Renewable Energy Options- A Step Towards Sustainable Development in India

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Abstract: The Energy scenario of India is challenging. Access to energy plays a very significant role in achieving inclusive growth. Though the electricity generation capacity additions are impressive, India's energy sector is becoming weaker to deliver a secure supply of energy amid growing demand and fuel imports. As expected the lighting and cooking scenario is very poor in rural areas. Data show that 43% of rural India still uses kerosene for light and 85% of rural households still depend on traditional biomass fuels for their cooking energy requirement. This indicates the failure of past policies and programs. The paper discuss the various energy challenges, lacuna in the recent policies etc. related to these two crucial energy sector and suggests how renewable could be the solution to these issues. Ensuring access to clean energies to meet the demand for cooking and lighting and lifestyle purposes and providing it at an affordable price remains the greatest challenge.

1. INTRODUCTION

Energy is one of the major inputs for the socio-economic development and human welfare of any country. Energy conservation becomes necessary in recent years as it has come to be known as a strategic commodity and any uncertainty about its supply can threaten the functioning of the economy particularly in developing countries.[1] Not much has changed since the governments across all developing nations have set the ball rolling to address energy access issues and according to IEA prediction this problem will not diminish by 2030 unless actions are taken urgently. Studies and research have reinforced the fact that access to energy plays a very pivotal role in achieving sustainable development[2].We are also in agreement that access to modern energy is closely linked with economic well-being and is a prerequisite to fulfill the Millennium Development Goals. For narrowing the gap between demand and supply of energy, its conservation and efficient utilization of resources is necessary. Improvement in energy efficiency is most desirable option for bridging the gap in the short term.[1] The demand and supply imbalance in energy is pervasive across all sources requiring serious efforts by Government of India to augment energy supplies as India faces possible severe energy supply constraints due to its increasing population which is growing at a rate of 1.38% annually and at present has population of 1.2 billion.[1,3] In year 2011, 3 billion people, depended on solid fuel wood, charcoal, and dung for domestic energy needs, primarily cooking. Non access to the modern energy and utilities limits income, affects the health of women and children, and accelerates deforestation and climate change.[1]The authors have tried to investigate the magnitude and status of energy-access issue in India and what are the proposed solutions to make "sustainable energy for all" a reality in India.

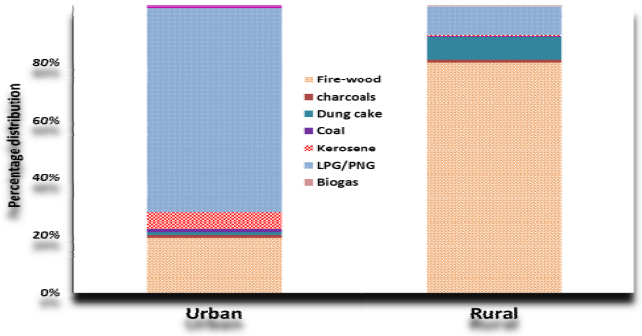

Fig. 1. Comparison of cooking fuel. [4]

1.1 Energy scenario in urban India

All the states and UTs use 80%-99% electricity for lighting purpose. However urban Bihar is lagging behind and on average 66% electricity is used for lighting. For cooking scenario, it is clear from the Figure 1 that LPG is widely used in urban areas and 78% household in rural India use firewood to meet their cooking energy requirement

1.2 Electricity and cooking scenario in rural India

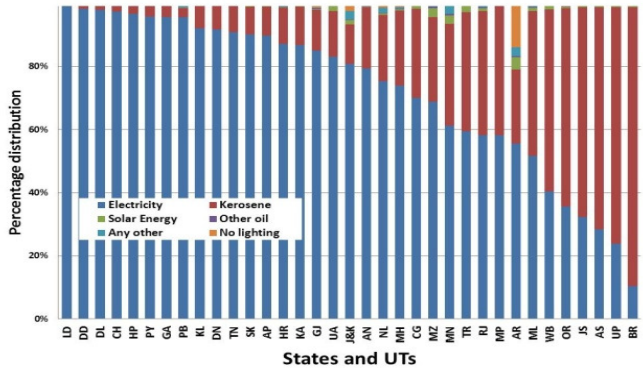

Fig. 2. Electricity scenario in rural India. [4]

