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Development of Framework for the Evolution of Alternative Energies Supply and Demand: A Review

Namrata V Lotia[1], R. L. Shrivastava [2], Mohd. Nematullah Nasim [3]
[1,3]Department of Mechanical Engineering, Anjuman College of Engineering & Technology, Sadar, Nagpur, Maharashtra, India-440001
[2]Department of Mechanical Engineering, Y.C.C.E., Nagpur. Maharashtra, India-440110
thenasim@gmail.com, n_lotia@yahoo.com, rlshrivastava@yahoo.com

ABSTRACT: *This is a review paper pertaining the information about non- renewable and renewable energy scenario of India. In India most of the power generation is carried out by non-renewable energy sources such as coal ,oil, gas which contribute heavily to greenhouse gases emission . Also these sources have limited life span maximum of about 200years.So it becomes essential to tackle the energy crisis through proper utilization of abundant renewable energy resources, such as solar energy, wind energy, geothermal energy and Nuclear energy. Last 30 years has been a period of exuberant hunt of activities related to research, development, production and demonstration at India. India has obtained application of a variety of renewable energy technologies for use in different sectors too. This paper presents current status, major achievements and future aspects of renewable energy in India and implementing renewables for the future is also been presented*
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Keywords*: Renewable energy, Solar, Wind, Geothermal, Nuclear*

I. INTRODUCTION

India is now the eleventh largest economy in the world, fourth in terms of purchasing power. It is poised to make tremendous economic strides over the next ten years, with significant development already in the planning stages. This paper gives an overview of the renewable energies market in India. We look first at the current status of non renewable energy potencial then moving on to renewable markets in India, the energy needs of the country, forecasts of consumption and production, and we assess whether India can power its growth and its society with renewable resources and how far.

The assessment of the anticipated power supply position in the Country during the year 2011-12 has been made taking into consideration the power availability from various stations in operation, fuel availability, and anticipated water availability at hydro electric stations. A capacity addition of 17191 MW during the year 2011-12 comprising 14111 MW of thermal, 2080 MW of hydro and 1000 MW of nuclear power stations has been considered. The gross energy generation in the country has been assessed as 855 BU from the power plants in operation and those expected to be commissioned during the year in consultation with generating companies/ SEBs and take into consideration the proposed maintenance schedule of the units during the year.(2)

II. PRESENT INDIAN ENERGY SCENARIO

2.1. Non Renewable Energy

2.1.1. Coal

The data below shows the energy consumption in power sector highlighting the fact that coal is the major and the most important source of power generation.[1] (Fig.1)

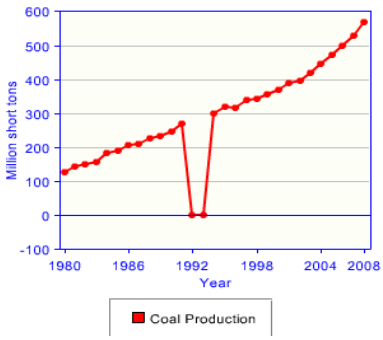

Figure 1.Energy consumption in power sector (2005) India

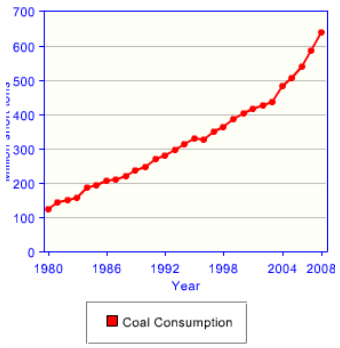

Figure 2: Coal Consumption and Production in

As per the annual report of Ministry of Coal, Government of India, the Coal production in all over India during the period April, 2009 to January, 2010 has been 416.47 Million tones (Provisional) as compared to the production of 385.02 Million tones (MT) during the corresponding period of the previous year showing a growth of 8.17% [3].

The coal reserves of India up to the depth of 1200 meters have been estimated by the Geological survey of India as 267.21 billion tones as on April 1, 2009.The 28 year history of coal consumption and production is shown through Fig.2 respectively [4]

Through sustained program of investment and great thrust on application of modern technologies, it has been possible to raise the production of coal from a level of about 70 million tones at the time of nationalization of coal mines in early 1970's to 365.09 million tones(All India–including Meghalaya) in 2009-10 (up to December 2009). India consumes 7% of coal of the world. World's 68% coal is consumed in Electricity generation (Fig.3).

