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India's Reliance on Energy Sources: An Overview Study towards Sustainability by 2022

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***Abstract* – India has a total installed energy generation capacity of 211 Gigawatts as of 2012 out of which renewables contribute about 30 % ,Conventional sources of energy contribute around 67 % and Nuclear 2 %. India has the reliance mostly on conventional sources of energy. India has the fifth largest coal reserves in the world .Coal contributes about 57% in the current energy mix .According to India's Central Electricity Authority (CEA) coal-fired power plants will continue to dominate India's electricity generation under Business As Usual Scenario. Furthermore, under the BAU scenario the growth rates of the energy from coal and lignite would be about 3.6%/yr during the years 2012–2022.**

Renewable energy is the most attractive investment because it will provide long-term economic growth for India. A favourable renewable energy policy creates millions of new jobs and an economic stimulus of at least US$1 trillion, and perhaps much more if all indirect economic effects are included. "India is the Saudi Arabia of renewable energy sources and if properly utilized, India can realize its place in the world as a great power, "Renewable energy also has the advantage of allowing decentralized distribution of energy particularly for meeting rural energy needs.

The current as well as future scenario of the energy resources of India has been discussed in this paper to find out the way for sustainable energy growth through renewable energy sources.

To meet increasing energy requirements, policy decisions to speedily, develop and utilize environmental friendly resources, support from renewable is a necessity. Full potential of the non-conventional renewable resources is required to be exploited at the earliest. The paper endeavored to present pros and cons of future sources of energy and their dependency.

***Keywords* – Renewable Energy, Conventional Sources of Energy, Decentralized Distribution and Future Sources of Energy.**

I. Introduction

Present population of India is around more than 1.2 billion and is growing at an annual rate of 0.70 % estimated to be 1.32 billion in 2022.The nation is amongst the fastest growing economies of the world, from 1990 to 2010 India's economy grew by 6.4 percent per year but global recession slowed down the growth to about 5.5 % in 2012. The current yearly growth rate is above 6.5 %. This High economic growth is placing enormous demand on India's energy resources. The International Energy Outlook, 2002 predicts a reference primary energy consumption growth rate of 3.6%/yr during 1997–2020 for India. The high and low growth scenarios correspond to 4.5%/yr and 2.6%/yr, respectively. Thus for the projection of energy demand till 2022, growth of 3.7 % is considered. Currently, there is overall energy deficit of 8.7 per cent, peak shortage of 9.0 per cent and may increase further over a long run. At the same time, more than 25 % of the population continues to live with no access to electricity and other forms of commercial energy. On the other hand those with access often have to cope with blackouts. This is likely to be the case in the foreseeable future, making energy access, a continuous and growing problem. [1][4][7]

II. Current Energy Scenario

India has a total installed energy generation capacity of 211 Gigawatts as of 2012 out of which renewables contribute about 30 % ,Conventional sources of energy contribute around 67 % and Nuclear 2 %.

The current as well as future scenario of the energy resources of India has been discussed below:

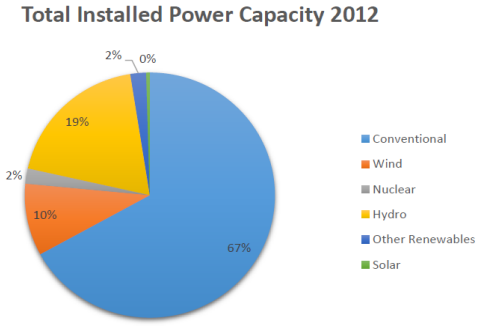

Fig.1. Percentage of contribution in the Energy Mix of India (EIA Report, 2013)

III. India's Reliance on Energy Resources

India has the fifth largest coal reserves in the world. Coal contributes about 57% in the current energy mix. According to India's Central Electricity Authority (CEA) coal-fired power plants will continue to dominate India's electricity generation under Business As Usual Scenario. Furthermore, under the BAU scenario the growth rates of the energy from coal and lignite would be about 3.6%/yr during 2012–2022. [7]

The contribution of coal in the future of India's energy mix is expected to be limited because of the following reasons:

1. Power plants heavily rely on coal as a fuel for producing electricity as it is one of the cheapest sources of energy available in the nation.
2. Good quality coal is rarely available and is used by the metallurgical industry, like steel plants. The coal supplied to power plants is of the degraded quality which comprises of Low calorific value and very high ash content. The ash content is as high as 55–60%, with an average value of about 35–40%.

Most of the coal mines are located in the eastern parts of the country and requires transportation over long distances, mostly by trains, which run on diesel.

