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Green Independence

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ABSTRACT

Even after six decades of independence, near about half of all households in India live without electricity and use kerosene oil for lighting. Even for the rural electrified areas there is tremendous shortage of power supply. Energy is the primary and most universal measure of all kinds of work by human beings and nature as well. Energy is necessary to do work and make all movements. While eating our body transforms the food into energy to do work. While our bodies, cars, planes, trolleys, boats and machinery also transform energy into work. Work means moving or lifting sources of energy that help to run the various machines invented by men. So, as the population and the requirement of any nation is increased the requirement of the energy demand which in turn will also increase for satisfying all types of the loads i.e., generation have to be increased .So as the time is going to pass the conventional sources of energy are going to be exhausted sooner or later. The best alternative of conventional energy sources are renewable energy resources, which are never going to be exhausted because they are the natural sources and they are the natural resources and they are permanently available for use, which make independence from conventional and pollution causing energy sources.

Keywords: Decentralization, Renewable Energy Resources, Energy Demand, Rural Electrification, Sustainability

I. INTRODUCTION

The objective of this paper is to focus on the comparison of the energy sources available in India, role of the emerging technologies and future scenario with respect to Renewable Energy Resources. The available energy sources can however divided into three main categories [1]

A. According to use of Energy

(a) Commercial: This includes sources which provide energy for commercial purpose such as energy from the fossil fuels such as coal, petroleum and natural gas. The fossil fuels are limited and are expensive. Their use has an adverse impact on the environment.

(b) Non-Commercial: The Energy sources available from forest resources etc. Included under this category. The Energy from cow dung, domestic as well.

(c) As the industrial wastes such as biogas come under this category.

B. According to its Availability

a) Commercial: The energy from fossil fuels and wood is considered as the conventional sources of energy.

b) Renewable Resources: This include the energy from the sun, wind, energy from biomass such as domestic and agricultural wastes, energy from the sea also called as tidal energy and geothermal

energy. They can also be called as sustainable sources of energy.

c) According to replenishment: The fossil fuels are formed from organic resources which after millions of years have been transformed into coal, petroleum, natural gas. As this formation takes a long time, these sources are considered as non-renewable energy sources.

The total percentage of various energy resources for the total energy consumption in the world is given in the table1 which will show that use the commercial energy sources more than non-commercial energy sources.

The paper also discusses the available estimated potential of the renewable energy sources their current scenario and future work regarding the same.

II. SUSTAINABLE ENERGY CHOICE -FUTURE SOURCES

The sustainable energy is the energy which has minimal negative impacts ,both in its production and consumption, on human health and the environment, and that can be supplied continuously to the future generations[2]-[4]

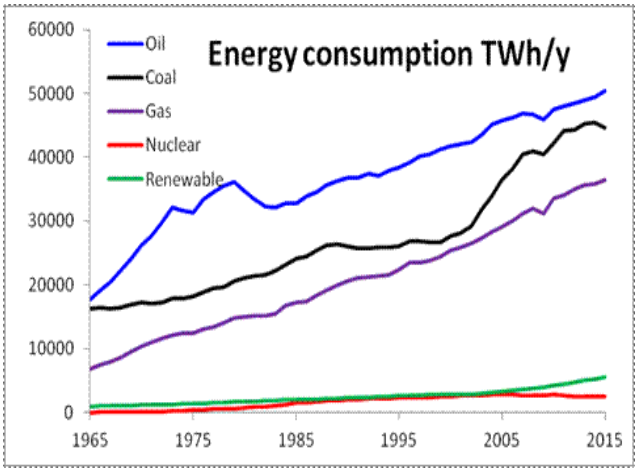

Figure 1. World Energy Consumption [16]

S.No.	Source Type	%	Energy type
1.	Coal	32.5	Conventional
2.	Oil	38.3	Conventional
3.	Gas	19.0	Conventional
4.	Uranium	0.13	Conventional
5.	Hydro	2.0	Renewable
6.	Wood	6.6	Renewable
7.	Dung	1.2	Renewable
8.	Waste	0.3	Renewable

