RENEWABLE ENERGY IN PAKISTAN: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

Most of the countries around the world have realized that the key to attaining and maintaining prosperity and sovereignty is having independence and self-reliance in access to and subsequent use of energy. To address the global challenges, the energy system needs to undergo a transformation from fossil-fuels to renewable energy and energy efficient technologies. Pakistan has a huge potential for harnessing renewable energy and its share in the electricity mix has to be increased to achieve energy security. Security issues and circular debt in the country are the key challenges that need to be addressed to promote on-grid renewable energy through private sector. Around 38 % of the total Pakistani population remains without access to electricity. Fifty four per cent of the rural population currently has no access to electricity, forcing them to live a sub-standard life of poverty and social inequity. Microfinance and other innovative financial tools need to be evolved to promote rural electrification through renewable energies.

1. INTRODUCTION

Economies around the world are facing challenges of high energy demand to sustain the economic growth and development. This comes with a dire fact that the conventional sources of energy the fossil fuels are depleting. The environmental impacts of these conventional energy sources are also alarming. The large gap between demand and supply of electricity, increasing costs of imported fossil-fuels and worsening air pollution, demand an urgent search for energy sources that are cost-effective, reliable and environment-friendly. Consequently, there has been a lot of recent interest worldwide in developing renewable energy sources.

The current energy crisis in the country has taught us many lessons and one of the keys is to utilize indigenous sources of energy. Pakistan s electricity mix is heavily tilted towards thermal and the country is making 33.6 % of the total electricity from oil (HDIP, 2011). Through this paper, renewable energy is highlighted as a potential resource that can be tapped immediately to overcome the current energy crises and warrants energy security. Ninety-seven million people live in rural areas, comprising 7 million households. According to a report published by the International Energy Agency, 38 % of the Pakistani population remain without access to electricity (IEA, 2011). Fifty four per cent of the rural population currently has no access to electricity, forcing them to live a sub-standard life of poverty and social inequity. As a result, development of the country is suffering as these areas possess abundance of resources and workforce that is currently disengaged from the mainstream. Use of renewable energy, due to its manifold advantages of having positive cross-cutting effects and impact over various strata of the economy and society can play a vital role in mainstreaming this large resource and help provide sustainability, and social and economic equity among the targeted rural population.

2. CURRENT SITUATION OF ENERGY IN PAKISTAN

At this juncture, we are encountering the worst electricity crisis in the history of Pakistan resulting in extended load-shedding to an extent that it virtually suspends social life. The situation has further forced the Government of Pakistan to take decisions like early market shutdowns, power cut-off to industry, and two holidays per week thus affecting all business activities. In the short term, we put all our eggs in the oil based rental power projects. It is nearly impossible at this time to bear the cost of electricity both by the consumers and the government (circular debt issue) because of the existing oil-based projects, which could lead to further complications after rental projects with a little price hike of oil in the international market. The country needs to have an out-of-the-box thinking to utilize its indigenous resources, like hydro, coal and renewable energies.

2.1 Electricity Mix of Pakistan

Unlike India, with an electricity mix based on indigenous sources and the share of oil-based generation of electricity is less than one per cent. The electricity mix of Pakistan is heavily tilted towards imported oil (Figure-1). Any oil price-hike in the international market badly impacts Pakistan s electricity generation rendering current circular debt issue even more critical.

3. GLOBAL PERSPECTIVE

Since the advent of the new millennium, the world has transformed in a lot of ways; important among them are the menace of climate-change and the ever-