3. One of the most inefficient plants in the nation is the Thermal Power Plants. They use old, energy consuming equipment which are not capable of reducing emissions moreover not even productive as compared to the plants in other nations of the world.
4. It produces particulates, oxides of sulphur, nitrogen, carbon and toxic metals like arsenic, mercury, etc., in trace concentrations. The health risk of all these is deterministic, it is certain somatic damage.
5. Weak Chain of the coal supply throughout the nation is leading to coal shortages at the time of peak demand which is the main factor behind the shortfalls in electricity generation. [3] This is evident by the achievements of production in 2012 which were much lower than the government's set targets. As 70% of total greenhouse gas (GHG) emissions related to energy, are mainly from the combustion of fossil fuels for heat, electricity generation and transport and the nation is aiming to reduce emissions under the MNRE Policy Scenario this steeply increased the requirements of high grade coal. [4] Thus, there is an immense pressure on the import of coal from Australia, Indonesia and South Africa. The projected imports show an increase from present 10 % to 70 % by 2030. [2]

According to MNRE, all the concerns related to energy security for a better future of the nation, the coal usage for generation of electricity will be declining drastically and will be taken over by the renewable energy in the coming decade.

Besides above energy mix, the contribution Oil & other Liquids, Natural gas and Nuclear Power in the future of India's energy mix is expected to be limited because of the following reasons:

1. India has poor oil reserves of about 5.9 billion barrels which is over 0.5% of global reserves with total proven, probable, and possible reserves of close to 11 billion barrels. In contrast, it is amongst the largest consumers of oil and petroleum products in the world as per 2011. Over the next 15-20 years country's domestic production is expected to remain constant but its annual demand for the oil is estimated to increase at an average rate of 2.9%. This results in heavy dependence on imported crude oil, mostly from the Middle East .Moreover, International Energy Agency projects that India's dependence on the oil imports will grow to 91.6% by the year 2022. This has led the Indian energy companies to attempt to diversify their supply source. [2] [3]
2. Natural gas has emerged as one of the most preferred fuels due to its environmentally benign nature, greater efficiency and cost effectiveness and mainly serves as a substitute of coal for electricity generation in India. The nation began to import LNG after 2004 as there wasn't any sufficient natural gas infrastructure on a national level to meet domestic demand. The net imports were increasing at a constant rate till 2010, but as in the recent years the production declined remarkably this resulted in increased dependency on imports. The predicted rate of consumption is above 1.4% per annum. [3]
3. Presently installed nuclear power in India is a mere 2.14% of the total electricity generation capacity which is generated by 20 reactors. The cost of generation of electricity from nuclear in India is highest. Finally, there has been significant opposition to every new nuclear reactor that has been planned since the 1980s, most dramatically illustrated by the intense protests over the Koodankulam reactors In addition to concerns about safety or radioactive waste, opposition to nuclear facilities also stems from their impact on lives and livelihoods. Nuclear reactors, for example, require cooling water and land and these compete with the needs of farmers, while discharges of hot water and radioactive effluents into the sea affect fish workers. This source of opposition will likely intensify over the decades as land and other natural resources become subject to tremendous competition.

IV. RENEWABLE ENERGY

Renewable energy is the most attractive investment opportunity in India because it associate long-term economic growth for India. A favourable renewable energy policy creates millions of new jobs and an economic stimulus of at least US$1 trillion, and perhaps much more if all indirect economic effects are included. "India is the Saudi Arabia of renewable energy sources and if properly utilized, India can realize its place in the world as a great power, "Renewable energy also has the advantage of allowing decentralized distribution of energy particularly for meeting rural energy needs. [3] Various sources of renewable energy potential in India like hydro power, wind power and solar power which is abandoned available are discussed below. However special impact on solar initiatives taken by Government of India is analysed subsequently.

A. Hydro Power in India

Hydropower, large and small, remains by far the most important of the renewable for electrical power production in India, the nation is under the top 10 largest producers of hydroelectric power. Currently its contribution in the total installed capacity is about 20 % i.e. about 42GW.

Among all renewable sources, small hydro is a clean and well utilizable source of energy. They are one of the most efficient sources of energy of the nation with benefits

such as providing electricity to remote and rural areas, facilitating water supply for irrigation, domestic purposes, fisheries and tourism.