A. Solar Energy

Every thirty minutes, enough of the sun's energy reaches the earth's surface to meet the global energy demand for an entire year. The sun is a fireball of free energy that can be harnessed for hot water and temperature control using solar collectors. In addition, solar energy can be used to provide electricity utilizing photovoltaic(PV) technology, which generates electricity from sunlight without producing greenhouse gases(GHG's).The world watch Institute reports that already rooftop solar collectors provide hot water to nearly 40 million household worldwide. Commercial solar PV modules are becoming more and more efficient and require less and less space. One of the benefit of solar PV is that it is extremely versatile and can either produce stand –alone electricity or connect to existing electricity grids. Solar PV can power equipment as small as an individual laptop, or as large as the 500 megawatt (MW) generator. Grid-connected solar PV has been cited as the world's fastest growing energy technology. Exciting developments in solar technologies include hybrid solar lighting (HSL), a system by which sunlight is refracted through optical fibres to light building interiors, significantly reducing the need for electricity. Lighting optical fibres also produces less heat than fluorescent or incandescent light bulbs, reducing the need to expand additional energy on cooling systems.HSL systems are integrated with conventional electricity,

which could eventually be supplied by other sustainable sources.

India receives a good level of solar radiations, the daily incidence ranging from 4 to 7 kWh/m² depending on locations. Solar thermal and solar photovoltaic technologies are both encompassed by the solar Energy Program that is being implemented by the MNEs. The Program, regarded as one of the largest in the world, plans to utilize India's estimated solar power potential of 20 MW/km² and 35 MW/km² solar thermal.

A solar PV program has been developed by the MNES for the two past decades, aimed particularly at rural and remote areas. The MNES has instituted a plan for establishing solar PV power generation of 1 MW for use in specialized applications: voltage support at rural sub-stations and peak shaving in urban centres. At the present time 15 grid-interactive solar PV power projects have been installed in seven states and a further 10 are under construction.

Solar energy can also be used to meet electricity requirements. Through Solar Photovoltaic (SPV) cells, solar radiation gets converted into DC electricity directly. This electricity can either be used as it is or can be stored in the battery. This stored electrical energy then can be used at night. SPV can be used for a number of applications such as:

- Domestic lighting
- Street lighting
- Village electrification
- Water pumping
- Desalination of salty water
- Powering of remote telecommunication repeater stations
- Railway signals.

B. Wind Energy

Wind has the potential to satisfy the world's electricity needs 40 times over and could meet all global energy demand five times over. Wind energy is harnessed using wind turbines-essentially giant fans-that are rotated by the wind and use the kinetic energy from their rotation to charge an electric generator. Like solar panels, windmills can be adapted to small and large uses. Depending on their designs, wind turbines can generate power as small as a few kilowatts (kW) or as large as several MW of electricity.

India estimates of the Indian wind resources had put it at 20 000 Mw (at the micro level) but recent studies have revised this figure to 45,000 MW (at 50 m hub height). Potential locations with abundant wind have been identified in the flat coastal terrain of southern Tamil Nadu, Kerala, Gujarat, Lakshadweep, Andaman & Nicobar Islands, Orissa and Maharashtra. Other favourable sites have also been identified in some inland areas of Karnataka, Andhra Pradesh, Madhya Pradesh, West Bengal, Uttar Pradesh and Rajasthan. With the assumption of a 20% grid penetration, it has been estimated that 9,000MW of potential is already available for exploitation in such states. In terms of currently installed wind turbine capacity, India now ranks 5th in the world behind Germany, USA, Denmark and Spain. At end -1999 the figure stood at 1081MW, of which 55MW represented demonstration projects and 1026 MW commercial projects. Tamil Nadu possessed 72% of the commercial plants. By mid-2000, total installed capacity had already grown to 175 (57 MW demonstration projects and 1118 MW commercial projects).

C. Hydro Energy

India's gross theoretical hydro power potential 2638 TWh/yr and theoretically feasible potential 660 TWh/yr are amongst the highest in the world. The public utilities total installed hydro –electric capacity exceeded 22,000 MW by the end of 1999 and rose by 1100 MW during 2000. Hydro output in 1999 was 88.2 TWh/yr; equivalent to 17.5 % of India's public sector electricity generation .According to the 1997

Energy statistics yearbook published by the United Nations Statistics Division, non-utility (self-producers) generation of hydro-electricity has so far been on a very small scale: however, several IPP hydro plants are now under construction.

