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Innovations that can Change Energy Scenario in India

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ABSTRACT: India is one of the fastest growing economies of the world and its energy requirement is going to increase manifold in the next four decades with the increase in population as well as per capita use of energy. This will require both increase in energy supply and its efficient use to cope up with growing demand of energy. Scientists throughout the world are working in this field to achieve this gigantic task to sustain human development. The present paper tries to describe what is going on in the scientific arena to fulfil this ever increasing human need. It also tries to suggest some innovations that have capability to change the energy scenario in India. What can be the best case scenario in the field of production-mix, innovative use of present sources of energy as well as efficient use of energy with the help of innovations in science and technology? The paper tries to point out that we should come out of scarcity mentality and think of abundance in each and every aspect of human endeavour with human creativity and innovations. With right blend of innovations and applications we can think of abundance in the energy scenario in coming decades.

KEYWORDS: Energy Scenario, Innovations, Generation-mix, Solar energy, wind-energy.

1 INTRODUCTION

"If at first an idea does not sound absurd, then there is no hope for it." -Albert Einstein (Slavoj, 2010). When we talk of innovations, we are referring to the process of translating an idea or invention into a good or service that creates value or for that consumer will pay. These innovations are divided into two broad categories:

1. Evolutionary innovations(continuous or dynamic evolutionary innovation) that are brought about by many incremental advances in technology or processes and
2. Revolutionary innovations (also called discontinuous innovations) which are often disruptive and new. (Business Dicyioary.Com, 2015)

Both these types of innovations are important for creating and satisfying some of the human needs. Innovations are happening in all areas of human endeavour and these are happening very fast in the last 100 years of human history. Energy sector is no exception to this. Innovation in energy technology is happening more quickly than expected—and it could accelerate economic growth and improve sustainability as early as 2015. (Rogers, 2012). As we are already in the year 2015 we could feel some of the effects of innovations in the field of energy sector. Here, we are limiting our discussion to electricity sector though energy has a large number of manifestations. From generation to consumption, the desirable goals of electricity value chain can be summarised in figure 1.

As we are limiting our study to India, we should be aware of the present position of power sector in the country as well as its future requirements. India is one of the fastest growing economies having world's second largest population. By 2050 it is expected to become largest populated country having biggest GDP as per Purchasing Power Parity. Its total population is expected to be 165 crores from 125 crores now. Figure-2 shows the population pyramid of India in 2015 and 2050. India is expected to turn from a country of young people to a country of mature people by then.

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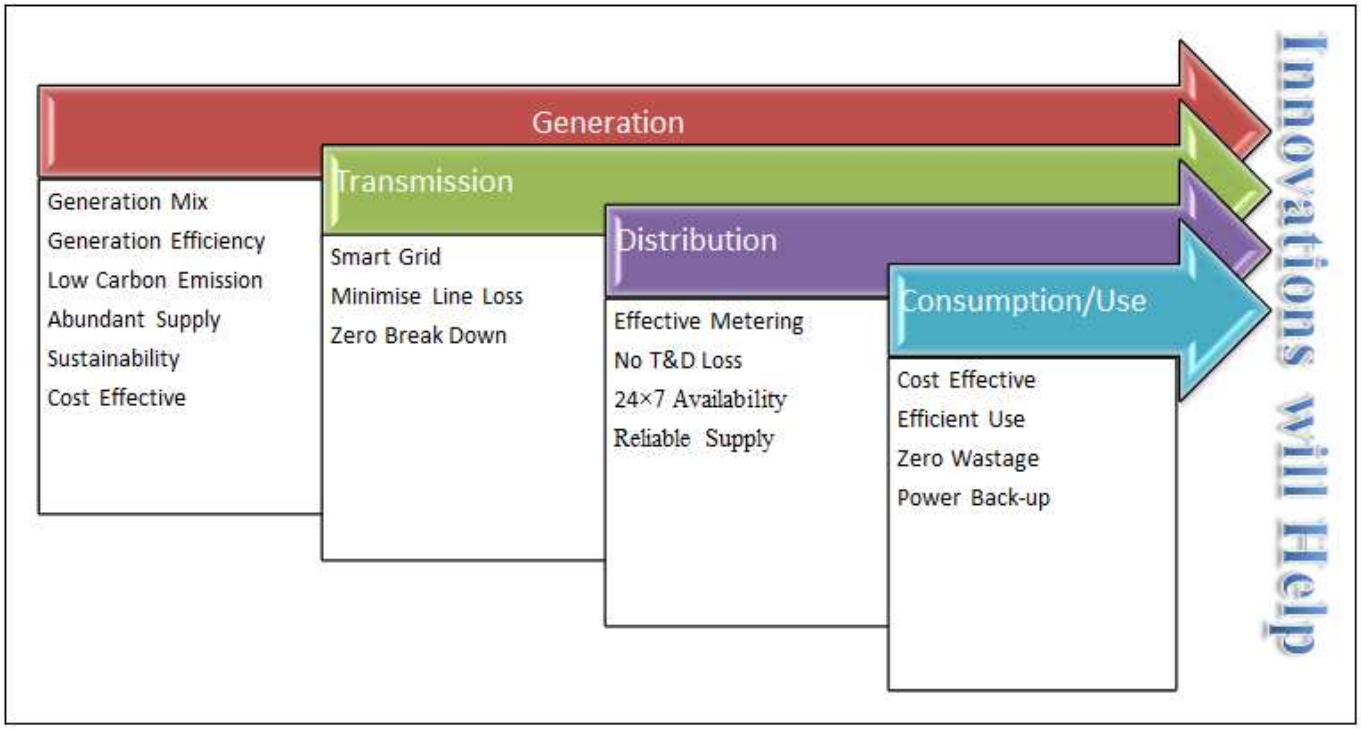