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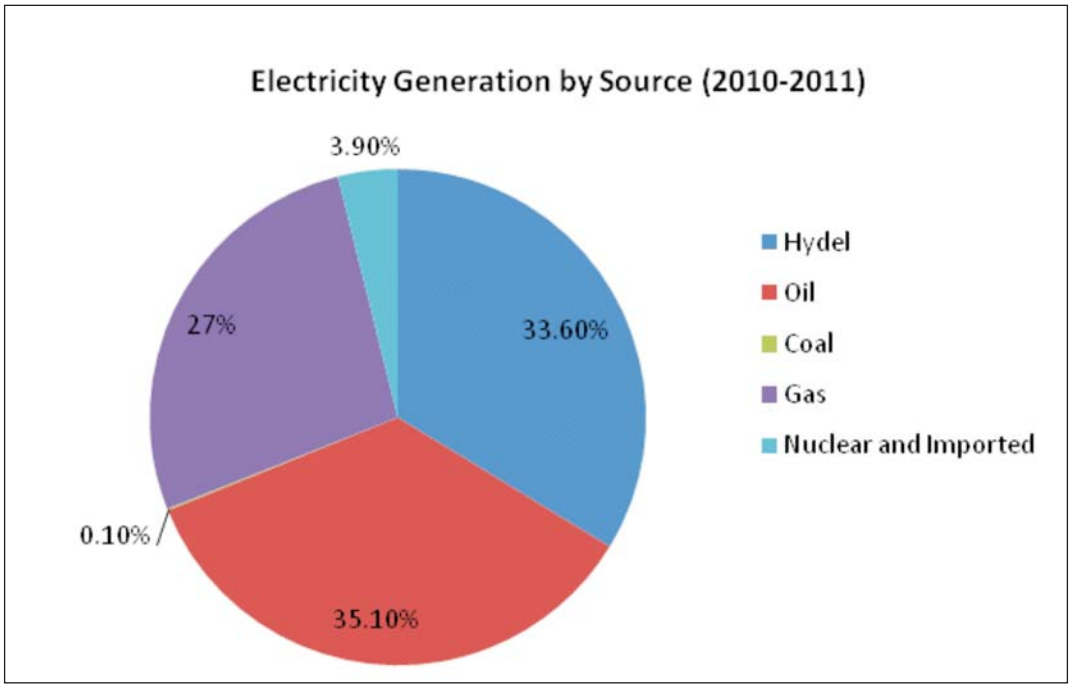
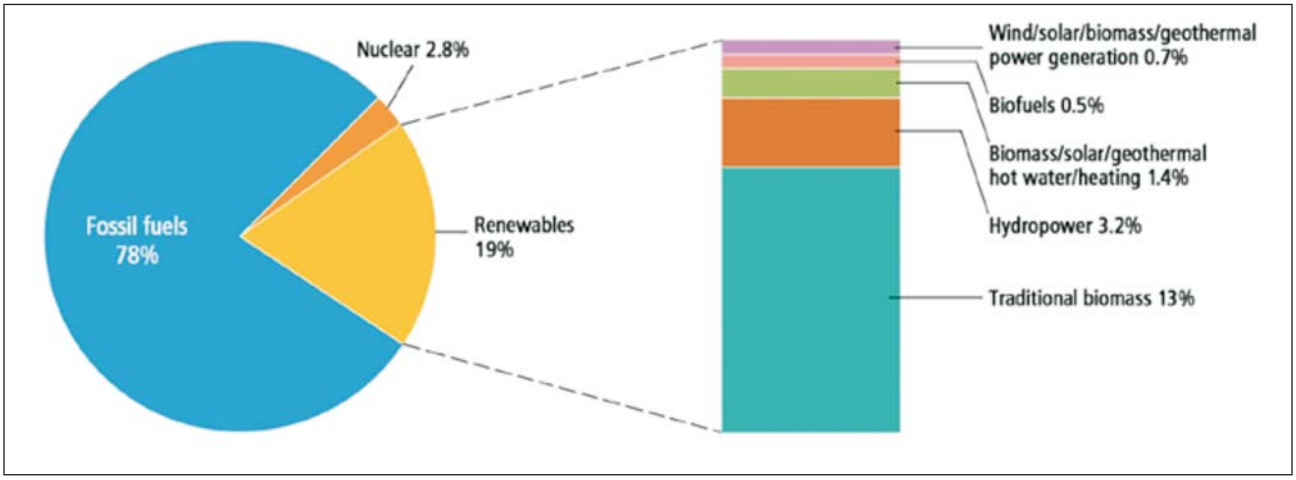


Source: *Pakistan Energy Yearbook by HDIP, 2011*

Figure-1: Electricity Mix of Pakistan



Source: *Global Status Report by REN21, 2010*

Figure-2: Renewable Energy Share of Global Final Energy Consumption, 2008

changing energy scenario in an increasingly volatile geo-political environment. Both the developed and the developing countries have realized that the key to attaining and maintaining prosperity and sovereignty is having independence and self-reliance in access to and subsequent use of energy. Coupled with the responsibility of keeping the climate-change under check for the sake of the future of our world, this has led to an all-time high emphasis on utilization of renewable energy resources world over. Global share of renewable energy in the energy consumption of the world is shown in Figure-2 (REN21, 2010).

