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A Comparative Analysis of Different Sources of Renewable Energy

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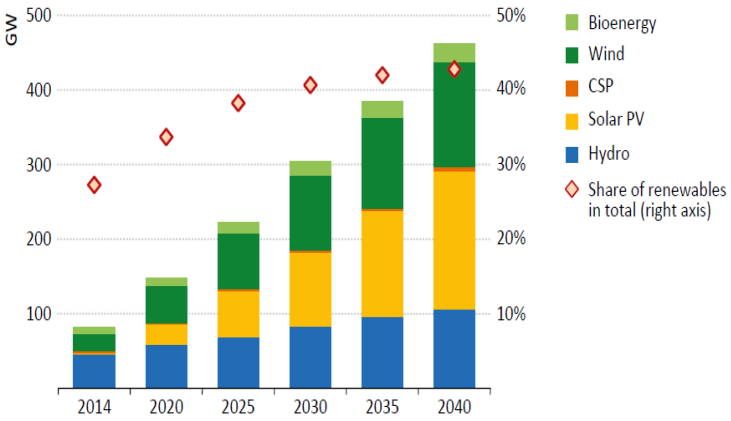
Abstract

The Energy Sector is one of the highest emitter of the Greenhouse gases which needs to be handled with care and requires the introspection by the policymakers in the investment in different sources of the renewable energy. The Renewable sources of energy like solar, wind, hydro etc. should be given greater share in the total energy mix in order to secure better natural environment for the future generation. The Study tries to put a comparative analysis of the different sources of renewable energy and how it will develop in the future by using the current trends and policies.

Keywords: Utility-scale Photovoltaic (PV), Concentrated solar power (CSP), Onshore Wind Power

Introduction

Given the Big size and the population of the Indian economy the government should focus on the sustainable development where the needs of the present generation can be fulfilled without compromising the needs of the future generation. Currently, India is highly depended on the non-renewable sources of the energy which have implication on the government budget and the natural Environment. The issues like global warming, GHG Emissions etc. are needs to be addressed by the policymakers around the world before it create havoc in the world in the form of reduction in the Economic output. The Energy Sector is one of the highest emitter of the Greenhouse gases which needs to be handled with care and requires the introspection by the policymakers in the sources of the energy. The Renewable sources of energy like solar, wind, hydro etc. should be given greater share in the total energy mix in order to secure better natural environment for the future generation There is an abundance of renewable energy resources across India which has created a fertile environment for their expansion due to the decrease in the costs of Generation of power from these sources.



Note: GW = gigawatts.

In the New policy scenario the renewables account for the half of new generation capacity over the period to 2040 which will increase the share of the renewables in the total energy mix from 28% to more than 40%.

India's renewable energy resources are spread much more evenly across the country but there are still some strong regional variations particularly for hydropower. There is a huge potential for hydro power plants in the North Eastern India. However hydro power comes at its own cost in terms of land acquisition and rehabilitation of the displaced

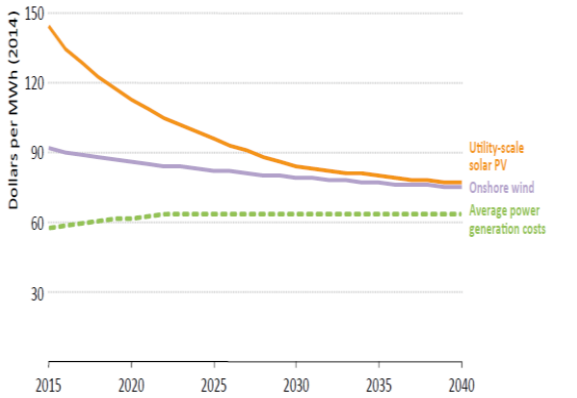
population.The Technological costs of solar power and the wind power is higher as compared to the other sources but its cost is falling rapidly but investment in these areas can't retain without some form of subsidy. There is no single system of official support for renewables in India, but it has an intricate patchwork of different national and state-level initiatives that encompasses feed-in tariffs, purchase obligations, bundling renewable with thermal output, accelerated depreciation schemes and a range of interventions that lower the cost of financing.

Aim of the Study

The Paper tries to bring out the challenges in the development of the renewable energy in India. It tries to address Economic returns of the various forms of the renewable energy technologies which can bring the change in the social and the Natural environment in India. The Study tries to put a comparative analysis of the different sources of the energy and how it will develop in the future by using the current trends and policies.

