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Identifying and Addressing Barriers to Solar PV Technology Indigenization in Pakistan

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***Abstract*— Energy plays a key role in social and economic development of a country. During the past Energy is the lifeline of socio economic growth of any country. Pakistan is facing serious electricity blackouts during the past few decades which is responsible for instability of the country. Pakistan energy mix is dependent on fossil fuels, and its local production capacity is up to 6 % of the energy mix while imports up to 24 %. The imports of fossil fuel have huge impact on national economy. In years 2008-09 Pakistan spent 9 billion US dollars on import of fossil fuels resulted a huge burden on national economy. Furthermore, fossil fuels are the main contributor of greenhouse gas (GHG) emissions resulting in climate change and environmental degradation. Developing and developed countries of the world are shifting for a source of energy which is long lasting, environment friendly and economical. Luckily, Pakistan is located in a region of the world with highest solar irradiations of almost 7-8 kWh/m^2. In Pakistan, the maxing blackouts are in summer season in which we have maximum solar radiations for almost 13 hours a day. Government of Pakistan is struggling from last decades to entre solar PV market, but there are some barriers in market which limits the technology transfer and adaptation process in the market. In this research, efforts have been made to identify and address the barriers for solar PV technology transfer and adaptation in Pakistani market.**

***Keywords*— Solar PV, Renewable Energy, Climate Change.**

1. INTRODUCTION

Sustainable development, industrial progress, economic stability and growth of a nation can be defined by the energy consumption in modern era. Lavish life style of peoples and rapidly growth in population are the main players in depleting the current energy sources [1]. Energy mix is highly dependent on fossil fuels which is responsible for environment damage [2]. To reduce the formation of greenhouse gases and ultimately the climate change, we need to find out the environment friendly sources of energy [3, 4]. According to data available on 30th Jun 2015, Pakistan was facing energy deficit of almost 5201 MW with daily blackouts of approximately 10 to 12 hours. Furthermore, most of the villages are still not connected to the grid [5]. The current gap in energy supply and demand is very high and will increase at rate of 5 to 6 % of the current requirement. The country available resources of fossil fuels only fulfills 6 % of the energy demands and we import up to 24 % of fossil fuel to overcome the energy crises, resulting a huge impact on national economy. In years 2008-09, fossil fuels of worth 9 billion US dollars were imported. Pakistan requires a major shift towards renewable energy to overcome the gap between supply and demand and also to meet the United Nations demand of shifting towards renewable energy and saving environment [1]. Pakistan, having abundant sources of renewable energy resources in form of solar, wind, biomass and hydal etc has not yet achieved the set target of shifting towards the renewables [5].

By efficiently utilizing the solar energy available in the country using solar PV technology, we can overcome the existing blackouts by providing power to the national grid and the villages located in off-grid areas of Baluchistan and Sindh [1]. To identify the barriers to solar technology transfer in the country, we followed the painuly's model to design a questionnaire for collecting the relevant stakeholders opinion [6]. By analyzing the feedback from relevant stockholders, recommendations are made to address the barriers considering Pakistani market.

2. SOLAR ENERGY AS AN OPTIONS FOR PAKISTAN

Pakistan is blessed with natural resources and solar radiations are abundantly available in majority of its cities with highest solar irradiation in the world. Using the available solar irradiation in the country, Pakistan utilize and can produce enough power to overcome the energy crises. Figure 1-1, shows the solar irradiations falling in major cities of the country.

The solar power potential in Pakistan is estimated around 2900 GW[7]. 300 days of sunshine has been recorded on average in most cities of the country.

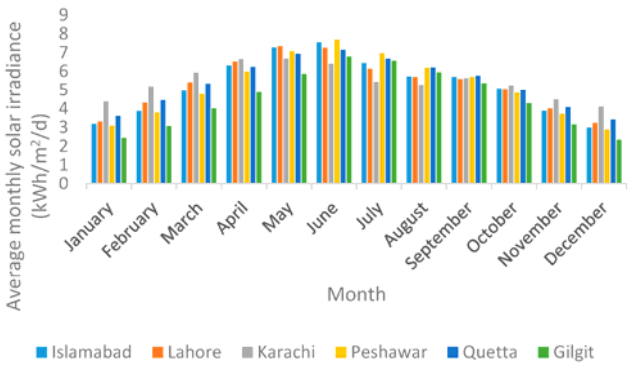

Figure 1-1: Average monthly solar insolation of Peshawar, Islamabad, Karachi, Quetta, Lahore and Gilgit.

