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Current status and future success of renewable energy in Pakistan

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ABSTRACT

Mismatch between energy demand and supply from last two decades has been increasing because of the domination of expensive imported oil in energy mix of Pakistan. To import crude oil Government paid US $ 9 billion in 2008–2009 to meet the energy demands of the country that put a heavy load on national economy. Sustained economic condition of a country is owing to the sustainability of its energy sector. In this paper current position and future success of Renewable Energy (RE) under the light of operational and under construction RE projects such as solar, wind, biomass, biogas and hydro power are discussed along with that role of organizations and institutions in RE field is studied. RE projects with a cumulative capacity of 100 MW solar, 308 MW wind, 145 MW bagasse and 98 MW micro hydro are operational while 856 MW solar, 1140 MW wind, 297 MW bagasse and 2638 MW micro hydro projects are under different project development stages. The results indicate a change in present energy mix by giving share to the RE sources and domination of RE sources in future energy mix in view of ongoing major RE projects encouraging the eradication of demand and supply gap. The overall results envisage a success of RE in future of Pakistan and will intrigue not only local as well as foreign investors to invest in energy sector of Pakistan.

1. Introduction

Recently renewable and alternative energy sources have attracted the attention of policy makers, researchers as well as the consumers, mainly because of the exponential increase in energy demand and concern to reduce the environmental pollutants generated from conventional fossil fuels. For this reason, Renewable Energy (RE) projects such as solar, wind, hydro and biomass started to replace oil, coal and gas based power projects.

In Pakistan scenario as on 30th June 2015, the gap between electricity demand and supply was 5201 MW [1] resulting a complete inevitable blackout of 14–18 h daily [2–4] which has been consistent for last 5 years as shown in Fig. 1. In 1980 share of hydro power in energy mix of the country was 70% but by reason of the political instability every elected government launched short term electricity projects that reduced the hydropower share to 31% and the extravagant imported oil replaced the reduced share of hydropower. In 2008–2009 Government paid US $ 9 billion [5] to meet the energy demands that put a heavy burden on national economy. In spite of having installed capacity of 24,823 MW dominated by thermal power plants operated on oil, gas and coal with 67.74% share in energy mix, demand of 21,701 MW could not be met with a deficit of 5201 MW [1] as shown in Fig. 1 and is expected to be sustained till 2018 as projected by National Transmission and Dispatch Company (NTDC) shown in Fig. 2. To meet the ever increasing energy demands RE resources could be an alternative to the traditional fossil fuels. Current energy mix either public or private Independent Power Producers (IPPs) is shown in Table 1. Owing to its strategic location, Pakistan is abundant in RE resources.

A number of researchers estimated theoretical RE potential [4,6–11] available in the country and their utilization to harness the useful form of energy using various technologies. Most of them focused on solar energy [8,12]. Available technical potential for electricity generation from wind, biomass, solar and small hydro is assessed in [13]. Uddin [14] stated that 35.625 million kWh could be generated from the available biomass on daily base. Procedure for bioenergy potential estimation from biomass resource has been studied in [15]. Rehman [5] has studied bioenergy potential available in industrial hemp. Biomass potential for biogas generation and biogas to electricity generation technologies have been studied in detail in [16]. Bioenergy potential for Pakistan, Nepal, Malaysia and Iran has been studied in [15,17–19]. Chaudhry [20] and Bhutto [21] investigated the prospects and challenges to the RE technologies in Pakistan. In this paper operational RE projects and ongoing efforts to exploit the RE resources like solar, wind, micro hydro, biomass and biogas are the cynosure of discussion. Conclusion endeavors to answer how much electricity is being generated from the RE resources? How much electricity would be available in future energy mix from ongoing RE power projects? Along with that the role of RE organizations & institutions in promoting, developing, disseminating and implementing RE resources and technologies has also been focused in this paper.

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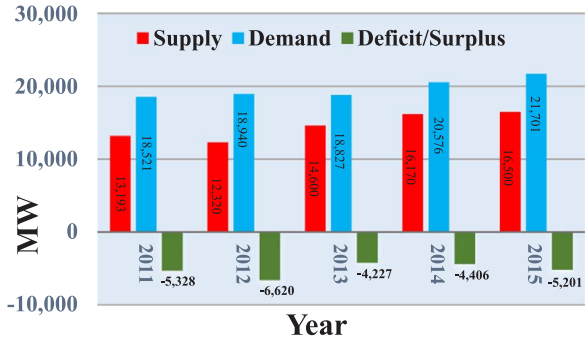

Fig. 1. Electricity demand and supply for 2011–2015.

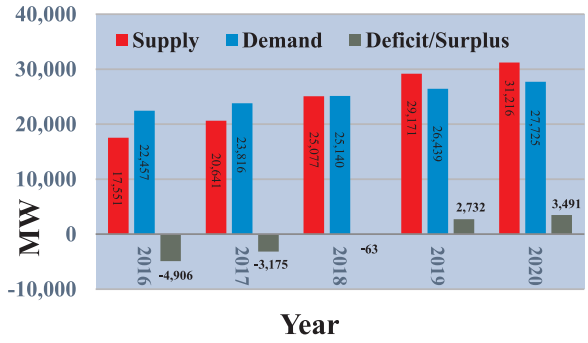

Fig. 2. Projected Electricity demand and supply for 2016–2020.

