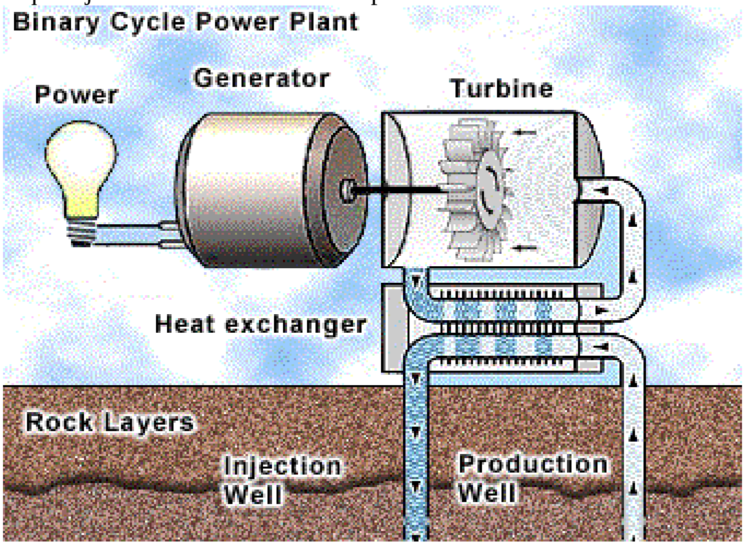

Figure 6: Binary cycle power plant (geothermal energy)

3.6 Tidal Energy

Tidal power, also called tidal energy, is a form of hydropower that converts the energy of tides (periodic rise and fall of the water level of the sea due to the attraction of sea water by the moon) into useful forms of power - mainly electricity. Although not yet widely used, tidal power has potential for future electricity generation. Benefits of tidal energy:

- It is reliable and predictable well into the future.
- Water is 800 times denser than air, which gives it huge potential for power extraction.
- It is a renewable energy source with no harmful greenhouse emissions.

These tides can be used to produce electrical power which is known as tidal power. When the water is above the mean sea level, it is called flood tide and when the level is below the mean level, it is called ebb tide. A dam is constructed in such a way that a basin gets separated from the sea and a difference in the water level is obtained between the basin and sea.The identified economic power potential is of the order of 8000 MW with about 7000 MW in the Gulf of Cambay, about 1200 MW in the Gulf of Kutch in the State of Gujarat and about 100 MW in the Gangetic Delta in the Sunder bans region in the State of West Bengal[5].The Ministry sanctioned a project for setting up a 3.75 MW demonstration tidal power plant at Durgaduani Creek in Sunder bans, West Bengal to the West Bengal Renewable Energy Development Agency (WBREDA), Kolkata. The National Hydro Power Corporation Ltd. (NHPC) is executing the project on a turnkey basis.

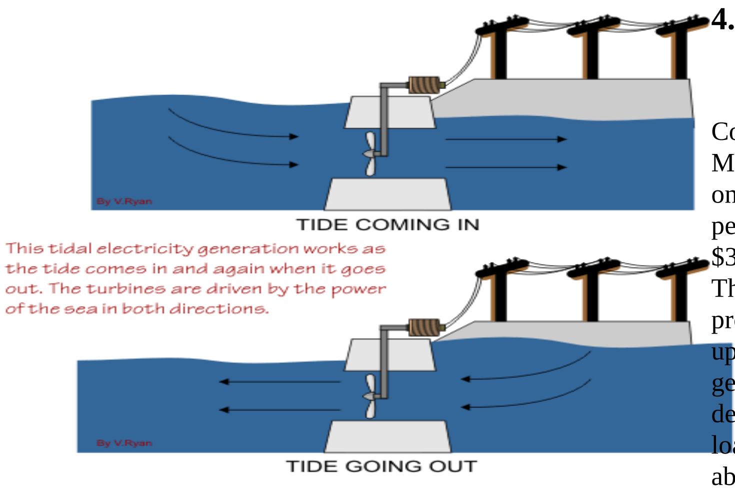

Figure 7: Tidal energy production (both times when tide comes in and also goes out)

3.7 Hydrogen Fuel Cell

A fuel cell by definition is an electrical cell, which unlike storage cells can be continuously fed with a fuel so that the electrical power output is sustained indefinitely. Electrical energy is produced by converting hydrogen, or hydrogen containing fuels, directly along with heat through the electrochemical reaction of hydrogen and oxygen into water. The process is known as electrolysis in reverse.