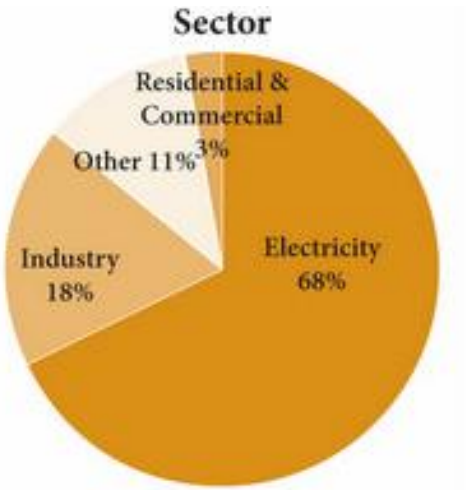

Figure 3: Sector wise coal consumption in India

2.1.2. Oil

India produced roughly 880 thousand barrels per day (bbl/d) of total oil in 2009 from over 3,600 operating oil wells. Approximately 680 thousand bbl/d was crude oil and the remainder was other liquids and refinery gain (Fig. 4) [4].

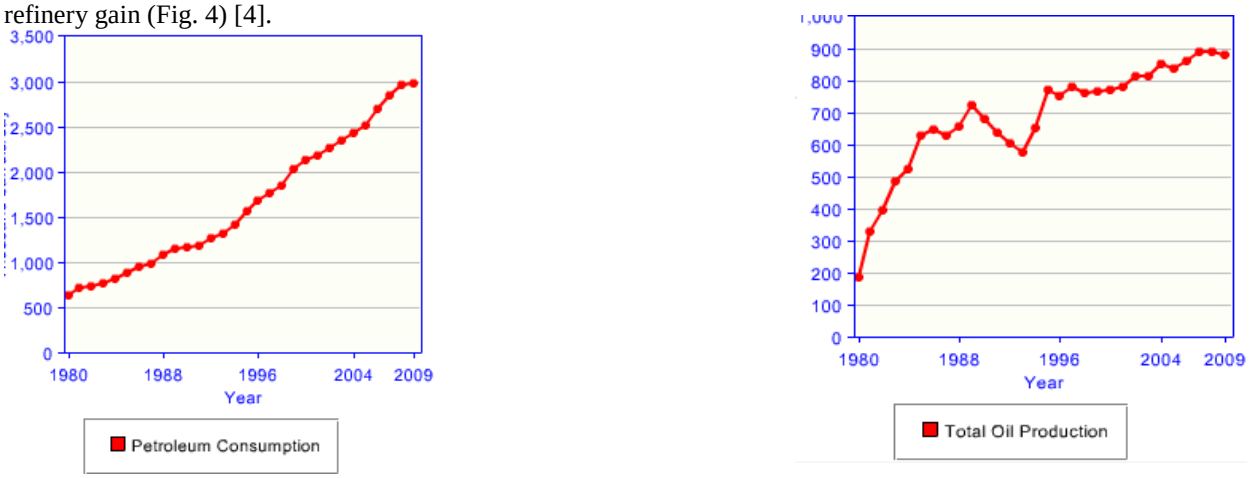

Figure 4: Petroleum Consumption and Production at India

In 2009, India consumed nearly 3 million bbl/d (Fig. 4), making it the fourth largest consumer of oil in the world. EIA expects approximately 100 thousand bbl/d annual consumption growth through 2011 [5]. In2009, India was the sixth largest net importer of oil in the world, importing, nearly 2.1 million bbl/d, or about 70 percent, of its oil needs.

2.1.3. Natural Gas

In 2009, India consumed roughly 1.8 Tcf of natural gas, almost 300 billion cubic feet (Bcf) more than in 2008, according to EIA (Energy Information Administration) estimations [4]. Natural gas demand is expected to grow considerably, largely driven by demand in the power sector. The power and fertilizer sectors account for nearly three-quarters of natural gas consumption in India .According to Oil and Gas Journal, India had approximately 38 trillion cubic feet (Tcf) of proven natural gas reserves as of January 2010[5]. The bulk of India's natural gas production comes from the western offshore regions, especially the Mumbai High complex, though the Bay of Bengal and its Krishna-Godavari (KG) fields are proving quite productive. Despite the steady increase in India's natural gas production, demand has outstripped supply and the country has been a net importer of natural gas since 2004. India's net imports reached an estimated 445 Bcf in 2009.