By early 2010, policy targets for renewable energy at the national level existed in at least 85 countries worldwide, including all 27 European Union Member States. Many national targets are for shares of electricity production, typically 5 to 30 per cent, but range from 2 per cent to 90 per cent. Other targets are for shares of total primary or final energy supply, specific installed capacities of various technologies, or total amounts of energy-production, including heat, from renewable energy resources. Targets also exist for biofuels in many countries. Many historical targets have aimed for the 2010 2012 timeframe, although targets aiming for 2020 and beyond have emerged in increasing numbers in recent years. In 2008, all the 27 EU countries confirmed national targets for 2020, following a 2007 EU-wide target of 20 per cent of final energy by 2020.

Examples of new national targets among developed countries include Australia (20 per cent of electricity by 2020), Ireland (500 MW of ocean power by 2020), Japan (14 GW of solar PV by 2020), South Korea (11 per cent of primary energy by 2030) and the USA (25 per cent by 2025). An increasing number of developing countries have prescribed energy related targets, and as a group, now account for over half the countries worldwide with such targets.

The Renewables 2007 Global Status Report counted 22 developing countries with targets, and this figure expanded to 45 countries by early 2010. The national plans of developing countries also reflect increasing ambition in targeted amounts. China aims for 15 per cent of final energy consumption from renewables by 2020, even as total energy demand continues to grow at nearly double-digit annual rates. China met its 2010 renewable energy target of 10 per cent of primary energy two years early, in 2008. The country s most recent draft development plan targets 300 GW of hydro, 150 GW of wind, 30 GW of biomass, and 20 GW of solar PV by 2020.

In 2009, India set a target of 20 GW for solar power production by 2022 (including 1 GW of off-grid solar PV by 2017). Brazil aims to maintain or increase its existing shares of total energy (48 per cent) and electricity (85 per cent) from renewable through 2030.

4. FORMATION OF IRENA

To address the challenges mentioned above, the energy system needs to undergo a transformation, from fossil-fuels to renewable energy and energy efficient technologies. The critical need for a powerful, international actor that provides support and assistance to transform the energy system has been heralded worldwide. Thus, in January 2009, IRENA the International Renewable Energy Agency was established to bridge the institutional gap. Mandated by governments worldwide, IRENA aims at becoming the driving force in promoting a rapid transition towards the widespread and sustainable use of renewable energy. Acting as a global voice for renewable energies, IRENA will provide practical advice and support for both industrialized and developing countries. Since its creation, IRENA has been recognized as a viable global organization. IRENA must fulfill high expectations, as more countries are expected to join and support its work to meet the challenges that lie ahead (www.irena.org).

5. POTENTIAL OF RENEWABLE ENERGIES IN PAKISTAN

5.1 Solar Energy

Located in the sunny belt, Pakistan is lucky to have long sunshine hours and high insolation levels and is ideally located to take advantage of solar energy technologies. Solar mapping conducted by National Renewable Energy Laboratory (NREL), USA, in collaboration with USAID, has indicated a potential of 2.9 million MW in Pakistan (NREL, 2012), as shown in Figure-3.

This energy source is widely distributed and abundantly available in the country. The mean global irradiation falling on horizontal surface is about 200-250 watt per m^2 per day. This amounts to about 1500-3,000 sunshine hours and 1.9 - 2.3 MWh per m^2 per year. Balochistan province of Pakistan is particularly rich in solar energy. It has an average daily global insolation of 19 to 20 MJ/m^2 per day with annual mean sunshine duration of 8 to 8.5 hours a day and these values are among the highest in the world (Khalil, Khan and Mirza, 2005). For daily global radiation up to 23 MJ/m^2, 24 (80%) consecutive days are available in this area. Such conditions are ideal for PV and other solar energy applications.