Costs

The Energy from the Hydropower is relatively competitive contributor to the Indian Power mix but at the same time the decreasing trend in output per unit installed is pushing up the average cost. However the Price of electricity generated by the hydropower is lowest among all sources of energy. In the case of Wind and the Solar power the cost trajectory is moving in the opposite direction but still it will require to incentivise the investment in this sector. Since 2010 the average levelised cost of the electricity generated by the utility-scale solar in India has fallen by around half which was largely due to the decrease in the investment costs of the solar cells .It is expected that the the costs will continue to decline over a period to 2040 and it will fall by over 45 % as compared to the current levels.



Notes: MWh = megawatt-hour. Onshore wind and utility-scale solar PV indicate the average cost of capacity deployed. Average power generation costs = average power generation costs for all technologies.

It is expected that the average cost of both solar power and the wind power will converge to the average cost of power generation in the Indian system.

The cost of onshore wind power will follow a different trajectory. Today the costs of Onshore wind power is significantly lower than solar PV but it will not see a material decline as it will fall by 18 % till 2040. This is because of the higher capital costs for the taller towers with a larger turbine blades which are increasingly deployed in order to maintain the efficiency factors after the best wind sites are occupied. There is a limited scope for technological improvements and local learning which can bring down costs. On the other hand the wind turbine technology is standardised across globe and much of the potential for the efficiency improvements is already exploited. The increase in the average cost of generation across the system as a whole nonetheless means that the cost of onshore wind goes from being around 60% higher than the average to being much closer to par.

Solar power

As per the estimates of the India's National Institute of Solar Energy at around 750 gigawatts (GW) which is based on the assumption that if 3 % of the wasteland in each state can be used for solar projects plus area for the Potential rooftop solar . It represents almost three times the India's total installed power capacity today. The Potential for the solar power is strongest in the Northern and North-Western region of the country. The States like Rajasthan, Jammu& Kashmir, Maharashtra, Madhya Pradesh and Andhra Pradesh is taking a lead in the generation of the electricity from the solar power. The Utility-scale solar Photovoltaic (PV) projects have made fastest in roads which was 4 GW of capacity in in 2015(up from 3 GW in 2014). On the other side the rooftop solar installations have taken a slower pace with around 450 megawatts (MW) of capacity installed as of 2014. The concentrated solar power (CSP) has just started to gain momentum which is around 200 MW in operation.

Solar power is at the heart of India's push towards low-carbon energy sources. The Government of India has taken the national target to reach 100 GW of the installed capacity by 2022. Among the 100 GW the 60 GW will be utility –scale projects (both solar PV and CSP) which will include a series of large large solar parks with a capacity above 500 MW each and other 40 GW will be rooftop solar power for commercial users and households. A range of national and state level initiatives have been announced in support of these objectives because electricity is a shared responsibility of the federal and the state authorities .

This boosts will increase the share of solar power in India's total power capacity to 17% in 2040 from around 1% today in which most of the new capacity is utility-scale. There are a number of challenges to the solar deployment which includes the difficulty of enforcing purchase obligations on the local distribution utilities, the ability of the grid to absorb the additional production and the availability of financing and land acquisition issues. One of the solution to problem of land acquisition for utility-scale solar development is to go for rooftop solar. However the deployment of rooftop solar has been slow to take off and most of the adopters of the rooftop solar are commercial and the industrial consumers in order to hedge for the risk of inadequate electricity supply. There is a need for greater clarity over the issues like

net metering and easier access to innovative business models and finance options so that more customers can be attracted to establish rooftop solar power.

Wind power

As per the estimates of the National Institute of Wind Energy, India have a potential of 302 GW of Onshore wind power generation. In this 90 % of the most promising sites are located in the states of Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Karnataka, Maharashtra and Gujarat. It is expected that Wind power generation will increase strongly with installed capacity rising from 23 GW to 142 GW in 2040. The Wind Power establishment is constrained by the number of challenges which which ranges from land acquisition and approval process. The Competition from the solar power is also a major hurdle in the development of the wind power which has limited the further growth of the wind power. The installed capacity of the wind power grows at less than the half the speed of the solar power which is due to the narrowing of the gap between the costs of solar and wind power. The Onshore wind farms suffers from problem of land acquisition issues whose growth is dampened by higher investment requirements and costs. In order to deal with the problem of land purchases it is suggested to build wind towers on existing farmland which will also help farmers to raise additional income.

The proximity of the large demand centres and the wind conditions means that the wind turbines have to be built away from prime areas which have driven up the capital costs. The development of wind power have also given the expertise to the domestic firms to develop wind technology which have served the purpose of make in India. The Domestic Company named Suzlon has now become the fifth largest wind turbine supplier to the world. Even the foreign companies are also entering the Indian market to take benefit of the low cost skilled labour force for example General Electric has set up its plant in Pune where it will manufacture wind turbines .