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It is clear from Figure 2 that electricity scenario is poor in rural India. Most of the rural communities in all the states and UTs still depend on kerosene for lighting purpose. If we exclude UTs and compare the states then the states with good access to electricity are Himachal Pradesh, Goa, Punjab and Kerala while in rural Bihar electricity scenario is very poor with only 10.37% electricity is supplied for lighting followed by Uttar Pradesh (23.77%), Assam(28.36%), Jharkhand(32.31%) and Odisha (35.55%).

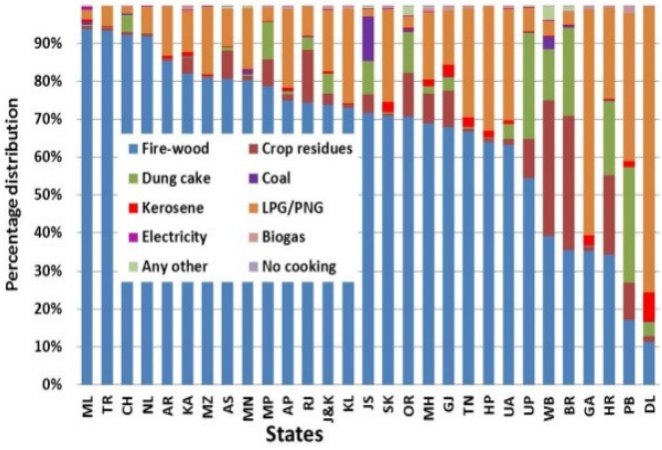

Fig. 3. Cooking scenario in rural India. [4]

Figure 3 shows that in rural areas firewood is widely used for cooking purposes followed by crop residue, cow dung cake, LPG and kerosene. States with best LPG presence in rural areas are- Goa (60%), Punjab (40%), Himachal Pradesh (35%) and Uttarakhand (30%).Traditional biomass fuels are mainly used by rural households. Indoor solid/biomass fuel combustion has its own risks. According to WHO, nearly 4.3 million deaths are reported due to indoor air pollution in India.

2. MAJOR POLICIES AND PROGRAMS FOR EXPANDING RURAL ENERGY ACCESS

2.1. For cooking

Policies for expanding cooking energy access in rural areas were started in 1957 through public distribution system (PDS) of kerosene supply with restriction of its quantity which ensure that its benefits reached to the poor and needy people.[5]Nearly 40% of the PDS kerosene gets illegally diverted and is used to adulterate diesel and petrol for transport.[5] It is still an unsolved issue. Laterin 1960's subsidies were provided on household cooking fuels like kerosene and LPG which aimed to provide affordable access to modern fuels for the poor but it did not impact the poor as it was anticipated.[5] It was followed by National project on Biogas development (NPBD) in 1982 which aimed to disseminate family type biogas plants and modern fuels for cooking and organic fertilizer torural households, to mitigate drudgery of women and reduce pressure on forest.[5]

In 1983, National programme on improved chulhas (NPIC) or cookstoves began to disseminate advanced biomass cookstoves for efficient use of fuel wood and avoid deforestation, reduce drudgery for women and health hazards caused by indoor pollution. NPIC found to be ineffective in promoting a shift to improved stoves therefore the funding was stopped in 2002.[5] After this the Ministry of Petroleum & Natural Gas launched the Rajiv Gandhi Gramin LPG VitaranYojna (RGGLVY) scheme in October,2009, its aimed to enhance LPG coverage through the launch of small sized LPG cylinders (5kg capacity) in the rural areas. The vision also aimed to assist poorer households in their move from kerosene to LPG through use of corporate social responsibility (CSR) funds available with oil Public Sector Undertakings. These programmes suffered from issues related to affordability and lack of access to supplies (on account of an under developed supply chain).[6] Later MNRE also launched National Biomass cookstoves initiative (NBCI) on 2nd December, 2009 with aim to enhance the use of improved biomass cookstoves. Although these programmes have been deployed but failed to sustain primarily due to lack of support and maintenance.[7] Recently MNRE formulated National biomass cookstove programme (NBCP) on 22nd April, 2014 during implementation in 12th plan period. Under this Programme, demonstration projects, existing and better cookstoves and different grades of process biomass fuel, will be undertaken which will facilitate exploring a range of technologies deployment, biomass processing and delivery models and improved biomass cookstoves will be disseminated for domestic and community cooking applications on cost sharing basis.[8] This programme is still in fancy.