Figure-1: Desirable Goals of Electricity Value Chain

Source: Prepared by Author in MS-Word 2010.

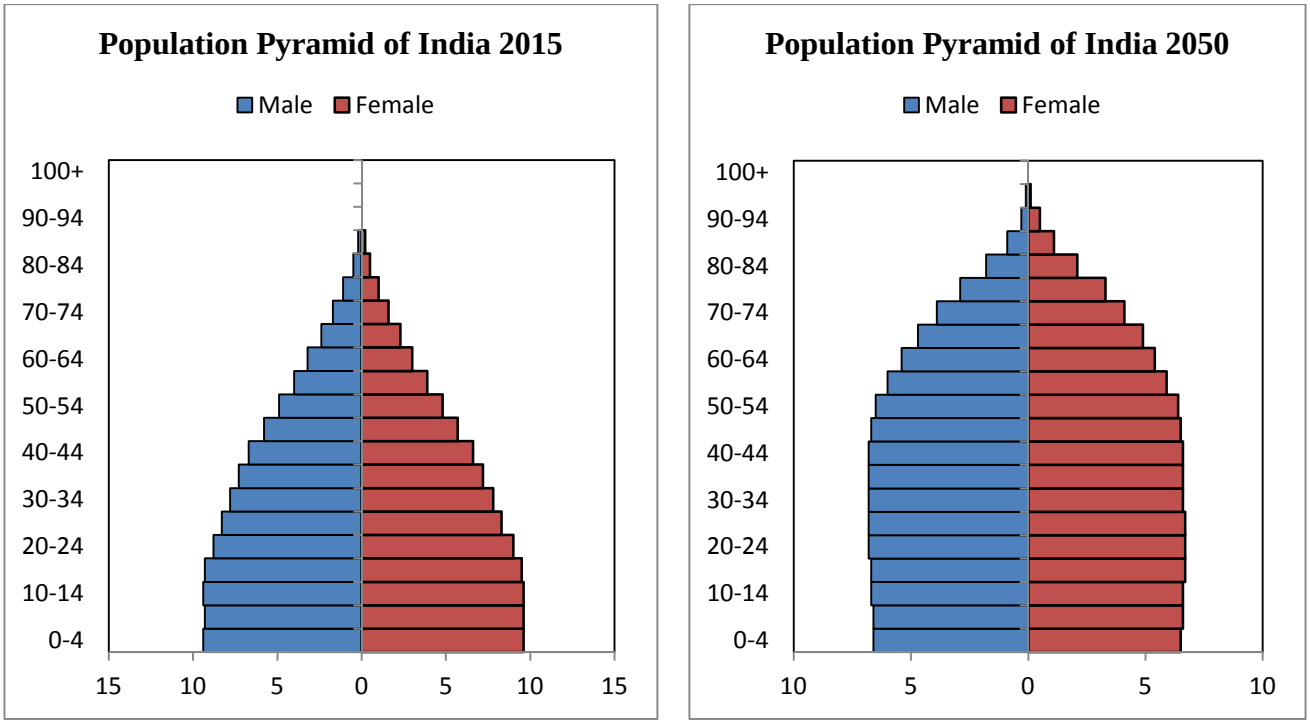


Figure 2: Population Pyramids of India in 2015 and 2050(Projected)