Hydropower

The Capacity of the Hydropower have increased over the years but its share in the overall energy mix declined from the 40 % in 1980 to 12 % in 2013. This is because of the challenges faced by the hydropower projects in India which includes extended timelines to procure all the necessary approvals especially environmental permits, difficulties with land acquisition (both for the plant and for new transmission lines to evacuate the power), public opposition and obtaining long-term finance. There are also many issues which are specific to the hydropower like the high levels of sediment in the rivers coming down from the Himalaya Mountains which reduces reservoir storage capacity and if not removed then it can cause heavy damage to turbine blades and other steel structures in a hydropower plant. There is also uncertainty over the water flows which kept changing due to changing climate.

It is projected in the New Policies Scenario the capacity for the hydropower will improve in future on the assumption that government will improve its efforts to simplify permitting and authorisation procedures as well as project planning and consultation will also improve (including better co-ordination to avoid water-sharing disputes between the different states affected by projects along the various river systems). The rise in installed capacity for large hydropower from 42 GW in 2014 to under 100 GW in 2040 will take place in the region of northern and North-eastern India where India's remaining hydro potential is concentrated. Small hydropower projects up to 10 MW is also playing growing role, particularly in meeting the power requirements of remote and mountainous areas. Their capacity will increase from 2.8 GW to over 10 GW by 2040. Although total output of Hydropower will rise to around 330 terawatt-hours (TWh) in 2040 (up from 142 TWh in 2013) but the hydropower's share in the total generation mix continues to decline i.e. it will fall from 12% in 2013 to 8% in 2040.

Another avenue for India to benefit from hydropower is through co-operation with neighbouring countries. Hydropower is becoming an important pillar in the relationship with Bhutan with three projects of around 1.5 GW in total already developed with Indian assistance and a further ten projects in various stages of construction or preparation and plans to strengthen transmission lines to export surplus power to India. Similar arrangements are in place with Nepal which will help in maintaining better relationship with Nepal.

Water issues are very sensitive in India and lack of public acceptance of hydropower development has already been a major obstacle to projects moving ahead. The most difficult issue has been the rehabilitation of people affected by new projects .The public attitudes have also been adversely affected by floods in the Himalayan state of Uttarakhand in 2013 which have started a major debate over whether intensive hydropower development in the region was to blame for the severity of the flooding. This episode underlined the importance not only of evaluating individual projects in depth, but also of taking a broader view on the development of river basins, assessing the linkages between projects and the cumulative social and environment impacts.

Bioenergy

It is expected that the demand for the Bioenergy will rise around 11% over the projection period to 2040 which is a moderate increase and it will result in the decrease in the share of bioenergy in the Indian Energy mix. The growth of biofuels is not constrained with the Availability of supply of biofuels .As per Data of the United Nations Food and Agriculture Organization (UNFAO, 2015) the total area covered by forests in India has actually increased in recent years which suggests that there is no overall scarcity of fuel wood for use by rural households as a traditional cooking fuel. However the excessive use firewood has limited the economic incentive for rural households to switch to alternative fuels, such as LPG where it is available or to invest in more efficient biomass cook stoves.

There is a potential to use the biomass in modern Energy applications such as power plants fired with bioenergy (e.g.bagasse-based cogeneration at sugar mills) or biomass gasifiers to produce biogas,

whose supply in practice will depend on reliable systems for collection, transportation and storage. In our projections, power generation based on biomass will rise by more than five-times to reach around 120 TWh in 2040 which can provide a valuable contribution to the reliable rural electricity supply. There are various policy support for modern biomass technologies in India but the increase of bioenergy-based supply is constrained by relatively high costs and poor access to financing .In urban areas the ready availability of LPG as a cooking fuel means that consumption of solid biomass is low.. One under-utilised option for urban energy supply is municipal waste which can be used to generate electricity .It is estimated that only 20% of the total urban waste is treated and the rest is dumped at untreated open sites (Planning Commission, 2014). The Ministry of New and Renewable Energy has classified waste-to-energy as a renewable energy source and put in place subsidies and incentives to encourage projects which are already underway in Hyderabad, Pune, Ghazipur and Delhi.