2.2. For Lighting

Programs were started in 1969, when Rural Electrification Corporation (REC) established to support the rural electrification schemes & rural electricity co-operative.[5] In 1974, Minimum Needs Programme started during the 5th Five-year Plan period with rural electrification as one of the important components with central assistance in the form of grants and loans to the states.[5] In 1988, Kutir Jyoti (bright hut) scheme started to provide single point lighting connections to households below the poverty line (BPL).[5] In 2000, Pradhan Mantri GramodayaYojna (Prime minister's village development programme) came in to picture under which rural electrification was one of the main programme to offer finance through loans (90%) and grants (10%).[5] After this rural electricity supply technology mission was initiated on 11th September, 2002 with aim to electrify all villages and households progressively by the year 2012 through renewable energy sources and decentralized technologies in addition to conventional grid connection followed by Accelerated Rural Electrification Programme (AREP) in 2003 in which interest subsidy of 4% was provided on loans availed by State Governments/Power utilities from financial institutions for carrying out rural electrification programme.[5]

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The Electricity Act made in 2003 with an objective of specific directions for expanding rural electricity access, first time mentioned rural electrification in a statute followed by Accelerated Electrification of one lakh villages and one crore households for the provision of providing 40% capital subsidy and the balance as loan assistance on soft terms from REC by merging the interest subsidy scheme of AREP and Kutir Jyoti Scheme.[5] National Electricity Policy made in 2005 to access the electricity for all households and demand for power to be fully met by 2012 and minimum lifeline consumption of 1kWh/household/day by 2012.[5] In 2005 itself Government biggest scheme of Rajiv Gandhi Grameen Vidyutikaran Yojna (rural electrification programme) started with the objective of providing access to electricity to all households with Rural Electrification Corporation (REC) as the nodal agency, individual state governments and power utilities were responsible for programme implementation under the overall supervision of the ministry of power.[5]Decentralized distributed generation (DDG) scheme of the MOP was being implemented under the RGGVY.[6] It focused only on providing electricity in remote villages(where grid would not be extended) with 100 or more households.[6] Rural electrification policy initiated in 2006 which elaborates on the issues mentioned in the national electricity policy and makes specific recommendations for effective implementation of the rural electrification programme followed by Remote village electrification (RVE Program) which planned during 10th plan period aimed at providing basic lighting / electricity facilities to renewable energy sources in remote villages and hamlets which are not electrified and where grid connectivity is either not feasible or not cost effective.[5,6] And latest programme of MNRE is Jawaharlal Nehru National Solar Mission (JNNSM) launched on 11thJanuary,2010 which has a small component of off-grid generation through SPV technology. Its main objective is to create an enabling policy framework for the deployment of 20,000 MW of solar power by 2022.[9]

There are lots of policies and programs of Government of India but due to lack of their proper planning and integration, these are not implemented properly. In rural areas of India, there are a total of 597464 inhabited villages. The target of 100% village electrification with 100% household electrification was fixed for 2009. But 25752 villages of India yet to be electrified as on 31st August, 2014. [4,10]

3. RENEWABLE OPTIONS

India is rich in renewable energy resources but the potential of these resources has not been tapped properly. The contribution of renewables is 12.3% of the total installed capacity. Grid-connected power constitutes around 97% of the installed capacity in the country and rest of the portion shared by off-grid power. India is the first country where Ministry of New and Renewable Energy was set up by its Government in early 1980's for renewable energy development. [11]