Table 1
Energy mix of Pakistan as on June 2015.

Source	MW	Percentage share
Gas (Public + IPPs)	7494	30.18
Oil (Public + IPPs)	9295	37.4
Coal (Public + IPPs)	25	0.001
Hydro (Public + IPPs)	7116	28.67
Wind (IPPs)	106	0.43
Nuclear (Public)	787	3.17
Total	**24,823**	**100**

Table 2
Weather stations in Pakistan.

Sr. no.	Weather station location
1	Quaid -e-Azam Solar Park (QASP), Bahawalpur
2	NUST Islamabad
3	KSK Campus UET Lahore, KSK
4	MNS Campus UET Lahore, Multan
5	UET Peshawar
6	NED University, Karachi
7	Mehran University, Jamshoro
8	BUITEMS, Quetta
9	BUET, Khuzdar

In organization, Section 2 discusses the operational projects in the country to measure the real time meteorological wind and solar data. Operational and ongoing RE projects in solar, wind, biomass, biogas and hydro have been presented in Sections 3, 4, 5, 6 and 7 respectively. Section 8 is devoted to the organizations and institutions involved in R & D in RE fields. Section 9 concludes the study.

2. Measurement of meteorological data

Until now highly authentic data regarding solar irradiance is not available in the country. To initiate a solar project, solar maps and geospatial toolkit for Pakistan developed by National Renewable Energy Laboratory (NREL) under USAID program is relied upon. To collect real time highly accurate solar data in Pakistan, different locations have already been identified and among them at nine locations weather stations have been installed by Alternative Energy Development Board (AEDB) funded by World Bank under Energy Sector Management Assistance Program (ESMAP) as shown in Table 2. Once the two year data is collected highly accurate solar maps and atlases will be published by World Bank and would be available for government and commercial developers [22,23].

World Bank has issued a preliminary solar map DHI of Pakistan from 2000 to 2012 in kWh/m^2 as shown in Fig. 3(a). This map indicates a high solar potential in Sindh, Baluchistan and deserted areas of Punjab. If solar energy is properly handled and harnessed could be oil like source of energy for the sustainability of the national economy. Fig. 3(b) is a preliminary wind map based on analysis data and existing ground data.

3. Solar energy

3.1. Solar Photovoltaic Energy

To get solar energy introduced in the country, first on grid solar power plant of 178.08 kW was commissioned in 2010 at Pakistan Engineering Council (PEC) building and Planning Commission building. The project was successfully inaugurated in 2012 and the plant had net metering facility selling surplus energy to the power distribution company Islamabad Electric Supply Company (IESCO). The site of the project is shown in Fig. 4(a). Another example in this race is the 2 MW solar system installed on National Assembly (NA) of Pakistan which not only full fills its own needs of electricity but also dispatches the surplus energy to the national grid [24]. The site is depicted in Fig. 4(d). NA has become the world's first parliament to be on solar completely. National Electric Power Regulatory Authority (NEPRA), electricity price setting company, has announced a Feed in Tariff (FiT) to both of the projects. The success of the above stated projects have been established as an example to the energy investors and after that 28 solar power companies with 956.52 MW cumulative capacity obtained Letter of Intent (LoI) from AEDB and are at different project development stages. In fiscal year 2015-16 Quaid-e-Azam Solar Park (QASP) was operational with a capacity of 100 MW generated 25 GWh while 3 solar projects of 100 MW each with cumulative capacity of 300 MW are under construction in QASP after achieving financial closing [25,26]. Site view of the park is shown in Fig. 4(b). AEDB has given Letter of Support (LoS) to 7 IPPs of 72.52 MW cumulative capacity and now are in financial closing process. LoI has been obtained by 17 solar projects with cumulative capacity of 484 MW. The expected cumulative capacity of PV available to the grid in next two years is shown in Table 4 [22] (Table 3).

3.2. Solar thermal energy

To promote solar energy in the country, AEDB announced exemption from tax duty on import of various solar products after which import has been increased every year and in 2013 there were 14,981 solar water heaters imported and deployed all over the country while 1429 solar water pumping systems were imported and installed for drinking purposes and agriculture irrigation [27]. After 2013 many local companies started manufacturing solar water heaters and solar pumping systems. Solar water heaters are gaining popularity in northern high mountainous areas where the gas availability is limited and weather is mostly cold. Currently more than 5000 solar cookers are being used in the country which is much less than India (14,500) and China (60,000). But with the successful operation of solar cookers different energy related NGOs in the country also showed interest and distributed solar cookers in rural areas. Such cookers well operate in sunny days from 9:00 a.m. to 3:00 p.m. throughout the year. Pakistan