Nuclear power

India was one of the first countries to adopt nuclear power technology with its first commercial reactor coming started in 1969. The Indian nuclear industry has developed by relying heavily on indigenous technologies because of the result of its status as a non-signatory to the Nuclear Non-Proliferation Treaty (which led to restrictions on the export of nuclear materials to India). However, following the India-US Civil Nuclear Agreement in 2008, the Nuclear Suppliers Group lifted the sanctions that had been in place since 1974, thereby opening the door for India to trade with foreign suppliers of nuclear fuel and technology. India has a strong commitment to develop additional nuclear power as a way to meet its rising energy needs and enhance its energy security on a low-carbon basis. Its current target is to triple nuclear power capacity over the decade from 2014 (which would equate to capacity of 17.3 GW in 2024). It also has a longer term target for nuclear power to supply 25% of the nation's electricity by 2050. India ranks as the world's 13th largest country in terms of nuclear generation with installed capacity of 5.8 GW in 2014 with 21 reactors at seven sites. India's domestic resources of uranium are limited compared with its current needs and future aspirations. These are estimated to include 129 000 tonnes of reasonably assured resources and a further 29 000 tonnes in the inferred category; or, in aggregate, around 2% of the world total (IAEA/OECD, 2014). However, these uranium resources are low grade and located in remote areas, meaning that imports represent a necessary and less expensive option. By alleviating shortages of reactor fuel, the 2008 agreement has enabled a substantial increase in the average load factor at India's nuclear power plants, from less than 50% in 2007 to over 80% in 2013. India also has the world's largest reserves of thorium, which is a potential alternative to uranium fuel in nuclear reactors. To take advantage of this rich resource base, and as it was not permitted to import uranium, India has become a leader in researching and developing thorium-based nuclear power. It plans to have a first pilot reactor in service by 2022 and commercial reactors deployed by around 2030.

The 2008 agreement also meant that foreign suppliers of nuclear power plants can do business in India. However, many suppliers were unwilling to make investments, due to concerns that India's nuclear liability law held them directly liable in case of an accident: standard practice internationally is that liability rests with the plant operator (which in India would effectively mean the government, since the sole operator – Nuclear Power Corporation of India Limited – is government owned). In June 2015, India set up an insurance pool that provides cover to both operators and suppliers in the case of a nuclear accident. Time will tell whether this solution provides adequate reassurance to overcome a serious obstacle to future development of nuclear capacity in the country.

Economic considerations will also be a major determinant of the future of nuclear power in India, as in all countries pursuing the technology. A useful, though imperfect, means of assessing the lifetime economics of new power plants is to consider the costs of electricity generation, compiled on a levelised cost basis (IEA, 2014). In the New Policies Scenario, levelised costs for nuclear power plants coming online in India in 2030 average around $69 per megawatt-hour (MWh). This is lower than in many other parts of the world – for example they are $110/MWh in the European Union – primarily because the overnight costs of construction are lower in India. Based on these estimates, nuclear power appears to be an economically attractive option in India, particularly in parts of the country that are distant from coal reserves (not surprisingly, this is where the current fleet is concentrated). Public concerns could also exert a powerful influence on the prospects for nuclear power in India. Earlier debate in the country about nuclear power plants focussed on the displacement of communities and the adequacy of compensation if plants were built near them. But, since the accident at Fukushima Daiichi in Japan these have been supplemented by more widespread concerns about plant safety and the risks of nuclear technology. Protesters have focussed on the Kudankulam Nuclear Power project which located on the coast in the southern state of Tamil Nadu, a region that was badly affected by the huge Indian Ocean tsunami in 2004. Confidence in regulatory frameworks and institutional capacity will be key factors in securing broad public support to expand nuclear power in India.

In the New Policies Scenario, India's nuclear power capacity increases by a factor of nearly seven, from 5.8 GW in 2014 to almost 39 GW in 2040, having reached 9.7 GW in 2020. On a worldwide basis, India sees the second most significant increase in installed nuclear capacity, after China. Reaching this level of capacity in 2040 implies a construction rate of 1.3 GW per year on average, which is significantly faster than the rate realised in the recent past and would need to be sustained over a long period. India's nuclear electricity generation increases from 34 TWh in 2013 to nearly 270 TWh in 2040, an average rate of growth of 7.9% per year (faster than growth in electricity supply as a whole), resulting in the nuclear share of total generation more than doubling from 3% to 7% over the period.

Conclusion

Currently , The cost of non Renewable energy is less than the cost of generating power from the renewable sources of energy but falling costs of the solar and wind power is giving a tough competition to the non renewables . However if we compare the technological aspects then the renewable energy technology is not promising as non renewables but if the Environmental aspects is taken care off then the renewable energy will work for the betterment of the natural environment . The Government of India is focussing towards increasing the share of renewable energy in the total energy mix of the nation so as to contribute to the sustainable development goals of the United Nations.

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