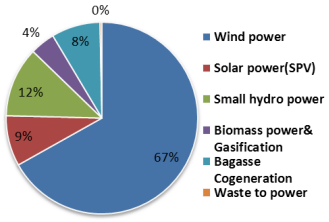

Fig.4. Sector wise installed capacities of Renewables. [12]

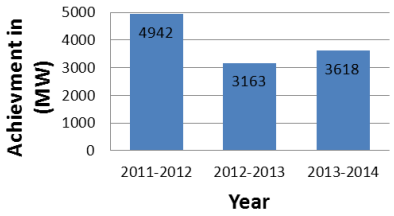

Fig.5. Progress made in renewable sector, in last three years. [12]

Figure 4 shows the different percentage share of installed capacities of Renewables in India as on 31st July, 2014.[12] Figure 5 shows the achievements of renewables made during last three years.[12] The main sources of renewable energy in India are solar, wind, biomass and Hydro power.

3.1. Solar Energy

India has vast solar energy potential. Solar is the most suitable option from an energy security point of view as it is abundantly available. The installed grid connected solar power has increased to 2753.00 MW by July 2014. India expects to install an additional 10,000 MW by 2017 and a total of 20,000 MW by 2022[11]. Solar energy can be used through two routes- First is thermal route and its applications are water heating, cooking, drying, water purification and power generation. Second is photovoltaic route and its applications are lighting, pumping and electrification of villages.[13]

3.2. Wind Energy

The most important use of wind energy is the generation of electricity. India has the fifth largest wind energy installed capacity in the world with 21692.98 MW installed capacity as of July, 2014.[12,13].Tamil Nadu is the largest wind power generating state accounting for 7275.68 MW of installed capacity, followed by Maharashtra(4064.95 MW), Gujarat(3447.28 MW), Rajasthan (2783.45 MW), Karnataka(2323.85 MW), Andhra Pradesh (783.35 MW),Madhya Pradesh (423.40 MW), Kerala (35.10 MW) and other states (4.3 MW).[14] Wind power generation potential for grid interaction has been estimated at about 48,500 MW taking sites having wind power density greater than 200 W/sq. m at 50 m hub-height with 1% land availability in potential areas for setting up wind farms @12 ha/MW. According to 12th Five Year Plan (2012-2017), Indian Government has set a target of adding 18.5 GW of renewable energy resources to the

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generation mix out of which 11 GW is contributes to Wind power.[15]For decentralized mode of power generation, wind energy can be harnessed in rural applications such as pumping and power requirement through water-pumping wind mills, aero generators and wind solar hybrid system. The water pumping windmills has following applications such as to pump drinking water and water for minor irrigation from wells, ponds and bore wells.[13]

3.3. Biomass power

Biomass energy is the principal source of energy in the rural regions of India and contributes about one –third of India's energy. Wood fuels which includes charcoal, waste wood, crop residues such as bagasse, rise husk and crop stalks and animal dung including biogas all these are the constituents of biomass energy.[16] It is estimated that the current availability of biomass in India is at about 500 million metric tons per year and surplus biomass availability is about 120-150 million metric tons per annum including agricultural waste and forestry residues which corresponds to a potential of about 18,000 MW.[16] Through bagasse based cogeneration in the sugar mills about 5000 MW of additional power can be generated, if these sugar mills were to adopt technically and economically optimal levels of cogeneration for extracting power from the bagasse produced by them.[16] As of 31July,2014, a total of 4,045.55MW has been installed under biomass power and bagasse generation under grid interactive power.[12] The main objective of the implementation of biomass power and cogeneration programme is to promote the technologies for optimum use of country's biomass resources for grid power generation.[16]

Biomass can be converted to convenient energy source by the use of three different ways : Thermal, chemical and biochemical conversion. Biogas which is produced from biomass waste has a lot of applications. In India biogas plants provide gas for cooking, lighting and power generation and it's a clean low carbon technology for efficient management and conversion of organic waste into clean renewable biogas as well as organic fertilizer source. It has the potential to tackle the local (land, air and water) and global pollution as well as for leveraging sustainable livelihood development. Biomass gasifiers power plants are providing electricity in rural areas as a great solution for off-grid decentralized power and lighting purpose.[16]

