Renewable Energy in India: Current Status and Future Prospects

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Abstract -- 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. This paper presents an overview of various renewable energy sources such as solar power, wind power, small hydro power (SHP), Biomass Power (BP), Geothermal Power (GP), Tidal Power (TP), Ocean Thermal Energy Conversion(OTEC), hydrogen fuel cell etc .This paper comprehensively elucidates why we are going towards RES ,their economic, social and environmental impact, challenges associated with RES and also suggests some recommendations in order to promote RES to ensure Sustainable Development.

Indexed Terms- Current status, MNRE, New initiatives, Renewable Energy, Renewable energy Potential

I. INTRODUCTION

Energy is one of the most vital building blocks in human development and a key factor influence the sustainable development of any nation [1]. The conventional sources of energy have major intimidation to our existing and future global safety environmental values, health and society. So there is urgent necessitate promoting renewable energy in present Indian power sector in sustainable and ecofriendly way [2]. Renewable energy is energy that comes from resources which are continually replenished such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy is one of the cleanest sources of energy options with least carbon emissions or pollution. By expanding renewable energy, India can improve air quality, reduce global warming emissions, create new industries and jobs, and move world towards a cleaner, safer, and affordable energy [3]. Jawaharlal Nehru National Solar Mission (JNNSM) targets total capacity of 20 GW grid-connected solar powers by 2022. The year 2016-17 has seen a paradigm shift in the way India's economy will function by focusing on laying the infrastructure for widespread inclusion of all economic activity on the digital platform. Power sector plays a vital role in the growth of Indian economy and it is growing at rapid pace. The total installed capacity has reached to 310 GW with generation mix of Thermal (69.4%), Hydro (13.9%), Renewable (14.8%) and Nuclear (1.9%). It is evident that the renewable power has secured 2nd position after Thermal and is spreading its wings rapidly in India [4].

II. RENEWABLE ENERGY SCENARIO IN INDIA

Over the years, renewable energy sector in India has emerged as a significant player in the grid connected power generation capacity. It supports the government agenda of sustainable growth, while, emerging as an integral part of the solution to meet the nation's energy needs and an essential player for energy access. The Government of India has taken several initiatives during the last two years such as introduction of the concept of solar parks, organizing RE-Invest 2015—a global investors' meet, launching of a massive grid-connected rooftop solar programme, earmarking of Rs.38,000 crore for a Green Energy Corridor, eight-fold increase in clean environment cess from

Rs.50 per tonne to Rs.400 per tonne, solar pump scheme with a target of installing 100,000 solar pumps and programme to train 50,000 people for solar installations under the Surya Mitra scheme, no inter-state transmission charges and losses to be levied for solar and wind power, compulsory procurement of 100 per cent power from waste to energy plants, and

Renewable Generation Obligations on new thermal and lignite plants, etc. The other significant initiatives are launching of improved cook-stoves initiatives; initiating coordinated research and development activities in solar PV and thermal; second generation biofuels, hydrogen energy and fuel cells, etc. The Ministry of New and Renewable Energy (MNRE) has taken several steps to fructify Government's dream of clean energy. The largest renewable capacity expansion programme in the world is being taken up by India. The government is aiming to increase share of clean energy through massive thrust in renewables. The core drivers for development and deployment of new and renewable energy in India have been Energy Security, Electricity shortages, Energy Access, Climate change etc [5].

2.1 Renewable Sources

India has an estimated renewable energy potential of about 900 GW from commercially exploitable sources viz. Wind – 102 GW (at 80 metre mast height); Small Hydro – 20 GW; Bioenergy – 25 GW; and 750 GW solar power, assuming 3% wasteland is made available. Renewable energy has a great potential to usher in universal energy access. In a decentralized or standalone mode, renewable energy is an appropriate, scalable and viable solution for providing power to un-electrified or power deficient villages and hamlets. Over 1.2 million households are using solar energy to meet their lighting energy needs and almost similar numbers of the households meet their cooking energy needs from biogas plants. Solar Photovoltaic (PV) power systems are being used for a variety of applications such as rural electrification, railway signaling, microwave repeaters, mobile towers, TV transmission and reception and for providing power to border outposts [6].

