Renewable Energy in Pakistan: Status and Trends

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ABSTRACT

Energy consumption in Pakistan is mainly dependent on conventional fuels that are usually imported and each increase in the oil prices in the international market results in a proportional increase in fuel prices in the country. This situation along with the concerns over the rapid depletion of country's natural gas reserves has raised very serious concerns on availability of energy and its security. As of 2003 there was no use of renewable energy in the country and the Government having realized that created an autonomous Alternative Energy Development Board (AEDB).

This Board has been created to coordinate, facilitate and promote Alternative / Renewable Energy technologies so as to achieve 5% share of power generation through renewable energies by year 2030. This article provides an overview of the potential of various renewable energy sources , various developments project undertaken by the Government of Pakistan and its mid term and long term plan.

KEYWORDS

Sustainability, Renewable Energy, Solar Energy, Wind Power, Photovoltaic

AN OVERVIEW OF ENERGY EQUATION OF PAKISTAN

Availability of energy in any country has a strong relationship with its economic and social stability. The per capita energy consumption is an index used to measure the prosperity of any society. Pakistan is basically an energy deficient country. Pakistan's per capita energy consumption, 3894 kWh as against the world average of 17620 kWh, gives it a ranking of 100 amongst the nations of the world [5, 6]. An analysis of Pakistan's energy supply market indicates that the country is a net importer of energy.

Pakistan's internal oil production meets approximately one sixth of the country's current oil requirements. Almost one third of the country's total energy requirements are met through imports. Historically, the country has been dependent on oil imports. The crude oil import cost for the year 2004-05 was USD 4.1 Billion. The total annual import bill for the year 2004-05 accounted for 25 per cent of the total imports. Pakistan's primary energy supplies for the year 2004-05 amounted to 54.1 million tones of oil equivalent (TOE).

Pakistan's commercially exploitable energy resources consist of coal, gas, oil, hydel power, nuclear power and a large base of traditional fuels in the form of fuel wood, agricultural and animal wastes. The current energy supply matrix is a composite of various technologies. Oil and gas form the bulk of primary commercial energy supply mix of Pakistan, contributing 75.3% (oil: 23.3%, gas: 51.6%, LPG: 0.4 %,) as shown in Figure. 1. The other sources include; coal: 6.2%, hydro electricity: 11.3% and nuclear electricity: 1.2% [7].

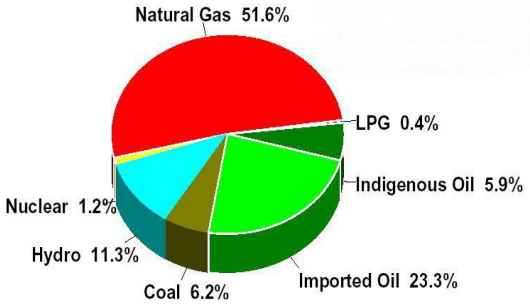


Figure 1. An overview of primary energy market for Pakistan, 2004-05

RENEWABLE ENERGY PROSPECTS IN PAKISTAN

Solar Energy

Pakistan being in the Sunny Belt and is lucky to have long sunshine hours and high insolation levels and is ideally located to take advantage of solar energy technologies as shown in Fig. 2. 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 m2 per day. This amounts to about 1500-3000 sun shine hours and 1.9 - 2.3 MWh per m2 per year. Balochistan province is particularly rich in solar energy. It has an average daily global insulation of 19 to 20 MJ/m2 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. For daily global radiation up to 23MJ/m2, 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 freely available 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. Harnessing the sun's power is considered an attractive alternative because it is a renewable resource, which causes no pollution. In contrast to conventional fuels, its use eliminates the need for refining, transporting and conveying fuels and power over long distances. The use of solar energy for heating and cooking promises a more repaid pay off than other energy alternatives because the basic technology already exists and need only minor refinements.