The nation has a hydro-development scheme for a capacity building of more than 40 GW through SHP (Small Hydropower). This scheme is the extended version of the older scheme discussed in Overall more than 800 small hydro projects are installed and under implementation. Thus, India considers commissioning of more hydro-capacity (especially small scale) a great priority, to increase the share of hydro from 25 to 40 per cent of national capacity. [6] This is evident from the study conducted by The Central Electricity Authority of India on the Hydro schemes. They recommended achieving cumulative hydro installed capacity of 115 GW by the year 2021–2022 and the full potential of 150 GWe to be achieved by the year 2025–2026 [7] Thus, for calibrating the future energy mix 2022 it is assumed that minimum of 95 GW will be achieved. I have excluded the capacity to be achieved by the larger hydropower projects as there are numerous issues related to the LHP such as high capital cost, rehabilitation, resettlement of people, geographical disturbance and long setup times. Thus, in future Small Scale projects are considered and promoted.

B. Wind Energy in India

The wind energy sector in India has an installed capacity of 20 GW out of total Installed Capacity of 211 GW. In terms of wind power installed capacity, India is ranked 5th in the world, and is a considered a major player in the global wind energy market.

The potential is far from exhausted. The Centre for Wind Energy Technology has re-assessed that with the current level of technology, the 'on-shore' potential for utilization of wind energy for electricity generation is more than enough to meet the demand-supply gap and according to the new assessment by Ministry of New and Renewable Energy (MNRE) projections for the year 2022 under BAU scenario is that 98,000 jobs will be created and an installed capacity of 50 GW will be achieved. The Global Wind Energy Organization has predicted a scenario of aggressive growth which, if taken into account, will result in overall capacity of 89GW by 2020. [8]

C. Solar Energy Development

India has initiated a great step towards solar energy development. To meet increasing energy requirements, policy decisions to speedily, develop and utilize environmental friendly resources, support from renewable is a necessity. Full potential of the non-conventional renewable resources is required to be exploited at the earliest. On the introduction of the National Action Plan on Climate Change on 30th June 2008 Prime Minister of India Dr. Man Mohan Singh stated:

"Our vision is to make India's economic development energy-efficient. Over a period of time, we must pioneer a graduated shift from economic activity based on fossil fuels to one based on non-fossil fuels and from reliance on no-renewable and depleting sources of energy to renewable source of energy. In this strategy, the sun occupies centre-stage, as it should, being literally the original source of all energy. We will pool our scientific, technical and managerial talents, with sufficient financial resources, to develop solar energy as a source of abundant energy to power our economy and to transform the lives of our people. Our success in this endeavour will change the face of India. It would also enable India to help change the destinies of people around the world." [5]

India is among top 5 destinations worldwide for solar energy development as per Ernst & Young's renewable energy attractiveness index moreover according to the National Renewable Energy market is experiencing a yearly growth rate of 15 % with an estimated 30 billion USD of private investments. India has a solar power reception of about 5 Trillion Kwh/yr on the basis of its land area. Yearly more than 1500 hours of sunshine is available with an average solar energy incident of 6 Kwh /m2 varying as per locations. This amount of untapped potential is more than enough to support the long term, reliable energy needs of the nation. [9] One of the major initiatives of the Government of India (GOI) regarding the solar energy sector of India is the Jawaharlal Nehru National Solar Mission. It is a $19 Billion plan launched by the government of India in January 2010.

The Targets of the mission are divided into 3 phases as follows:

Table 1: Targets of Jawaharlal Nehru National Solar Mission (source:MNRE)

Source	Till 2009	Phase 1 (2012-13)	Cumulative Target Phase-2 (2013-17)	Cumulative Target Phase-3 (2017-22)
Grid-connected	6 MW	1100 MW	10000 MW	20000 MW
Off-Grid	2.4	200	1000	2000
Thermal Collectors	3.1 Mm2	7 Mm2	15 Mm2	20 Mm2
Solar Lighting Systems	1.3 Mill	5 Mill	10 Mill	20 Mill

Below are the illustration shown for mission targets vs. achievements as well as future projections as per the analysis of the mission.

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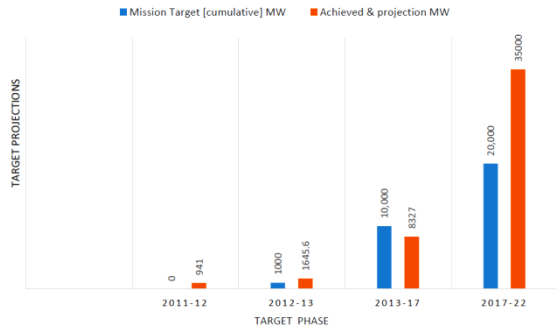

Fig.2. Mission targets vs. achievements

V. Results & Discussions

Overall the mission will contribute about 36GW of Capacity by the year 2022. The current growth rate of installed capacity for the Renewables especially solar PV indicates that the achievements are likely to be higher than the MNRE set targets. Additionally, it is expected that 4000 MW World's largest Ultra Mega Solar Power Project will also be commissioned in around 3-4 years. This will enhance the solar capacity and is well ahead of target set in JNNSM policy of GOI. Moreover this mission is benefiting through US-India Energy partnership Program called SERIIUS (the Solar Energy Research Institute for India and the United States). This collaboration was formed to lay a foundation for Government of India to get an advanced technology for satisfying the future needs of the nation.