2.1.4. Electricity Generation and Consumption

In 2007, India had approximately 159 gigawatts (GW) of installed electric capacity and generated 761billion kilowatt hours. Nearly all electric power in India is generated with coal, oil or gas. Conventional thermal sources produced over 80 percent of electricity in 2007. Hydroelectricity, a seasonally dependent power source in India, accounted for nearly 16 percent of power generated in 2007. Finally, nuclear energy produced roughly 2 percent of electricity during the same year, while geothermal and other renewable sources accounted for approximately 2 percent (Fig.8) [4]

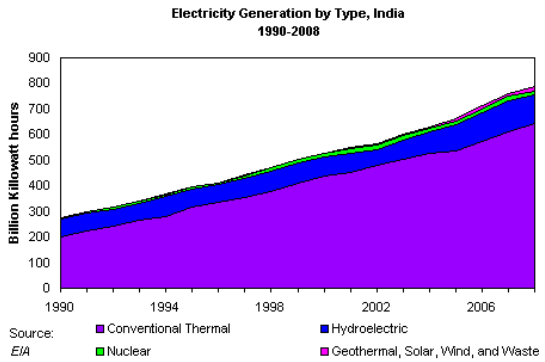

Figure 5 Electricity generation by type in India

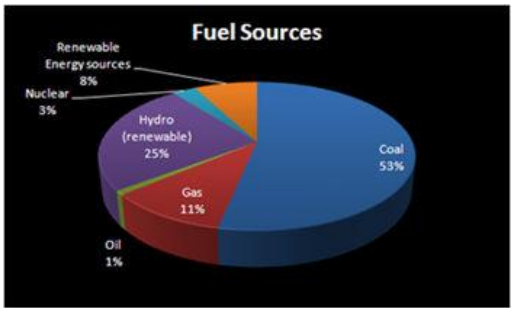

Figure 6 Fuel Sources

2.2 Renewable Energy

India has a vast supply of renewable energy resources, and it has one of the largest programs in the world for deploying renewable energy products and systems. Indeed, it is the only country in the world to have an exclusive ministry for renewable energy development, the Ministry of Non-Conventional Energy Sources (MNES). Since its formation, the Ministry has launched one of the world's largest and most ambitious programs on renewable energy. Based on various promotional efforts put in place by MNES, significant progress is being made in power generation from renewable energy sources. India currently has 15,326 MW of installed renewable energy sources as of July 2009 with distribution shown below. (figure 5)[6]

The key drivers for renewable energy are as follows

- The demand-supply gap, especially as population increases
- A large untapped potential
- Concern for the environment
- The need to strengthen India's energy security
- Pressure on high-emission industry sectors from their shareholders
- A viable solution for rural electrification

Figure 6:Solar Resource Map of India

2.2.1 Solar Energy

India is densely populated and has high solar insolation, an ideal combination for using solar power in India. In the solar energy sector, 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 GW to 2,100 GW. Also India's Ministry of New and Renewable Energy has released the JNNSM Phase 2 Draft Policy, by which the Government aims to install 10GW of Solar Power and of this 10 GW target, 4 GW would fall under the central scheme and the remaining 6 GW under various State specific schemes.

In July 2009, India unveiled a US$19 billion plan to produce 20 GW of solar power by 2020. Under the plan, the use of solar-powered equipment and applications would be made compulsory in all government buildings, as well as hospitals and hotels. On 18 November 2009, it was reported that India was ready to launch

its National Solar Mission under the National Action Plan on Climate Change, with plans to generate 1,000 MW of power by 2013 From August 2011 to July 2012, India went from 2.5 MW of grid connected photovoltaics to over 1,000 MW.