Source: Prepared in MS-Excel 2010 from data down loaded from United State Census Bureau website http://www.census.gov/population/international/data/idb/region.php?

To cater to such a huge population with increased use of per capita electricity consumption even equal to present day China, India needs to increase its installed capacity to 1650 GW in 2050 from 258 GW at present. An aggressive approach is required by Indian electricity sector to achieve such a big target. Therefore, innovation is the need of the hour in each and every segment of electricity value chain to fulfil this aggressive target of energy trilemma of energy security, energy equity and environment sustainability. Now, let us consider the evolutionary and revolutionary innovations in each of the activities from generation to consumption of electricity that has power to change the energy scenario in India in coming decades. :

2 INNOVATIONS IN GENERATION

The basic aim of generation sector is to have production mix as per need and availability of resources ensuring maximum efficiency with low carbon emission, abundant supply and environmental sustainability in cost effective manner. The present and expected generation mix in 2050 can be shown in the Fig-3 given below:

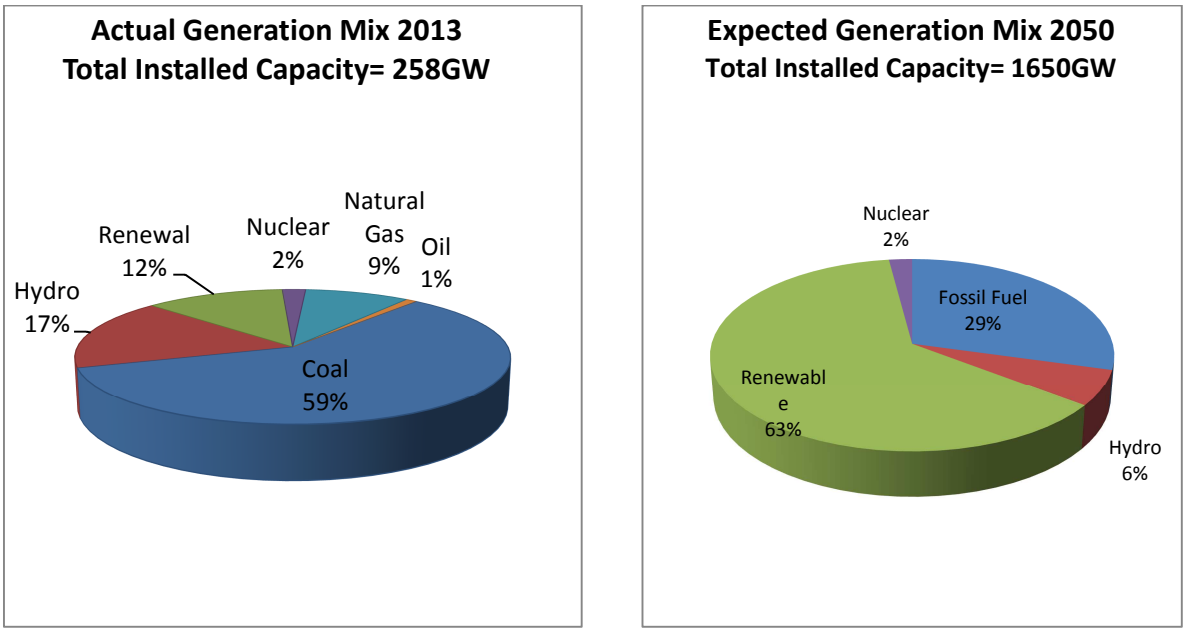


Fig-3: Generation Mix of Electricity in India

Source: Prepared in MS-Excel with the help of Electricity Data of 2013 and Projection for 2050.

This can be possible only if we pursue the path of renewable energy in aggressive manner.