2.2 Renewable Energy Targets

The Government has up-scaled the target of renewable energy capacity to 175 GW by the year 2022 which includes 100 GW from solar, 60 GW from wind, 10 GW from bio-power and 5 GW from small hydro-power. The ta rget of 100 GW capacity set under the National Solar Mission (NSM) will principally comprise of 40 GW Rooftop and 60 GW through Large and Medium Scale Grid Connected Solar Power Projects. With this target, India will become one of the largest Green Energy producers in the world, surpassing several developed countries. Government of India in its submission to the United Nations Framework Convention on Climate Change on Intended Nationally Determined Contribution (INDC) has stated that India will achieve 40% cumulative Electric power capacity from non-fossil fuel-based energy resources by 2030. A target of 16660 MW grid renewable power (wind 4000 MW, solar 12000 MW, small hydro power 250 MW, bio-power 400 MW and waste to power 10 MW), has been set for 2016-17.

III. RENEWABLE ENERGY INFRASTRUCTURE

Every State/UT has a nodal agency/department, for implementation of renewable energy programmed/schemes of the Ministry, besides their own programmed of renewable energy. In addition, institutions namely National Institute of Solar Energy, National Institute of Wind Energy, national Institute of Bio-Energy, Solar Energy Corporation of India and Indian Renewable Energy Development Agency have been established to provide technical support to the renewable energy sector in the country. The reputed technical institutions i.e. IITs, NITs and Universities provide support for research and development work, capacity building of stakeholders, potential assessments, monitoring and evaluation etc. A large domestic manufacturing base has been established in the country for renewable energy systems and products. Companies investing in these technologies are eligible for fiscal incentives, tax holidays and accelerated depreciation apart from the remunerative returns for the power fed into the grid. Further, the government is encouraging foreign investors to set up renewable power projects with 100 percent foreign direct investment. The Indian Renewable Energy Programme has received wide recognition internationally in the recent years. and experience in promoting renewable energy, both grid interactive and off-grid/stand-alone applications for meeting electrical energy needs. India has been interacting with several developed and developing countries and have established bilateral and multilateral cooperation frameworks for cooperation in new and renewable energy sector [8].

IV. NEW INITIATIVES

The Government has taken up the following new projects/schemes during the 2016-2017 year:

4.1 Green Energy Corridor

A Rs.38,000 crore Green Energy Corridor is being set up to ensure evacuation of Renewable Energy. Power Grid Corporation of India Limited (PGCIL) has sought a Loan assistance of US$ 1,000 million from the Asian Development Bank (ADB) comprising of Sovereign guaranteed loan of US$ 500 million and Non-Sovereign loan of US$ 500 million. The loan would be utilized for funding of the following transmission projects including a project under Green Energy Corridor projects in next 3-4 years:

4.2 Net Metering Policy

The consistent follow-up by the Ministry resulted into the notification by State Electricity Regulatory Commissions (SERCs) of thirty four States on net-metering and feed-in-tariff to encourage rooftop solar plants. Net-metering scheme has been rolled out in all States/ UTs which will help in meeting 40 GW rooftop grid connected solar projects. So far, 20 States namely Andhra Pradesh, Chhattisgarh, Delhi, Gujarat, Haryana, Himachal Pradesh, Jammu & Kashmir, Jharkhand, Karnataka, Kerala, Madhya Pradesh, Manipur, Punjab, Puducherry, Rajasthan, Tamil Nadu, Telangana, Uttar Pradesh, Uttarakhand and West Bengal have come out with Solar Policy supporting grid connected rooftop systems.

4.3 Wind Power

- Comprehensive Guidelines for Development of On-shore Wind Power Projects in the country have been formulated and issued.
- Guidelines for implementation of ―Scheme for Setting up of 1000 MW Inter-State Transmission System (ISTS) - connected Wind Power Projects‖ issued.
- The Policy for Repowering of the Wind Power Projects has been released on 5th August, 2016 to promote optimum utilization of wind energy resources by creating facilitative framework for repowering.

4.4 Solar Rooftops

- All major sectors i.e. Railways, Airports, Hospitals, Educational Institutions, Government Buildings of Central/State/PSUs are being targeted besides, the private sector.
- Ministry has tied up with ISRO for Geo tagging of all the Rooftop plants using ISRO's VEDAS Portal.