Overall Reaction: $2H_2$ gas + O_2 gas $\rightarrow$ H_2O + energy

Because hydrogen and oxygen gases are electrochemically converted into water, fuel cells have many advantages over heat engines. These include: high efficiency, virtually silent operation and, if hydrogen is the fuel, there are no pollutant emissions. If the production of hydrogen is from renewable energy sources (such as wind, solar, geothermal, and hydroelectric power), then the entire system is truly sustainable. Formation of water and carbon dioxide are the two principle reactions in the burning of any hydrocarbon fuel. With the formation of water becoming more significant, there is an increase in the hydrogen content in a fuel resulting in lower carbon dioxide emissions.

3.8 Ocean Thermal Energy Conversion (OTEC)

OTEC, Ocean Thermal Energy Conversion systems use the ocean's natural thermal gradient, consequently the temperature difference between the warm surface water and the cold deep water below 600 meters by about 20 C. The oceans are thus a vast renewable resource, with the potential to help us produce billions of watts of electric power. The cold seawater used in the OTEC process is also rich in nutrients and it can be used to culture both marine organisms and plant life near the shore or on land.

The total influx of solar energy into the earth is of thousands of times as great as Mankind's total energy use. All of our coal, oil and natural gas are the result of the capture of solar energy by life of the past. There have been many projects for harnessing solar energy, but most have not been successful because they attempt to capture the energy directly. The problem with this is that huge collectors must be deployed to do this, and resulting in large costs. The idea behind OTEC is the use of all natural collectors, the sea, instead of artificial collector [16].Unlike wind and solar, the Plant Load Factor (PLF) of these plants may be around 80 percent. India has built a 1MW floating OTEC pilot plant near Tamil Nadu [17]. A pilot plant of capacity 14 MW is proposed to be set up in this State

4. Cost Analysis

According to International Energy Agency (IEA) Levelised Cost of Energy (LCOE) of solar photo voltaic was $260 per MWh in 2008 which is now $220 per MWh and predicted to be only $45 per MWh by 2030. And for wind power it is now $50 per MWh and by 2030 it is predicted to be decreased down to $30 per MWh.

The capital cost of installation of bagasse based co-generation projects is in the range of Rs. 4.5 to Rs. 5.0 Cr/MW depending upon technical, financial and operating parameters. Costs of generation are expected to vary from Rs. 3.25 to 3.75/kWh, depending upon the plant load factor, and interest on term loans, location etc. The PLF of bagasse cogeneration projects is about 45% - 55% . Installation cost of RES is higher than fossil fuel based generation and this is the challenges behind RES. The values shown in the table-3 do not include any government or state incentives. In other words, they represent the actual cost to the society. We can see that at present natural gas, geothermal and coal are the most economic fuels. However, in future the price of coal-based electricity can nearly double due to government imposed cost on CO_2 emissions. Photovoltaic systems are still more expensive than fossil-based ones. The values in the table-3 represent just the cost of electricity production- the retail prices of course are always higher.

Table-3: Generation cost from various energy sources

power Plant Type	**Cost $/kW-hr**
Coal	$0.10-0.14
Natural Gas	$0.07-0.13
Nuclear	$0.10
Wind	$0.08-0.20
Solar PV	$0.13
Solar Thermal	$0.24
Geothermal	$0.05
Biomass	$0.10
Hydro	$0.08

Source: www.renewableenergy.com

5. Challenges With RES

Several challenges come into the picture for implementation of renewable energy technologies like:

a) Almost all the renewable energy sources are suffering from high *cost of installation*. It has been largely proven that as of now wind energy, small hydropower, and biomass are considered to be comparable or almost comparable to conventional energy technologies in the narrow economic sense and perhaps even cheaper considering entire life-cycles. But solar energy is not cost comparable in the narrow economic sense. However there is hope that this might be cost comparable in a few years time with new technological developments .

b) They are dependent on certain conditions. Wind energy projects cannot be set up in an area with little wind. Small hydropower cannot be utilized in an area without small rivers.

c) The average power output of an area of land planted with bio fuels , with windmills, with solar panels, and with a conventional fossil or nuclear power plant is given in table - 4.Although *power density* (watt/sq.m) of various RES is very low comparative to coal and nuclear based generation , Considering the limitless potential of the RES technology (especially since India receives a lot of sunlight) it is expected that research will make this technology cost-competitive soon.