Pakistan is ranked among the top countries of the world in terms of solar energy potential with availability of approximately 1900-2200 kWh/m^2 of annual global irradiance. These conditions makes Pakistan highly favorable for solar energy applications especially solar PV. Solar PV can be effective in overcoming the energy crises in the country along with supplying the electricity to off-grid areas of the country [8]. Advantages of using renewable as source of power and energy are shown in figure 1-2 [1].

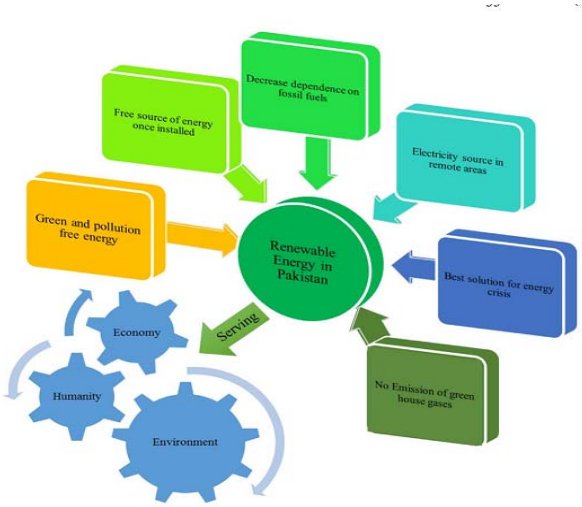

Figure 1-2: Advantages of renewable energy in Pakistan [1]

3. PAKISTAN ADVANCEMENT IN SOLAR PV INDUSTRY IN LAST DECADES

First on gird solar PV electricity production in Pakistan was introduced by commissioning of 178.08 kW of plant in Planning Commission and Pakistan Engineering Council (PEC) building in 2010. The solar PV system was officially inaugurated in 2012 with net metering facility which gives the surplus power to national grid. Similarly, National Assembly building of Pakistan has the world first parliament to be completely run by solar power, with a 2 MW od solar PV system was installed having net metering facility for supplying surplus electricity to the national grid [9]. A feed in tariff (FiT) has been announced by National Electric Power Regulatory Authority (NEPRA) to both the projects. The above stated projects has motivated the local and international investors and as a result almost 28 solar PV organizations has obtained Letter of Intent (LoI) from alternate energy development board (AEDB) for approximately 956.52 MW capacity and are at different development stages. Under the China Pakistan Economic Corridor (CPEC), In year 2015-16, the,100 MW capacity, Quaid-e-Azam Solar Park (QASP) was made functional and other 3 solar PV projects of cumulative capacity of 300 MW are under project construction phase with government of Punjab energy department and under the supervision of AEDB [10]. AEDB has provided Letter of Support (LoS) to seven (7) independent power producers (IPPs) of cumulative capacity of 72. 52 MW and are in financial closing stage. The table 1 shows expected cumulative capacity of solar PV available to the grid in next two years [11].

Table 1
Yearly projected cumulative capacity in Pakistan

Year	Yearly cumulative capacity (MW)
2015	100
2016	400
2017	730
2018	1556

The country's national environment friendly power policy and to meet the energy demands, has directed AEDB to upgrade the stake of renewable energy technologies to 5 % of total country's power production by the year 2030 [12]. The given target may be addressed by adaptation of solar PV technology in local market of Pakistan.

4. BARRIERS TO SOLAR PHOTOVOLTAIC (PV) TECHNOLOGY ADAPTATION IN PAKISTAN

4.1 Stakeholders opinion ranking

Barriers to solar PV energy adaptation and promotion in Pakistan may have some similarities with other developed and developing countries. Painuly's [6] model for general characterization of barriers to renewable energy has been adopted as a model for analysis. The barriers may be specific to a country, region or technology.

A detailed questionnaire was sent to various stakeholders including solar PV producers, government departments, solar PV distributers, policy makers, solar PV producers, and Universities and research and development centers out of which twenty stakeholders responded to the questionnaire.