On 16 May 2011, India's first 5 MW of installed capacity solar power project was registered under the Clean Development Mechanism. The project is in Sivagangai Village, Sivaganga District, and Tamil Nadu. [7]

With about 300 clear, sunny days in a year, India's theoretical solar power reception, on only its land area, is about 5000 Petawatt-hours per year (PWh/yr) (i.e. 5000 trillion kWh/yr or about 600 TW).The daily average solar energy incident over India varies from 4 to 7 kWh/m^2 with about 1500–2000 sunshine hours per year (depending upon location), which is far more than current total energy consumption. For example, assuming the efficiency of PV modules were as low as 10%, this would still be a thousand times greater than the domestic electricity demand projected for 2015.

By the end of March 2013 the installed grid connected photovoltaics had increased to 1686.44 MW, and India expects to install an additional 10,000 MW by 2017, and a total of 20,000 MW by 2022

2.2.2 Wind Energy

The development of wind power in India began in the 1990s, and has significantly increased in the last few years. Although a relative newcomer to the wind industry compared with Denmark or the United States, India has the fifth largest installed wind power capacity in the world. In 2009-10 India's growth rate was highest among the other top four countries.

As of 31 Jan 2013 the installed capacity of wind power in India was 19979.15 MW, It is estimated that 6,000 MW of additional wind power capacity will be installed in India by 2014. Wind power accounts for 8.5% of India's total installed power capacity, and it generates 1.6% of the country's power.
India is the world's fifth largest wind power producer, with a generation capacity of 8,896 MW.

The short gestation periods for installing wind turbines, and the increasing reliability and performance of wind energy machines has made wind power a favoured choice for capacity addition in India.
Suzlon, an Indian-owned company, emerged on the global scene in the past decade, and by 2006 had captured almost 7.7 percent of market share in global wind turbine sales. Suzlon is currently the leading manufacturer of wind turbines for the Indian market, holding some 43 percent of market share in India. Suzlon's success has made India the developing country leader in advanced wind turbine technology. [8]

2.2.3 Geothermal energy

Geothermal energy is thermal energy generated and stored in the Earth. The geothermal energy of the Earth's crust originates from the original formation of the planet (20%) and from radioactive decay of minerals (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. The adjective geothermal originates from the Greek roots γη (ge), meaning earth, and θερμος (thermos), meaning hot.

Earth's internal heat is thermal energy generated from radioactive decay and continual heat loss from Earth's formation. Temperatures at the core-mantle boundary may reach over 4000 °C (7,200 °F). The high temperature and pressure in Earth's interior cause some rock to melt and solid mantle to behave plastically, resulting in portions of mantle convecting upward since it is lighter than the surrounding rock. Rock and water is heated in the crust, sometimes up to 370 °C (700 °F). From hot springs, geothermal energy has been used for bathing since Paleolithic times and for space heating since ancient Roman times, but it is now better known for electricity generation. Geothermal power is cost effective, reliable, sustainable, and environmentally friendly, but has historically been limited to areas near tectonic plate boundaries. Recent technological advances have dramatically expanded the range and size of viable resources, especially for applications such as home heating, opening a potential for widespread exploitation. Geothermal wells release greenhouse gases trapped deep within the earth, but these emissions are much lower per energy unit than those of fossil fuels. As a result, geothermal power has the potential to help mitigate global warming if widely deployed in place of fossil fuels.

Forecasts for the future of geothermal power depend on assumptions about technology, energy prices, subsidies, and interest rates. At present as a result of government assisted research and industry experience, the cost of generating geothermal power has decreased by 25% over the past two decades. In 2001, geothermal energy cost between two and ten US cents per kWh.

2.2.4 Nuclear power

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. As of 2012, India has 20 nuclear reactors in operation in six nuclear power

plants, generating 4,780 MW[2] while seven other reactors are under construction and are expected to generate an additional 5,300 MW. In October 2010, India drew up "an ambitious plan to reach a nuclear power capacity of 63,000 MW in 2032 but, after the 2011 Fukushima nuclear disaster in Japan, "populations around proposed Indian NPP sites have launched protests, raising questions about atomic energy as a clean and safe alternative to fossil fuels". There have been mass protests against the French-backed 9900 MW Jaitapur Nuclear Power Project in Maharashtra and the Russian-backed 2000 MW Kudankulam Nuclear Power Plant in Tamil Nadu. The state government of West Bengal state has also refused permission to a proposed 6000 MW facility near the town of Haripur that intended to host six Russian reactors. A Public Interest Litigation (PIL) has also been filed against the government's civil nuclear programme at the Supreme Court.