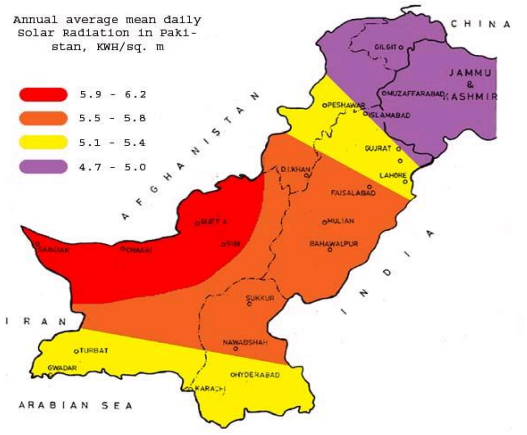


Figure 2. Solar Radiation map of Pakistan

Solar technology is being used in Pakistan for stand alone rural telephone exchanges, repeater stations, highway emergency telephones, cathodic protection, refrigeration for vaccine and medicines in the hospitals etc. The Public Health Department has installed about 20 solar water pumps for drinking purposes in different parts of Balochistan. Both the private and public sectors are playing their roles in the popularization and up-grading of photovoltaic activities in the country. A number of companies are not only involved in trading photovoltaic products and appliances but also manufacturing different components of PV systems. They are selling PV modules, batteries, regulators, invertors, as well as practical low power gadgets for load shedding such as photovoltaic lamps, battery chargers, garden lights etc. Recently, a commercial scale solar cell manufacturing facility has also been set up by private sector

The provinces of Sindh and Balochistan are ideal for utilization of solar energy. In Balochistan, 77% of the population is living in the rural areas. 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 approach roads. Transmission lines are very expensive in this area and there is no chance of grid connection in the near future.

In remote area, houses are mostly `kacha hut type' and light is their only requirement. Most of the houses consist of one room only. The electric requirement for each house varies from 50 watt to 100 watt maximum. Solar energy is the only and best solution for these areas. 100 solar homes project has been completed in nine villages in all four provinces and now 26,000 houses are being electrified in Balochistan and Sindh provinces.

Wind Energy

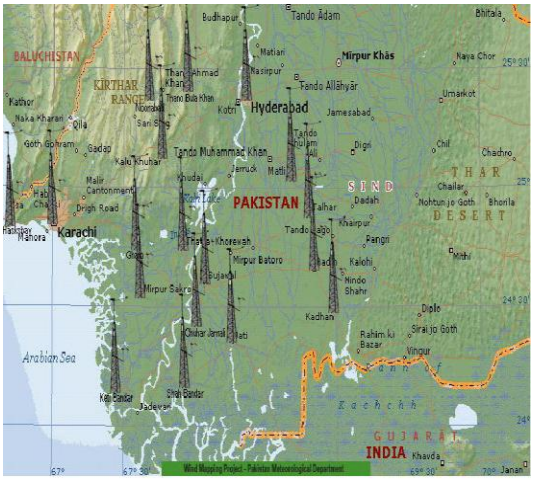


Figure 3:Wind Mapping Stations in Sindh.

Pakistan has a considerable potential of wind energy in the coastal belt of Sindh, Balochistan and as well as in the desert areas of Punjab and

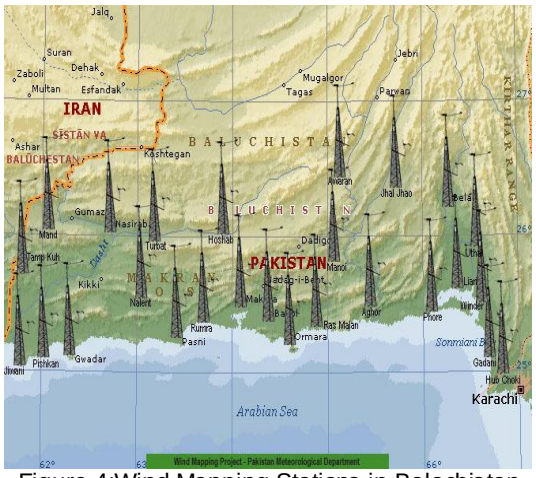


Figure 4:Wind Mapping Stations in Balochistan

Sindh. This renewable source of energy has however, not so far been utilized significantly. The Wind Data of all Pakistan has been collected from Pakistan Metrological Department and analyzed by AEDB. As per the collected data, the coastal belt of Pakistan is blessed with a God gifted wind corridor that is 60 km wide (Gharo ~ Kati Bandar) and 180 km long (up to Hyderabad). This corridor has the exploitable potential of ***50,000 MW*** of electricity generation through wind energy. In addition to that there have been some other wind sites have been exploited in coastal area of Balochistan and some Northern areas. Most of the remote villages in the south can be electrified through micro wind turbines. It is estimated that more than ***5000*** villages can be electrified through wind energy in Sindh, Balochistan and Northern areas.