3.4. Small Hydropower

India is rich in hydro resources. Small hydro projects can provide solution for the energy problem in rural, remote and hilly areas of India which are characterized by inadequate, poor and unreliable supply of energy. About 20,000 MW is the estimated potential of power generation from such plants. Himalayan states has most potential in the form of river-based projects and in other states on irrigation canal.[17] The aim of ministry is that at least 50% of the potential in the country is harnessed in the next 10 years and to install 700 MW capacity of Small hydro projects at the end of 12^{th} plan.[17] Its main focus is to lower the cost of equipment, increase its reliability and to set up projects in that areas which gives maximum advantage in terms of capacity utilization.[17] Databases has been created by the Ministry of New and Renewable Energy for potential sites of small hydro and 6,474 potential sites for projects up to 25 MW capacity with an aggregate capacity of 19,749.44MW.Water mills have been used traditionally in the Himalayan regions for rice hulling, milling of grains and oil extraction. These converts the energy of water into useful mechanical energy. [17]

A small portion is contributed by Tidal Energy, Geothermal Energy and OTEC. The estimated potential of tidal energy is 1200MW and potential sites are Gulf of Cambay (7000MW) and the Durgaduani Creek in the Sundarbans Delta (100 MW) and the estimated potential of Geothermal energy is 10,000MW respectively.[18]

3.5. Issues and Challenges

The issues associated with renewable based power can be categorized as political, economic, socio-cultural, technological, environmental, legal and regulatory.[19]Some of the identified political barriers are non-availability of financial resources for supporting renewable energy and lack of interest to support such resources by other Ministries as well as wide variation in the political support at the State Government level /institutions.[19] Economic barriers include lack of subsidies, high initial installation costs and high transaction costs for small decentralized system.[13] Project financing and high cost of debt of renewable energy projects is also a major issue for why financing communities are always worried about the bankability of these projects.[19]

These economic barriers will affect those consumers who have low-incomes and who cannot pay for such a high cost technologies and make unaffordable and infeasible to them.[19] Socio-cultural issue is the resistance from local community/end-users towards the use of certain technologies e.g. wastes to power.[19] Technological barriers include technology bottlenecks i.e. the lack of availability of adequately skilled technical manpower, transmission and implementation infrastructure as well as distribution and service network and environmental issues are associated with the setting up of renewable energy projects which are outside the purview of Environment Impact Assessment and it is a matter of concern. It is seen that wind energy and small hydro projects have had significant effect on local ecosystem.[11,19] Second major issue is the availability of land as these projects are set up in forest, revenue/government or private land.[11] Legal and regulatory issues are related to inadequate legal and policy frameworks for renewable energy power sources due to this private companies are normally reluctant and unable to participate in these programmes.[19] Many of the states are

not complying with their RPO targets due to lack of enforcement of RPO regulations and the absence of imposition of penalties on obligated entities.[11] There are also some financial and institutional barriers which involves the lack of sufficient technical, geographical and commercial information which results in lack of attractiveness and low investment in renewable energy projects.[19]

4. CONCLUSION

In this paper the rural energy status in India was discussed from the perspectives of access to clean energy options for electricity and cooking requirements. The issue of sustainable development is a key concern as a considerable percentage of India's population resides in rural areas and without ensuring reliable supply of energy to the entire population, sustainability cannot be achieved. There is a need of designing innovative policies and targeted programmes for expanding rural energy access. The efforts should be made at all the three levels i.e. local, regional and national to achieve the significant developmental goals. Different business models should be developed which will make renewable energy projects more sustainable. There is need to develop an overall capacity building and communication programme to spread the awareness among people about the effective utilization of these resources. Our country is blessed with immense potential of natural resources the only need is to utilize them properly with suitable regulatory framework.

Thus, a transition to cleaner forms of energy in terms of access to electricity and other modern energy forms is necessary not only for energy security but to achieve its long run goal of sustainable development and social progress. To achieve the projected growth outcomes India's success in resolving energy bottlenecks is one of the key challenge.

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