Over 1500 small –scale hydro plants are in operation, with an aggregate installed capacity of about 400 MW; a further 365 MW of small scale capacity is under construction in more than 80 schemes. Over 1000 schemes, totalling around 500 MW in capacity, are at the planning stage.

D. Tidal Energy

Energy can be extracted from tides by creating a reservoir or basin behind a barrage and then passing tidal waters through turbines in the barrage to generate electricity. Tidal energy is extremely site specific requires mean tidal differences greater than 4 meters and also favourable topographical conditions, such as estuaries or certain types of bays in order to bring down costs of dams etc.

Since India is surrounded by sea on three sides, its potential to harness tidal energy has been recognised by the Government of India. Potential sites for tidal power development have already been located. The most attractive locations are the Gulf of Cambay and gulf of Kutch on the west coast where the maximum tidal range is 11m and 8m with average tidal range of 6.77m and 5.23 m respectively. The Ganges delta in the sunder bans in west Bengal also has good locations for small scale tidal power development. The maximum tidal range in sunder bans is approximately 5 m with an average of tidal range of 2.97 m. The identified economic tidal power potential in India is of the order of 8000-9000 MW with about 7000MW in the Gulf of Cambay about 1200MW in the Gulf of Kutch and less than 100MW in sunder bans. The Kutch tidal power project with an installed capacity of about Rs1460/- crore is generating electricity at about 90 paisa per unit. The techno-economic feasibility report is now being examined.

E. Geothermal Energy

Geo-thermal energy is renewable heat energy from underneath the earth, heat is brought to near surface by thermal conduction and by intrusion into the earth's crust. It can be utilized for power generation and direct heat applications. Potential sites for geo-thermal power generation have been identified mainly in the central and northern regions of the country. Suitable technologies are under development to make its exploitation viable.

Geothermal energy is produced when magma from the earth's core towards its outer crust heats nearby water, creating high temperature water and vapour that collects in reservoirs close to the surface. This energy is converted to electricity by pumping steam out of the ground and through a turbine, which in turn powers a generator. Geothermal energy can also be used to directly heat and cool buildings, and it has agricultural applications as well. The geothermal energy stored in the top six miles of the earth's crust contains an estimated 50,000 times the energy of the world's known oil and gas reserves. Geothermal energy can meet 100% of all the needs of 865 million people around the globe. Moreover, in many areas in the developing world, small geothermal projects have great potential to satisfy electricity demands of rural populations. Perhaps the most dramatic example of geothermal power's potential is found in Iceland, which was largely dependent on imported fossil fuels only a few decades ago. Today Iceland obtains more than 70% of its energy from domestic, renewable energy resources.

F. Biomass Energy

Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. It is derived from numerous sources, including the by-products from the timber-industry, agricultural crops, raw material from the forest, major parts of household waste and wood. Biomass does not add carbon dioxide to the

atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel. Its advantage is that it can be used to generate electricity with the same equipment or power plants that are now burning fossil fuels. Biomass is an important source of energy and the most important fuel worldwide after coal, oil and natural gas.

At present biogas technology provides an alternative source of energy in rural India for cooking. It is particularly useful for village households that have their own cattle. Through a simple process cattle dung is used to produce gas, which serves as a fuel for cooking. The residual dung is used as manure. Indian sugar mills are rapidly turning to baggasse, the leftover of cane after it is crushed and its juice is extracted to generate electricity. This is mainly done to clean up the environment, cut down power costs and earn additional revenue. According to current estimates, about 3500 MW of power can be generated from baggasse in the existing 430 sugar mills in the country. Around 270 MW power has already been commissioned and more is under construction.

G. Hydrogen and Fuel Cell Energy

Hydrogen is called as fuel of the future. But the main problem associated with hydrogen energy is the storage problem. Fuel Cells are electro chemical devices that can convert the chemical energy of a fuel directly and very efficiently into electricity (DC) and heat, thus doing away with combustion. The most suitable fuel for such cells is hydrogen or a mixture of compounds containing hydrogen. A fuel cell consists of electrolyte sand witched between two electrodes. Oxygen passes over one electrode and hydrogen over the other, and they react electrochemically to generate electricity, water, and heat.