Hydro Power:

- Besides the small hydro projects India can think of exploiting its potential of big hydropower projects if our river water projects are taken up by central government and water resource resources are used for national interest keeping the local politics aside. It has potential of adding 40000 MW of new capacity by 2050. Hydroelectric power is said to be the cheapest source of power as well as zero GHG emission after installations.

Wind Energy:

- Bladeless Wind Mills: Current windmill designs, although less environmentally damaging than fossil fuels, are criticized because they are noisy, and unsafe because they pose a danger to the birds and animals in the surrounding areas that happen to pass by. This problem can be solved with the help of bladeless wind mills, inspired by sailboats in design. These zero blade turbines are said to be 2.3 times more efficient and almost noise-free. They have potential to change the whole wind power scenario in times to come. (Caulfield, 2013).
- Rooftop Micro Wind Mills: Spiral micro wind mill have capacity to harness about 50% electricity requirement of a normal household. Technology, if used widely will become cheaper and affordable and have potential to change the energy scenario in the times to come. (Tracy, 2014)

Source: http://www.treehugger.com/wind-technology/silent-wind-turbines-could-generate-half-household-energy.html

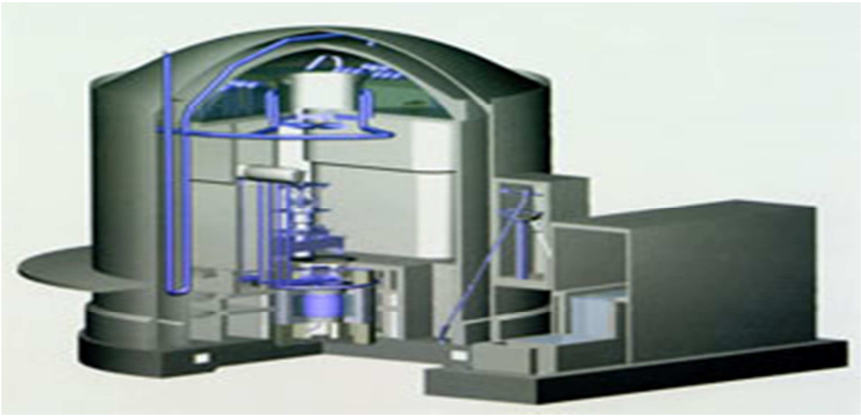
- Offshore floating Windmills: A study by Scottish Development International done in January 2012 has indicated potential to establish around one GW capacity wind farm each along the coastline of Rameshwaram and Kanyakumari in Tamil Nadu. India is estimated to have 350 GW of offshore wind energy capacity. (Press Information Bureau, GOI, 2013). Shallow water offshore wind mills as well as offshore floating mills can help tap this vast source of energy. Even 30% of this potential can harness more than 100GW of power.

Solar Energy: India is blessed with good solar insolation throughout the year in most of its parts. Regions receiving Global insolation of 5KWh/m^2 per day and above can generate at least 77W/m^2 (on actual onsite basis) at 16% efficiency level. Hence, even 0.1% of the land area of the identified solar hotspot (1897.55 Km^2) could deliver nearly 146 GW of SPV based electricity (379 Billion units) considering 2600 hours of sunshine annually. This power capacity would enhance considerably with improvement in the efficiency of SPV technology (T.V.Ramachandra, 2011).

Rooftop Micro SPV generation: Besides rooftop SPV both grid-connected and isolated have potential to generate 127 GW if only 10m^2 SPV is installed on 50% of 330 million houses in India. Though, it will take time to have social acceptability yet we can save reduce GHG emission substantially. With such a tremendous scale of SPV installation the technology will become very cheap as we have no dearth of silicon in our country that is used in manufacturing of SPV cells.

Geothermal Energy, Tidal Energy and Ocean Wave Energy: Energy potential of our seas and oceans well exceeds our present energy needs. India has long coastline with estuaries and gulfs where tides are strong enough to move turbine for electric power generation. A variety of different technologies are currently under development throughout the world to harness this energy in all its forms including waves (40000 MW), tides (9000 MW) and thermal gradients (180000 MW). Development is currently limited but the sector has potential to grow, fuelling economic growth, reduction in carbon footprint and creating jobs not only along the coast but also in inlands along its supply chain. (Goverment of India, 2012). If 50% of this initial potential can be developed by 2050 it can contribute to the tune 114500 MW of electricity generation capacity.