According to [6], interaction with solar PV stakeholders allows a process of barrier investigation to be accompanied at different levels as shown in figure 1-3 [6] . The first level emphases on extensive classification, the second level launches a more thorough and specific barriers within a major category, and various elements of these barriers are proven at the third level of the model; the breakdown of a barrier into elements give a clarity to overcome the causes.

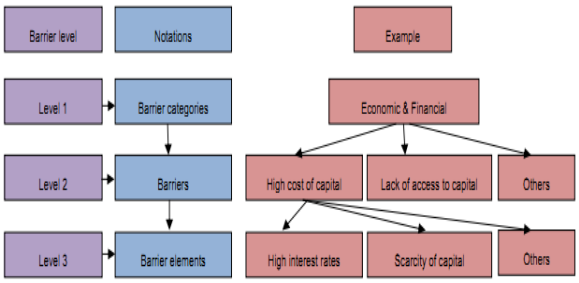

Fig. 1-3. Barriers level to renewable energy penetration [6]

As per data collected from questionnaires, some barriers were identified. Among the key barriers in the country solar PV energy market, are: lake of information and awareness, policy barriers, institutional barriers, financial barriers, Weak Regulatory Framework, Inefficient infrastructure, and lack of interaction between Universities, R&D centers and solar PV policy makers. These are discussed in more detail as under:

4.2 Policy barriers

No doubt, Pakistan has developed a number of energy related policies and plans, the solar PV have been accorded on low priority. Furthermore, the solar PV as an alternative source of energy has triumphed in some of the policy and plan documents, almost negligible follow-up work has been done for its meaning development. Also the solar PV investors are not encouraged properly.

4.3 Institutional barriers

There are organizations exist, for solar PV technology uptake in the country but they are not playing there role and mandate given to them by the National Assembly (NA) and Senate of Pakistan. There passive behavior also acts as a major barrier to implementation and adaptation of solar PV technology transfer to Pakistan.

4.4 Regulatory Barriers

There is no strong regularity framework exist for adaptation of solar PV technology.

4.5 Financial barriers

There are not special packages and soft loans available for adaptation of solar PV in Pakistan. No special economic zones are created/available for solar PV technology. Also financing schemes are limited for solar PV stakeholders.

4.6 Information barriers

Potential in Pakistani market for solar PV technology is high. Most of the consumers are willing to adopt solar PV technology. Also the international investor is ready to invest in solar PV energy based projects in Pakistan. But one of the major problems is lack of general information, technical know-how and awareness to peoples, local and international solar PV investors, suppliers and distributers. Especially the solar energy is site specific.

4.7 Lack of Coordination

No doubt, Universities, research and development centers e.g. CASE-P UET, CERAD UET Lahore are producing advanced and high quality research regarding renewable energy technology like solar PV etc. but the problem is that they are not sharing and coordinating the R&D out-put with each other. Similarly they are not arranging the hands on workshops and training for solar PV industries to strengthen their skills for improving the quality of work and facilitating the investors as well. There are Universities, R&D institutes and centers for solar PV related research e.g. CERAD, CASE-P UET, but there work needs to be promoted and implemented.

4.8 Infrastructure barriers

The existing transmission infrastructure is very old and there are huge losses. It needs to be updated. Furthermore, due to non- availability of a strong physical infrastructure in high solar irradiance zones/areas leads to little utilization of their prospective.

5. RECOMMENDATIONS

i. Government is required to have favourable regulations, supportive policies, and cooperation by taking various steps e.g. setting special economic zones for solar PV technology.
ii. Government is required to facilitate the stakeholders by providing high discount rate for solar PV technology.
iii. Government of Pakistan is required to guide, regulate and facilitate the local banks, to issue necessary finance, various packages and soft loans for all stakeholders relevant to solar PV projects at reasonable and lower interest rates.
iv. Universities, R&D centres, and other relevant government departments are required to facilitate, guide and technically assist the solar PV stakeholders.
v. AEDB is required to guide and facilitate stakeholder of solar PV energy by developing standards, providing them testing centers and facilities, training centers, and setting standard specifications in coordination with various government stakeholders, R&D centers and academia.
vi. Technical Information, financial knowledge and general information and awareness related to solar PV technology are required to be made easily available to stakeholders

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