India has a large gap between the demand and supply of power. Conventional large-scale power plants use non-renewable fuels with significant adverse ecological and environmental impacts. Fuel cell systems are excellent candidates for small –scale decentralized power generation.

Fuel cells can supply combined heat and power to combined buildings, hospitals, airports and military installations at remote locations. Fuel cells have efficiency levels up to 55% as compared to 35% of conventional power plants. The emissions are significantly lower CO_2 and water vapours being the only emissions. Fuel cell systems are modular and can be set up wherever power is required. A 10 KW PEMFC has been used in a prototype vehicle developed in India, in addition to a battery bank. Efforts are being made to build indigenous technology for production of fuel cell for power generation, transport and other applications is expected to reduce dependence and scarce fossil fuels and help in preserving the environment.

H. Indian Energy Scenario

India ranks sixth in the world in total energy consumption [5], where more than 70% of its primary energy needs are being met through imports, mainly in the form of crude oil and natural gas.
Coming to the power generation in the country, India has increased installed power capacity from 1362 MW to over 112,058 MW since independence and electrified more than 500,000 villages. This achievement is impressive but not sufficient. It is a matter f concern that 44% of households do not have access to the electricity (Census 2001) and as many as 80,000 village s are yet to be electrified. The electricity supply is not even sufficient for those who have been connected. The country still encounters peak and energy shortage of 7.7% and 12.3% respectively (up to august 05). The annual per capita consumption of 580 KWh is amongst the lowest in the world. The Ministry of Power has now drawn a roadmap to ensure power on demand by 2022.The anticipated demands per 16thElectric Power Survey requires an addition of 1,00000 MW. In other words, the achievements of more than five decades need to be replicated in the next decade. This requires

resources of Rs.8, 00,000 crores. The task is daunting but not unachievable. India has vast hydro power potential of 150,000 Mw out of which only 17% has been tapped so far. Then there are coal reserves to last for more than 200 years along with other exploitable energy resources such as oil and gas etc. Even the potential of renewable is more than 82,000 MW. It is significant that the ministry envisions adding 10.000MW up to 2022 through renewable energy resources alone. Till now the total installed capacity based on these resources is only 6422 MW consisting of 3595 MW wind,1705 Mw small hydro,750 Mw biomass,264 kW solar,66 MW gasifier and 42 MW from urban /industrial waste energy. This constitutes only 7.8% of total installed capacity in the country. The MOP has drafted New and renewable Energy Policy Statement 2005 issuing guidelines to indigenously develop new renewable energy technologies, products and services, at par with international standards, specifications and performance parameters for deployment in a manner so as to arrive at an optimal fuel –mix that most effectively meets the overall concerns of the country. To ensure integrated development, a coordination committee for power has been constituted for close coordination amongst the concerned Ministries to deliberate on issues pertaining to generation ,programs, evacuation schemes, operational issues and grid connectivity related problems.

III. SUSTAINABLE-ENERGY: AN ALTERNATIVE FOR RURAL ELECTRIFICATION

Renewable energy based power system can play an important role in electrifying the villages where power supply through grid connectivity is not possible. There has been considerable change in the energy consumption pattern and a paradigm shift has taken place making electricity most popular form of energy [6].

Rural electrification through renewable power systems assume special significance in India where out of some 85,000 unelectrified villages, 35,000 villages pose considerable problems in connecting to the power grid. This is more important from a point of view that most of the renewable sources of energy such as biomass biogas energy crops, solar power, wind power etc. are abundantly available in villages itself. The exploitation of the potential of these resources locally will result in reduction of T&D losses and the burden on fast depleting fossil fuels. Most relevant and potential renewable energy sources, which can be harnessed for the purpose of rural electrification, are:

1. Bio-mass
2. Wind Power and Solar Power

Present Status of Renewable Energy Sources in India:
In India, the development of Non-Conventional Energy Sources (DNES) was created in the Ministry of Energy in the year of 1982 to look after all the aspects relating to new and renewable energy. The Department upgraded into a separate ministry of Non-Conventional energy sources (MNES) in 1992 and was rechristened as Ministry of New & Renewable Energy (MNRE) in October; 2006.As per the information furnished by MNRE, starting with the 9th plan has been consistent increase in place of renewable energy development. Reportedly, India's renewable energy installed capacity has grown at an annual rate of 23%, rising from 3900MW in 2002-03 to about 24,000 MW in solar, small hydro, tides, geothermal heat, and biomass is known as Renewable Energy. Our country has been endowed with adequate renewable power growth, as presented by MNRE [4].