Pakistan can make use of this abudant and widely distributed solar energy for improving the socio-economic conditions of the people living in remote areas and to reduce the poverty level. It is calculated that approx. 40,000 remote villages will be electrified through solar energy. The provinces of Sindh and Balochistan are ideal for utilization of solar energy. In Balochistan, 77 % of the population is living in the rural

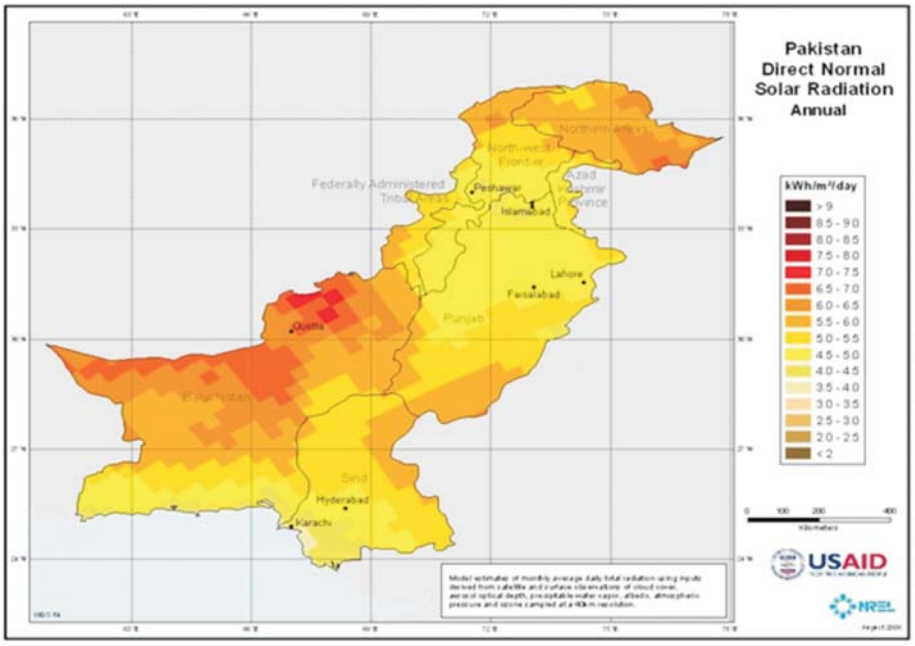


Figure-3: Pakistan Solar Energy Potential

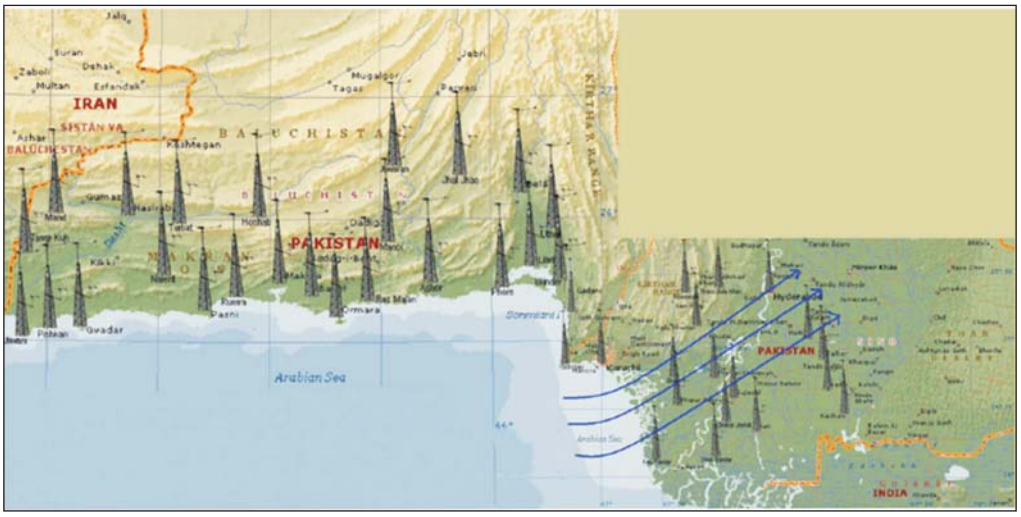


Figure-4: Wind Meteorology Masts Installed by PMD

areas and the population density is very thin. About 90 % of the villages are yet to be electrified. These villages are separated by large distances with absolutely no connecitng roads. Transmission lines are very expensive in this area and there is no chance of grid connection in the near future.

Within the broad scope of Solar Power Technologies, following concrete opportunities are available in both on-grid and off-grid applications:

i. Village electrification;
ii. Solar water pumps;
iii. Solar water heating and space heating solutions;
iv. Outdoor lighting (Solar/LEDs);
v. On-grid solar power projects using solar PV and solar thermal technologies;
vi. Net metering applications.

There are other options available but it is believed that fast-track development in solar energy for immediate

impact can be obtained by exploiting the above-mentioned segments.

5.2 Wind Energy

In the year 2002, Pakistan Meteorological Department (PMD) launched a campaign for the assessment of wind resources in the south of Pakistan. Meteorological masts were installed with anemometers at 10 m and 30 m heights (Figure-4). Analysis of the data gathered through these masts confirmed the presence of a logical wind corridor in coastal belt of Sindh province with wind speeds averaging more than 7 m/s at a height of 80 m. Further analysis of this wind regime showed a promising exploitable wind potential of more than 50,000 MW only at Gharo Keti Bandar corridor of Sindh Province (Qamar, 2009).