4.5 Raising of Bonds

- Ministry of Finance approved raising Rs. 4000 crore bonds for renewable energy sector by IREDA during 2016-17.

4.6 Skill Development

Surya Mitra Scheme has been launched for creating 50,000 trained solar photovoltaic technicians by March 2020. A total number of 7500 Surya Mitra's would be trained by 31.03.2017. A network of over 200 Institutions, spread all over the country, have been created for implementing Surya Mitra scheme. In addition, short term training programmes for small hydro, entrepreneurship development, operation & maintenance of solar energy devices and boiler operations in co-generation plants, have been organized.

Shri Piyush Goyal, Minister of State (IC) for Power, Coal and New & Renewable Energy launched ―Surya Mitra‖ mobile App at National Workshop on Rooftop Solar Power on 07.06.2016. The GPS based mobile app has been developed by National Institute of Solar Energy (NISE). The Surya Mitra Mobile App is currently available in Google play store, which can be downloaded and used across India. This App is a high end technology platform which can handle thousands of calls simultaneously and can efficiently monitor all visits of Suryamitra's. The trained Suryamitra's who opts for entrepreneurship have joined in the Mobile App in several states. These Suryamitras are once

again sensitized by NISE on soft skills Customer Relations Management, Punctuality and are now ready to deliver the services [4].

V. DIFFERENT RENEWABLE ENERGY SOURCES (RES)

5.1 Solar Power

Solar energy is clean energy as it produces no hazardous solid, liquid or gas wastes and does not create pollution. Solar power can be produced through PV cell which is made of semiconductor Energy collectors classified into parabolic trough, parabolic tower and parabolic disc system etc.

In most parts of India, clear sunny weather is experienced 250 to 300 days a year. India receives nearly 5,000 trillion KWh/year, which is far more than the total energy consumption of the country today. The solar power on the surface of earth is 1016 W. The total worldwide power demand of all needs of civilization is 1013 W. Therefore, the sun gives us 1000 times more power than we need. If we can use 5% of this energy, it will be 50 times what the world will require [7]. Some parts of India like western part of Rajasthan (Thar desert) receive solar radiation for use of Concentrating Solar Power (CSP) Technology. It is estimated that a 60 Km × 60 Km of area can produce 100000 MW of power using CSP technology. Among the various renewable energy resources, solar energy potential is the highest in the country. The equivalent energy potential is about 6,000 million GWh of energy per year. The National Solar Mission targeting 20,000 MW grid solar Power, 2,000 MW of off-grid capacity including 20 million solar lighting systems and 20 million square meters solar thermal collector area by 2022 is under implementation [9].

5.2 Wind Power

Wind energy is one of the most promising alternative energy technologies of the future. During recent years, the amount of energy produced by wind-driven turbines has increased rapidly due to considerable advancement in turbine technologies, making wind power economically compatible with conventional sources of energy. Wind energy makes up the majority about 68 percent of the total renewable energy capacity installed in India. Initial estimates from Centre for Wind Energy Technology (C-WET) suggest that wind energy potential at 80 metres height (with 2 % land availability) would be over 100 GW. Some studies have estimated even higher potential ranges up to 300 GW [10].

5.3 Bio Energy

Bio energy refers to bio mass power, bagasse cogeneration, waste to energy, biomass gasifier, bio ethanol, bio diesel etc. Biomass is a renewable energy resource derived from the carbonaceous waste of various human and natural activities. Biomass takes carbon out of the atmosphere while it is growing and returns it as it is burned. If it is managed on a sustainable basis, biomass is harvested as part of a constantly replenished crop.

Wood and wood waste: forest wood, wood from energy plantations, saw dust, tree branches and leaves etc. Agricultural residues:rice husk, bagasse, ground nutshells, coffee husk, straws, coconut shells, coconut husk, arhar stalks, jute sticks etc. Aquatic and marine biomass: algae, water hyacinth, aquatic weeds and plants, sea grass beds, kelp, coral reef etc. Wastes: municipal solid waste, municipal sewage sludge, animal waste, paper waste, industrial waste etc[11].