The tables 1, 2 &3 below show the potential and comparison of installed capacity of renewable and sustainable Energy sources in Rural Electrification since independence:

Table 1. % Wise generation and consumption of fossil Fuels:

Year	coal	Pet .Pro.	Natural Gas	Electricity
1953	80.1	16.7	0.0	3.2
1960	75.3	19.9	0.0	4.8
1970	56.1	34.1	0.6	9.2
1980	47.9	40.3	1.1	10.7
1990	35.9	43.6	5.5	15.0
2000	32.0	44.5	6.4	17.1
2010	31.4	45.2	7.1	18.4
2017	29.3	46.7.	8.1	18.8

Table 2: Plan-Wise Renewable Power Growth in India

Type of Energy	Starting of 10^{th} Plan(MW)	Starting of 11^{th} Plan	Target 11^{th} Plan	11^{th} Plan Achievement	Cumulative Achievement
Wind	1628	7092	9,000	10,260	17353
Small Hydro	1434	1976	14,00	1419	3395
Bio Power	389	1184	1780	2042	3225
Solar	2	3	200	938	941
Total	3453	10,255	12,380	14659	24,914

Table3: Installed Capacity of Renewable Energy Resource in Rural Electrification

Source	Estimated potential (MW)	Estimated potential (MW)	Capacity addition target for 12th Plan (2012 - 17)	Target installed capacity at the end of 12th Plan
Wind	49,000	17353	15,000	32553
Small Hydro	15,000	3395	2,100	5495
Biomass	17,000	11500	500	1650
Baggasse cogeneration	5,000	1985	1400	3385
Waste to Power	2,600 1300	90	500	590
Solar Power	>100,000	941	10,000	10,941
Total	>189,900	24914	29,500	54,414

IV. KEY ACHIEVEMENTS AND MISSIONS OF MNRE

- World's largest Renewable Energy expansion programmers 175 GW till 2022.
- Solar capacity increased 370% in the last 3 years from around 2.6GW to more than 12.2 GW.
- About 9 times solar pumps installed between 2014-17 (1.1 Lakh) versus 1991-2014 (11,600).
- Solar Power Tariff reduced by more than 75% by using "PLUG & PLAY" model.
- Solar Park Scheme doubled from 20GW to 40GW.
- Record low solar tariff ₹2.44 per unit achieved in BHADLA, RAJASTHAN.
- Record wind tariff ₹ 2.44 per unit.
- Highest ever wind capacity addition of 5.5GW in 2016-17

V. CONCLUSION

The sustainable economic development and growth of any country are closely related to the development and security of its energy sectors. Concerning the finite and limited reserves of conventional energy sources and their impact on environment, a great emphasis should be given to the development of non-conventional energy sectors and their proper utilisation for the benefit and betterment of mankind. Such initiatives would also be helpful to create many employment opportunities

at all levels, especially in rural areas. Thus, mainstreaming of non-conventional and renewable energy technologies is becoming very essential for the developing countries.

Energy independence is a life line for the nation. As the population and requirement of any energy is going to increase. As the demand is increasing the generation has to be increased. With the passage of time the conventional energy sources are going to be decreased and it might happen that after some years these sources are going to exhaust. The one the best option of conventional energy resources are never going to exhaust because they are the natural sources and they are going to be available forever.

On the whole both the energy sources i.e., conventional and non-conventional have advantages and disadvantages with respect to each other. It will depend on the system of the nation in which manner it is going to use the available resources. But one thing is for sure that when the conventional sources are exhausted one has to depend on the non-conventional energy sources. so, the requirement is there to develop new technologies to use more and more non-conventional energy resources to get better output from such sources so it can fulfil the requirement of energy in all the sectors in a much more and most efficient way.

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