National Renewable Energy Laboratories (NREL) of USA under the USAID assistance programme in 2007 has carried out the wind resource study of Pakistan and developed a meso-scale map of Pakistan, showing the wind speed potential available at 50 m height. NREL study has also confirmed the availability of wind resource in Sindh. As per the wind resource map of Pakistan developed by NREL of USA, in collaboration with Alternative Energy Development Board (AEDB) and USAID, Pakistan has a potential of more than 300,000 MW of wind energy in whole of the country (Mirza, Khan and Memon, 2010) (Figure-5).

As mentioned above, more than 40,000 villages in Pakistan are not connected with the national grid and most of the remote villages in the south can be electrified through micro wind turbines. It is estimated that more than 5,000 villages can be electrified through wind energy in Sindh, Balochistan and Northern Areas. So far, 5 villages have been electrified using micro wind turbines by AEDB, Pakistan Council for Renewable Energy Technologies (PCRET) and other governmental and non-governmental organizations in Pakistan*.

5.3 Hydropower

The potential of only micro-hydro is discussed in this paper. The northern part of the country is rich in hydro power resources. Other than small hydro power plants (capacity greater than 1 MW), there is a large number of sites in the high terrain, where natural and manageable waterfalls are abundantly available. The recoverable potential in micro-hydropower (MHP) up to 100 kW is roughly estimated to be 300 MW on perennial water falls in northern Pakistan. The population in these areas is distributed in thin clusters