The energy mix is the snapshot of a country's dependency on each energy source and provides a good indication of a country's energy challenges. The timeframe of 2020 has been set for proposing the current energy mix because the most notable change in the country's energy mix will be seen in a 10 yr span of 2012-2022. This will be due to the aggressive mission targets of solar, wind and hydro will be tested at their potential level in this span so as to transform the energy mix towards renewable. For the optimum energy mix, the following assumptions would add contribution of renewable energy.

1. Under the aggressive renewable scenario ARS, by MNRE, it is assumed that future use of renewables will develop as projected in the ''Policy'' scenario described by MNRE. Moreover it is assumed that renewable will replace the coal-fired power plants to be built after the year 2013 and the closing of small inefficient plants as well as efficiency improvements in the others. Thus, the capacity to be added by these coal fired plants will be now covered by the renewable. As a result, the total capacity and fuel input are lower than in the BAU scenario.
2. As considered in IEA report, demand as per the previous Growth occurrence is considered to be rising at a rate of about 3.7 % per annum for the projections up to the year 2022. i.e. 340 GW.
3. Increase of Oil & Gas with a lower rate and majorly used as an alternative to coal.

Based on the stated assumptions, under the aggressive growth situation, I think the energy mix of India in 2022 will be based on an increased contribution of renewables which will account for around 49% of the total energy mix. Coal, oil and natural gas in addition to other conventional energy sources are expected to contribute about 51%. The highest contribution of renewable energy sources will be from Hydropower followed by wind and solar energy. Based on this, the energy mix will be:

Projected Total Installed power capacity
340 GW by 2022

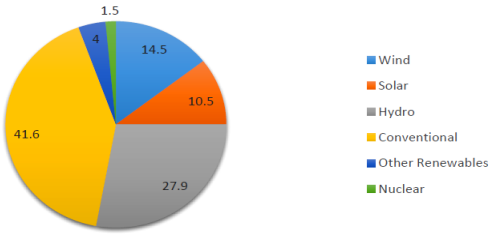

Fig.3. Percentage of contribution in the energy mix of India by 2022

The current growth rate of Solar, Wind and Hydro Power indicate that the achievements are likely to be higher than the MNRE predicted Targets. The Government has been supporting renewable energy development through an attractive mix of fiscal and financial incentives. These include capital/ interest subsidy, accelerated depreciation, nil/ concessional excise, customs duties and Generation Based Incentives or feed-in-tariff programmes including National Rural Electrification policies ,renewable energy to rural areas for lighting, cooking and motive power etc. Moreover, Indian Renewable Energy Development Agency (IREDA) and other public sector agencies are also actively funding renewable energy projects. So as to increase the contribution of renewable energy in the future energy mix of the nation. In addition to the government initiatives for promoting renewable energy, private sector is also a key role player in boosting the growth of renewable. Ernst and Young ranked India the fourth most attractive country for renewable energy investment in the world, as per an estimate; in 2009 the total financial investment in clean energy in India was at 135 billion. The decline in the fossil fuel contribution to the future energy mix of India and aggressive implementation of renewable and clean fuels to the energy mix not only reduce the overseas dependency for energy fuels but also help to:

1. Enhance the energy security
2. Mitigate CO2 emission
3. Reduce environmental pollution
4. Reduce health hazards.

VI. Conclusion

Thus, Future of human prosperity depends on how successful the below mentioned central challenges are addressed:

1. Securing the supply of reliable and affordable energy
2. Adopting a low carbon, efficient and environmentally benign system of energy supply.

To address these concerns, it is essential to shift to energy sources that can substantially reduce CO2 emissions compared with fossil fuels rather than concentrating energy-saving efforts on the existing energy portfolio. One of the most important aspects for developing countries is that a technology is required which is able to compete with the rapidly rising demands. Countries like India have the advantage of reduced prices due to large economies of scale as in the case of solar power. Factors as discussed above and foreign contribution and cooperation in development of renewable technologies will drastically improve the contribution of renewable energy can make in India to achieve its goal for energy sustainability.

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