Table-4: Power density of various energy sources

Technology	Power density W/Sq. m
Bio fuel	~0.2-0.4
Wind	~1-2
Solar	~25
Coal and Nuclear	~3000-4000

3. Government Initiatives

The Government of India(GOI) initiatives for promotion of renewable energy sources (RES) includes:

a) Exemption of industrial clearance for setting up of renewable energy industry .
b) Exemption of clearance from Central Electricity Authority for power generation projects of up to Rs 1,000 million.
c) Five-year tax holiday for renewable energy power generation power generation projects.
d) Soft loan made available through IREDA for renewable energy equipment manufacturing.
e) Facilities for promotion of export-oriented units for renewable energy industry .
f) Financial support extended to renewable energy industries for taking up R&D projects in association with technology institutions.
g) Power project import allowed.
h) Allowance to private sector companies to set up enterprises to operate as license or generating companies.
i) Customs duty concession for renewable energy parts/equipment, including for machinery required for renovation and modernization of power plants.
j) Excise duty on a number of capital goods and instruments in the renewable energy sector has been reduced/ exempted.
k) Different types of plans like *Jawaharlal Nehru National Solar Mission(JNNSM) ,Rural Electrification Program(REP),National Solar Mission, Central financial assistance (CFA)* scheme etc are being taken under planning commission.

4. Future Outlook

We should remember that low-cost electricity generation is crucial to the economy. It increases income and employment in all sectors, the purchasing power of the consumer. Recently electricity suppliers are showing increased interest in distributed generation through RES as it acts as a tool which can help them to fill in niches in a liberalised market. In that type of market, customers seeks the electricity service best suited for them. In short, distributed generation empowers suppliers in the electricity sector to respond flexibly to the changing market conditions because of their small sizes and the short construction lead times compared to most types of larger central power plants RE certainly can supplement conventional power and its use will likely continue to grow steadily with the advancement of newer technologies and R& D activity.

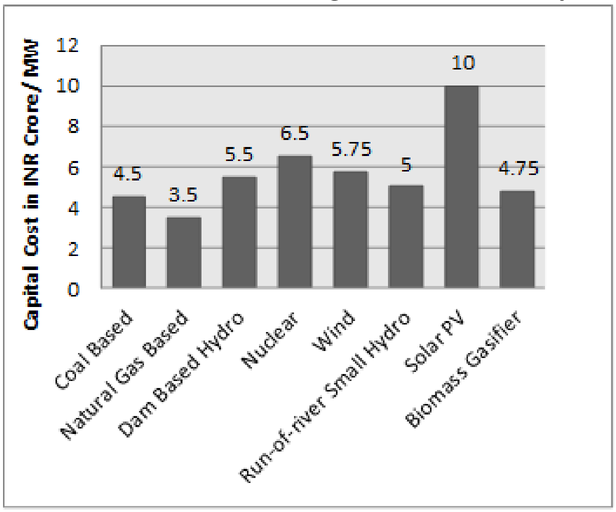

Figure 8: Capital cost in INR crore/ MW for different types of generating plants

The fig- 8 clearly shows that present value of capital cost for different electricity generation technologies powered by conventional and non-conventional sources of energy is running almost side by side. Capital cost is decreasing day by day in case of renewable distributed generation energy plants due to scientific innovation and international energy policy and the same is increasing (fig 9) for the fossil fuel powered conventional power plants as fossil fuel price is increasing due to their limited availability.

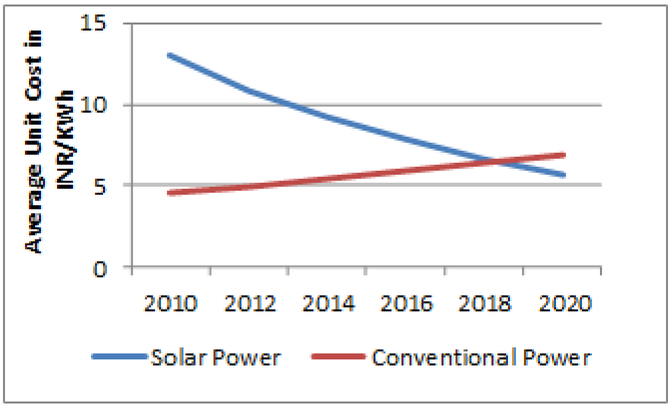

Figure 9: Variation of average unit cost in INR/KWh of Conventional Grid power and Solar power with respect to year

The Government of India (GOI) has set a renewable energy capacity addition target of 29.8 GW for the 12th FYP, taking the total renewable capacity to almost 55 GW by the end of financial year 2017 [5]. It is worthwhile to mention in this context that in 2009, the GOI launched the Jawaharlal Nehru National Solar Mission (JNNSM), one of the 8 key missions of the National Action Plan on Climate Change (NAPCC), to install 20 GW of Solar power by 2022 [5].

5. Other Recommendations

Based on our study, some recommendations are given to take a march towards renewable energy such as:

Lack of awareness is one of the major resistances incurred in expansion of renewable energy specifically in case of Biomass. Awareness program should be run by Central and state governments to propagate awareness about the technology.

a) Subsidy and support to the local entrepreneurs, those are initiated to install renewable energy set up, should be extended specially those who are acting in rural area.
b) More and more government support through tax exemption, feed-in tariffs(FITs) , green certificate(GC), production tax credit(PTC),investment tax credit(ITC),soft loan etc.
c) Enhancement of R&D activity for efficiency improvement, innovation of new technology, benchmarking etc.
d) Hybrid plants technology may be most reliable than harnessing single source i.e distributed generation(DG) concept is highly recommended.