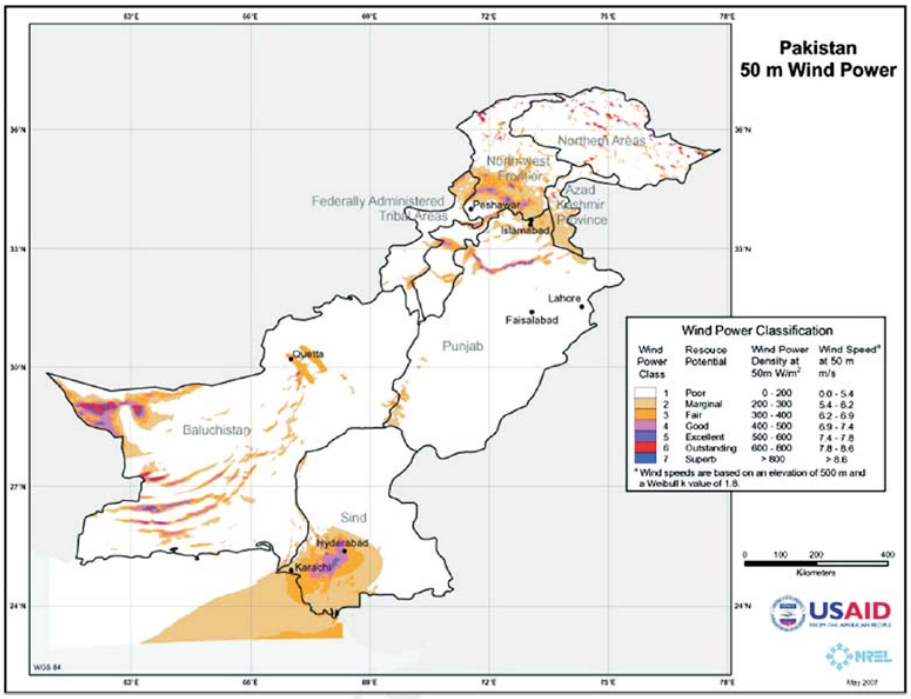


Figure-5: Wind Map of Pakistan

* The author has not been able to get the data as to whether these wind turbines are still producing electricity or not.

and is located far from physical infrastructures. Such remote population can greatly benefit from renewable energy sources. Besides, there is an immense potential for exploiting water falls in the canal networks, particularly in the Punjab province of Pakistan, where low head high discharge exists on many canals. The potential is estimated to be around 350 MW. The Government of Punjab has recently started exploiting this potential through the private sector. Punjab Power Development Board (PPDB) has started facilitating various projects of around 100 MWs in Punjab.

Pakistan also has commenced development of Micro Hydro Kaplan Turbine in a local industry for beneficial utilization of available low head in the canal system of Pakistan. A total of 228 run-of-river type plants with a total capacity of 3 MW have so far been installed in the Khyber Pakhtunkhwa Province of Pakistan. These plants not only provide electricity for light at night but are also used to run small industrial units, such as flour mills for wheat and maize thrashing, and cotton ginning during the day time when electricity is not required for lighting.

5.4 Biomass

Millions of tons of solid biomass comprised of cotton and wheat stalks, rice husk, corn cobs and other crop residues are produced in Pakistan annually. Wheat stalk is used as feed for the livestock. Except for use of this resource by rural households, mainly for cooking, the biomass is not being used for power-generation on a wide scale. Some companies use solid biomass residues to burn in boilers to generate steam for power generation. Burning biomass is not efficient from an energy conversion point of view. World is now using new technologies like gasification that uses controlled conditions of temperature and oxygen level to convert the original biomass feedstock into producer gas or wood gas (if the feedstock is wood) and more heat content of the biomass is captured.

There is a huge potential of generating electricity from biomass in Pakistan. Only the sugar industry has a potential of producing more than 1,000 MWs of electricity from bagasse. Private Power Infrastructure Board (PPIB) of Government of Pakistan has already announced a cogeneration policy for the fast track development of electricity from bagasse. Experts suggest that biomass can also play a vital role in reviving SMEs for fulfilling their requirements of electricity and heat if they start installing their own biomass projects in the 500 kW to 5 MW range (PPIB, 2008). Moreover, being clean and renewable, it will also contribute towards environmental protection, sustenance of ecosystem and conservation of the biodiversity.

5.5 Other Renewable Energy Sources

In addition to the sources mentioned above, Pakistan is also blessed with the following other renewable energy sources:

- Biogas;
- Geo-thermal;
- Tidal / wave; and
- Bio-fuels Biodiesel and Ethanol.

6. ISSUES AND CHALLENGES

Introduction of renewable energies at a large scale for both on-grid and off-grid applications in Pakistan have many issues and challenges. These are listed below:

6.1 On-Grid

- Success stories need to be created which can be replicated.
- Integrated policy and attractive FITs feed in tariffs are required for each technology to be exploited, like wind, solar, hydro, etc.
- Circular debt and the ability of the utility to pay is one of the biggest challenges at this time.
- Investment capacity of the local banks to lend the projects is also a big issue as the foreign lenders are reluctant to come to Pakistan in the current geo-political scenario.
- Security situation of the country is also a key threat at this time. Foreign investors are reluctant to come to Pakistan.
- R&D and adoption of appropriate technology is also a key challenge under the current circumstances. No university is geared up to take this role.
- Capacity issues are there in public sector institutions, private sector and also among financial institutions.