5.4 Small Hydro Power (SHP)

India was the 7th largest producer of hydroelectric power in 2008 after Norway. The potential for hydroelectric power in India is one of the greatest in the world. Hydro projects in India, which are under 25 MW in capacity, are classified as ―small hydropower‖ and considered as a ―renewable‖ energy source. India's first SHP plant come up in 1987. The total installed capacity of SHP projects in India was 3,632 MW in March 2013. This is spread over 950 projects, hence, the average SHP project capacity is 3.8 MW. This does not include micro-hydel plants. The draft 12th Five Year Plan (2012-17) has, as its target, 2,100 MW of SHP capacity [12]. The total potential country-wide capacity is estimated at 19,749 MW, of which about 1,250 MW is under development. The current total installed capacity of small hydro power plants is 3746.75 MW [13].

5.5 Tidal Energy

Tidal power, also called tidal energy, is a form of hydropower that converts the energy of tides (periodic rise and fall of the water level of the sea due to the attraction of sea water by the moon) into useful forms of power - mainly electricity. Although not yet widely used, tidal power has potential for future electricity generation. Benefits of tidal energy: It is reliable and predictable well into the future.

Water is 800 times denser than air, which gives it huge potential for power extraction. It is a renewable energy source with no harmful greenhouse emissions. These tides can be used to produce electrical power which is known as tidal power. When the water is above the mean sea level, it is called flood tide and when the level is below the mean level, it is called ebb tide. A dam is constructed in such a way that a basin gets separated from the sea and a difference in the water level is obtained between the basin and sea.The identified economic power potential is of the order of 8000 MW with about 7000 MW in the Gulf of Cambay, about 1200 MW in the Gulf of Kutch in the State of Gujarat [14].

5.6 Ocean Thermal Energy Conversion (OTEC)

OTEC, Ocean Thermal Energy Conversion systems use the ocean's natural thermal gradient, consequently the temperature difference between the warm surface water and the cold deep water below 600 meters by about 20 C. The oceans are thus a vast renewable resource, with the potential to help us produce billions of watts of electric power. The cold seawater used in the OTEC process is also rich in nutrients and it can be used to culture both marine organisms and plant life near the shore or on land. The total influx of solar energy into the earth is of thousands of times as great as Mankind's total energy use. All of our coal, oil and natural gas are the result of the capture of solar energy by life of the past. There have been many projects for harnessing solar energy, but most have not been successful because they attempt to capture the energy directly. The problem with this is that huge collectors must be deployed to do this and resulting in large costs. The idea behind OTEC is the use of all-natural collectors, the sea, instead of artificial collector. Unlike wind and solar, the Plant Load Factor (PLF) of these plants may be around 80 percent. India has built a 1MW floating OTEC pilot plant near Tamil Nadu [15].

VI. CHALLENGES

Several challenges come into the picture or implementation of renewable energy technologies like:

a) Almost all the renewable energy sources are suffering from high cost of installation. It has been largely proven that as of now wind energy, small hydropower, and biomass are considered to be comparable or almost comparable to conventional energy technologies in the narrow economic sense and perhaps even cheaper considering entire life-cycles. But solar energy is not cost comparable in the narrow economic sense. However, there is hope that this might be cost comparable in a few years' time with new technological developments [16].

b) They are dependent on certain conditions. Wind energy projects cannot be set up in an area with little wind. Small hydropower cannot be utilized in an area without small rivers.

VII. CONCLUSIONS

In the past century, research and literature have concluded that CO2 concentration increased by 28% following the industrial revolution. The global average temperature has increased by 0.3˚C to 0.6˚C, and the sea level rose 10 to 15 cm in the past 100 years. Scientists predict that if greenhouse gas emissions continue and no effective protection policies for the environment are put into place, the global temperature will increase by 1˚C to 3.5˚C, and the sea level will increase by 15 to 95 cm. Rise in temperature of 4˚C would decrease the food grain production some 28% and 68% for rice and wheat, respectively. This will make many countries uninhabitable by 2100. In this situation, renewable energy is the most elegant choice to make for meeting our energy demand, ensuring sustainable development and help human race to continue, at least not make an end from energy crisis. Though renewable energy industry is now capital intensive, its increasing use will surely decrease its cost. Per dollar investment in renewable energy will ensure sustainable development for future, whereas per dollar investment in traditional energy will push

human race at the verge of extinction. India has plenty of renewable energy potential to bridge the gap between demand and supply .so, India must put continuous effort in harnessing various form of RES with newer technologies for a cleaner, greener and safer place for our future generation.

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