8.Conclusions

In the past century, research and literature have concluded that CO_2 concentration increased by 28% following the industrial revolution . The global average temperature has increased by 0.3˚C to 0.6˚C, and the sea level rose 10 to 15 cm in the past 100 years. Scientists predict that if greenhouse gas emissions continue and no effective protection policies for the environment are put into place, the global temperature will increase by 1˚C to 3.5˚C, and the sea level will increase by 15 to 95 cm. Rise in temperature of 4˚C would decrease the food grain production some 28% and 68% for rice and wheat, respectively. This will make many countries uninhabitable by 2100 .

In this situation, renewable energy is the most elegant choice to make for meeting our energy demand, ensuring *sustainable development* and help human race to continue, at least not make an end from energy crisis. Though renewable energy industry is now capital intensive, its increasing use will surely decrease its cost. Per dollar investment in renewable energy will ensure *sustainable development* for future, whereas per dollar investment in traditional energy will push human race at the verge of extinction . India has plenty of renewable energy potential to bridge the gap between demand and supply .so, India must put continuous effort in harnessing various form of RES with newer technologies for a cleaner, greener and safer place for our future generation. Researchers hope very soon the innovative newer technologies will reduce the capital cost and also the cost per unit of electricity (example of PV technology is given in fig 10)

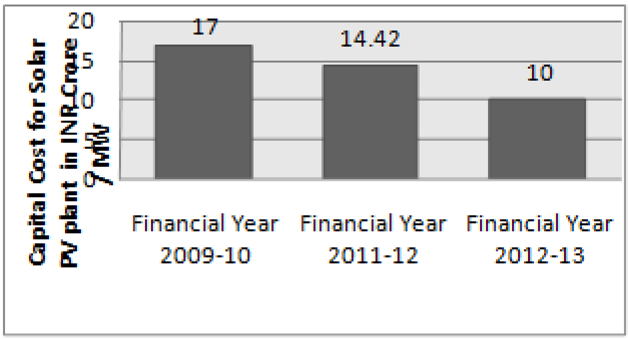

Figure 10: Variation of capital cost for Solar PV plants

References

[1] http://www.eia.gov/countries/analysisbriefs/India/india.pdf
[2] http://www.greenspace.org/india/Global/india/report/2013/poweringahead with-renewables.pdf
[3] Dr, Tarlochan Kaur"Indian Power Sector-A Sustainable way forward",IEEE IPEC 2010, pp 666-669
[4] Current Trends/Status in Solar Power Market, Workshop on "Challenges and Issues in Solar RPO Compliance/RECs" Hyderabad May 23, 2013.
[5] Mapping India's Renewable energy Growth Potential: status and outlook 2013, http://www.ey.com/publication
[6] http://cea.nic.in/reports/monthly/inst_capacity/dec 2013
[7] "Energy statistics 2013", http://www. Mospi.gov.in
[8] D.M Rahman et al. "A stydy on Renewable Energy: A sustainable solution foe future energy security", IJEE ,vol 2,issue 3.Aug 2012,pp 63-68
[9] D. Pandey et al. " Renewable Energy Sources and Distributed Generation in India", IJAREEIE,vol2, issue 12, dec 2013, pp 6361-6366
[10] http://www.mnre.gov.in
[11] www.planningcommission .nic.in/hackathon/Energy.pdf
[12] Green norm for wind poer and small hydro power 2013,http://www.cseindia.org
[13] P.C Roy" Role of Biomass Energy for sustainable Developement of Rural India",Case Studies: vol 3,special issue 3 ,ICERTSD 2013,pages 577-582
[14] A Kumar ,A Garg et al."Uyilization of Geothermal Energy Resources for Power generation in India: A Review", 7th International conference and exposition on petroleum geophysics,Hyderabad 2008, p-290
[15] India's Energy Scenario in 2013 - Challenges & Prospects, http://www.hcasia.safan.com/mag/hcajanmar13/r06.pdf
[16] Maria Bechtel and Erik Netz, Ocean thermal energy conversion, http:// www.exergy.se/ftp/cng97ot.pdf
[17] Ocean thermal energy conversion, http://www.mareasistemi.com/DIDATTICA%2014/Ocean%20thermal%20energy%20conversion.pdf
[18] http://data.gov.in/sites/default/files/Estimated_Renewable_Energy_Potential_As_On_15th_April_2013.xls

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