6.2 Off-Grid

According to a report published by the International Energy Agency (IEA, 2011), 38 % people in Pakistan remain without access to electricity. More than half of the rural population currently has no access to electricity, forcing them to live a sub-standard life of poverty and social inequity.

Water and Power Development Authority (WAPDA) of

Pakistan estimates indicate that there are over 40,000 villages across the country that cannot be provided electricity as it would not be technically and economically viable to extend the national grid to the rural areas. Out of these 40,000 villages, 6,968 have been identified in Balochistan. Renewable energy can be effectively used for sustainable development and poverty alleviation in these areas by enhancing sustainable livelihood opportunities. Rural demands for electricity pertain to, and are not limited to, lighting, heating & cooking, clean drinking water, agro-industries, small commercial and manufacturing establishments and production uses, e.g., water/irrigation pumping, crop processing, refrigeration, and motive power.

Following key challenges are there for introduction of renewable energy in off-grid areas:

- Lack of information prevents the outreach in rural areas in Pakistan. There is very limited information available on both demand and supply. Base-line information about the energy needs assessment of people living in the rural off-grid areas is not available. There is limited knowledge available to the potential investors/technology suppliers/microfinance institutions about the potential clients and their needs, which is required to take initiatives to serve in these areas. Also, the people living in these areas or the clients are unaware of the resources where they can tap into solve their energy-related problems due to poor physical and social infrastructure.
- Operations & Maintenance issues as well as unavailability of trained technicians in such remote areas.
- Risk Perception because it is a new product for a new market alongwith the high cost of renewable energy equipment is also a concern. Most of the people living in the off-grid areas are at or below the poverty borderline and have insufficient capacities to pay their electricity bills.
- Unstable, volatile and explosive law and order situation in both Khyber Pakhtoon Khawa and Balochistan poses a serious challenge.

7. CONCLUSIONS

Both the developed and the developing countries have realized that the key to attaining and maintaining prosperity and sovereignty is having independence and self-reliance in access to and subsequent use of energy. Coupled with the responsibility of keeping the climate change under check for the sake of the future of our world; this has led to an all-time high emphasis on utilization of renewable energy resources world wide.

Perhaps one of the most relevant and unique application of renewable energy is its cross-cutting relevance with the Millennium Development Goals (MDGs). In particular, the following MDGs link the role of Renewable Energy to social equity and sustainable development:

MDG 1: Eradicate Extreme Poverty and Hunger
MDG 7: Ensure Environmental Sustainability

Target: Integrate the principles of sustainable development into country policies and programmes; reverse loss of environmental resources.

Pakistan is currently facing a two-pronged crisis of threat to its Energy Security and an alarmingly low Human Development Index (HDI). Effective use of renewable energy can successfully address both these issues by improving the quality of life of the under-developed population, economic empowerment of the socially deprived and contribute to achieving the MDGs.

Opportunities exist for investors, developers, manufacturers, lenders and other players to exploit the Pakistani renewable energy market. The Government has the opportunity to use renewable energies to overcome the existing energy crises and create job opportunities. The key challenge for the government is to give confidence to investors under the current security scenario, along with an assurance to address the circular debt issue for on-grid power projects.

Pakistan s government has to create an enabling environment for off-grid electrification of villages and needs to create success stories. Microfinance models used in Bangladesh for renewable energy village electrification can be replicated to create success stories. Renewable energy can be effectively used for sustainable development and poverty alleviation in these areas by enhancing sustainable livelihood opportunities.

The potential is huge and renewable energy can play a vital role to achieve energy security, supplement the on-grid electricity and change the lives of people living in rural areas. Out-of-the-box thinking and innovative solutions need to be evolved to create success stories.

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