Thorium Based Nuclear power plant: India's forward looking attitude has established the country as the leader in thorium reactor development. Now, their AHWR design is finished, taking them one big step forward.



Source: INTERNATIONAL THORIUM ENERGY ORGANISATION

The reactor is equipped with passive shutdown systems, core heat removal through natural circulation, emergency core coolant system (ECCS) and gravity-driven water pool (GDWP), a large tank of borated water on top of the primary containment of vessel. It can operate for 120 days without operator - that's 4 months without anyone controlling it. This reactor will last some 100 years (International Thorium Energy Organisation, 2014). Thorium energy is highly concentrated as one ton of thorium generate energy equivalent to 35,00,000 tons of coal. Therefore, whole energy landscape will change once thorium energy is harvested on commercial scale.

3 INNOVATION IN POWER TRANSMISSION

The basic aim of the efficient power transmission system is to have Smart Grid having minimum line loss with zero break downs. It is not only India that faced prolonged blackout in July 2012 due to grid failure but also countries like US live with the threat of grid failure by demand-supply mis-match. "Due to the increasing interconnectedness in combination with rather old infrastructure, we expect this risk to increase in both frequency and severity" (Welch, 2014). Smart Grid facilitates efficient and reliable end-to-end intelligent two-way delivery system from source to sink through integration of renewable energy sources, smart transmission and distribution. In this way Smart Grid technology shall bring efficiency and sustainability in meeting the growing electricity demand with reliability and best of the quality (Power Grid Corporation of India Limited).

4 INNOVATION IN DISTRIBUTION

The main aim of a power distribution company should be to make available 24×7 reliable supply of electricity. But at the same time it expect to realize its price without any T&D losses; that is possible only through temper proof metering and willingness of consumer to pay for the services. People tend to pay only when they get reliable electricity and distribution companies can survive only when they can get regular stream of finance. We are facing problem of heavy T&D losses as well as irregular supply by power corporations. To improve this thing we have to start giving regular supply with effective metering with real-time online monitoring system. Following innovations can help in this case:

Wi-Tricity: Wireless electricity would be a reality in coming times and houses will not have any wiring as what we are doing for wi-fi internet and mobile telephony. To achieve wireless power transfer in a way that is both practical and safe, one needs to use a physical phenomenon that enables the power source and the device to exchange energy strongly, while interacting only weakly with living beings and other environmental objects, like furniture and walls. The phenomenon of *coupled resonators* precisely fits this description. Two resonant objects of the same resonant frequency tend to exchange energy efficiently, while interacting weakly with extraneous off-resonant objects.

The team of MIT scientists that invented WiTricity technology. Note that they are positioned between the experimental power source coil and the power capture coil —as 60 watts of power are being safely transferred a distance of over seven feet to illuminate the light bulb. (WiTricity, 2009)

5 INNOVATION IN ENERGY USE

The **Home Energy Management System** will enable the end user to monitor energy consumption & cost of electricity, optimize energy usage, control appliances and other devices, make informed decisions under variable pricing structure,

participate in demand response programs empowering consumer involvement in energy management process (Power Grid Corporation of India Limited)

LED for lighting: Lighting accounts for 18 percent of a typical household's electricity bill. Cutting your lighting bill is one of the easiest ways to save energy and money. Houses typically use a mixture of standard light fittings and down lighters or spotlight fittings. Energy LED can save about 49% of electricity and money as well as cutting CO_2 emission (Energy Saving Trust, 2014).

6 CONCLUSIONS

Innovations are happening in the energy sector in such a pace that even while publication of this paper, somewhere some scientist may have invented a new technique that may change the whole scenario. We should have abundance mentality that science, nature and our scientist will provide us with best of technology, resources and talents to tap these resources for the betterment of human race. India's vast resource of deserts and sand, rivers and seas, coal, thorium and uranium and talented pool of scientist has power to transform India from a power deficient to a clean power surplus country in the decades to come. We can prove Albert Einstein's words right by our will to achieve, "Imagination is more important than knowledge, for you must be able to imagine a better world before you can do your part to create one."

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