Despite this opposition, the capacity factor of Indian reactors was at 79% in the year 2011-12 compared to 71% in 2010-11. Nine out of twenty Indian reactors recorded an unprecedented 97% Capacity factor during 2011-12. With the imported uranium from France, the 220 MW Kakrapar 2 PHWR reactors recorded 99% capacity factor during 2011-12. The Availability factor for the year 2011-12 was at 89%.

India has been making advances in the field of thorium-based fuels, working to design and develop a prototype for an atomic reactor using thorium and low-enriched uranium, a key part of India's three stage nuclear power programme. The country has also recently re-initiated its involvement in the LENR research activities, in addition to supporting work done in the fusion power area through the ITER initiative.

India has signed Nuclear agreements with other nations to encourage and support scientific, technical and commercial cooperation for mutual benefit in this field.

By 2020, India's installed nuclear power generation capacity will increase to 20,000 MW (2.0×10^{10} Watts, which is 20 GW).

Indian President A.P.J.Abdul Kalam, stated while he was in office, that "energy independence is India's first and highest priority. India has to go for nuclear power generation in a big way using thorium-based reactors. Thorium, a non fissile material is available in abundance in our country." India has vast thorium reserves and quite limited uranium reserves. [10]

3 Future requirement and availability

"The struggle for existence is the struggle for available energy"

Ludwig Boltzmann

Energy for everybody?

The ever increasing world energy demand cannot be satisfied much longer with fossil fuels ,alternatives are required to limit the chance of a climate collapse and the spreading of wars for natural resources. The 21st century will be largely defined by the way we face and resolve the energy crisis. This is an intricate and fascinating scientific challenge, in which chemistry will play a fundamental role, and also an unprecedented opportunity to shape a more peaceful world. [12]

III. SUGGESTIONS

Following suggestions are given for best possible utilization of available renewable energy sourses for" power to all":

1) Establishment of biomass /solar / wind power generation systems and energy saving in every government office to encourage and inspire people.

2) Strenuous exaltation of renewable energy by government agencies, public sector, corporate, academic institutions etc.

3) Foundation of national-level body to increase awareness of renewable energy at comprehensive level.

4) Research and development of renewable energy technologies get provided the financial support and sponsorship.

5) Setting up aspiring goals and targets for power generation from non-conventional sources.

6) Making it compulsory to install solar water heating systems for all urban residential and commercial establishments.

7) Imperative renewable energy systems provision for new residential, commercial and industrial buildings.

8) Restricting use of large battery energy storage systems and promoting use of biofuels in vehicles.

9) Abrogating duties / taxes on import of small-scale renewable energy generating equipment and providing manageable loans for setting up renewable energy enterprises.

10) Handsome incentives and subsidies for installation and successful operation of renewable energy equipment and additional incentives for buyers and manufacturers of renewable energy equipments in rural areas.

11) Cultivation of energy crops on marginal and degraded land.[11]

IV. CONCLUSIONS

Now a time has come for transition from petroleum-based energy systems to one based on renewable energy resources to decrease reliance on depleting reserves of fossil fuels and to mitigate climate change. In addition, renewable energy has the potential to create many employment opportunities at all levels, especially in rural areas.

1) Mainstreaming of renewables is very essential. Energy security, economic growth and environment protection are the national energy policy drivers of any country of the world. The need to boost the efforts for further development and promotion of renewable energy sources has been felt world over in light of high prices of crude oil.

2) A disparaging part of the solution lies in promoting renewable energy technologies as a way to address concerns about energy security, economic growth in the face of rising energy prices, competitiveness, health costs and environmental degradation. The cost-effectiveness of Wind and Small Hydro power energy should also be taken into account.

3) An emphasis should be given on presenting the real picture of massive renewable energy potential to attract foreign investments which may lead to a Green Energy Revolution in India.

4)Specific action include promoting deployment, innovation and basic research in renewable energy technologies, resolving the barriers to development and commercial deployment of biomass, hydropower ,solar and wind technologies.[11]

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