With the efforts of AEDB, aggressive lobbying for investment has been done with national and international investors to make them realize the potentials of renewables particularly the wind energy. Working papers with national and international companies have been signed. Till date, 34 LOIs have been issued for 1700 MW wind power generation projects. About seven companies have already applied for the generation licenses of 50 MW each through wind energy. Also, for the indigenous production of various components of wind turbines in Pakistan Wind Turbine Manufacturing Consortium (WTMC) has been formed. The Board is negotiating with international companies to start micro wind turbine manufacturing and manufacturing of parts of large wind turbines in this consortium. So far, large wind turbines for power generation have not been installed in Pakistan. However, about 30 wind mills for pumping water have been installed for experimental purposes in different parts of Sindh and Balochistan. In addition to the development activities in wind energy field for on grid electricity production, the wind energy is also being used for the electrification of remote off grid villages in the southern coastal areas of Pakistan. So far more than 18 villages have been electrified using micro wind turbines. Indigenous development of micro wind turbines has also commenced in Pakistan.

Hydropower

The Northern part of the country is rich in hydro power resources. Other than big (capacity greater than 1MW) hydro power plants, there are 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 isolated in thin clusters and is located far from physical infrastructure. Such remote population can get great benefit from such energy sources. Besides, there is an immense potential for exploiting water falls in the canal network particularly in Punjab, where low head high discharge exists on many canals. Besides, there is an immense potential for exploiting water falls in the canal network particularly in Punjab, where low head high discharge exists on many canals. There have been located more than ***300 sites*** which have nearly ***350 MW*** power potential.

Pakistan has signed MOU with Turbo Institute of Slovenia for the transfer of know-how for making micro hydro turbines. In addition to that they are willing to transfer know-how for the refurbishment of bigger hydro power plants. Pakistan also has commenced development of Micro Hydro Kaplan Turbine in local industry for beneficial utilization of available low head in the canal system of the Pakistan. A total of 228 "run of river type" plants with total capacity of 3MW have so far been installed in the North Western Frontier region. 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.

Biomass

Biomass consist of growing plants or the remains of growing things, it includes trees, grasses, crops, agro residues aquatics plants, animal manure, etc. As sun is the source of wood and all other biomass, wood conforms to be a renewable

source of energy, which will be available as long as the sun shines.

Biogas, one of the most significant types of biomass energy, makes optimal utilization of the valuable natural resource of dung. It provides (soot-free) clean gas for meeting cooking and energy needs as well as enriched bio-fertilizer for improvement of fertility/ productivity of agricultural lands. Promotion of the biogas technology seems to be one of the best options, which cannot only partially offset the fossil fuel from wood consumption but also facilitates recycling of agro-animal residues as a bio-fertilizer. Moreover, being clean and renewable, it will also contribute towards environment protection, sustenance of ecosystem and conservation of biodiversity.

As per livestock census 2002-03, there are 48 million of animals (Buffaloes, Cows, Bullocks) in Pakistan. The average (daily dung dropping) of these animals @ 15Kg comes to be 690 million Kg. Assuming 50% collect-ability, 17.25 Million cubic meter of biogas can be daily produced by anaerobic fermentation of dung through installation of about **5.0 million family size biogas plants,** which could meet the cooking need of 50 million people. Doing this we can meet about 50% cooking requirements of the rural masses from this source of energy (biogas) alone. Besides, producing 96.6 million Kg of bio-fertilizer per day or 35.04 million tons of bio-fertilizer per year, which is an essential requirement for sustaining the fertility of agricultural lands.

The Government of Pakistan started a comprehensive biogas scheme in 1974 to beneficially utilize the available bio-gas generation potential and commissioned 4,137 biogas units by 1987 throughout the country. The units were designed to provide 3,000 and 5,000 cubic feet of biogas per day for cooking and lighting purposes. This program was developed in three phases.

During the first phase, 100 demonstration units were installed under grant by the Government. During the second phase, the cost of the biogas was shared between the beneficiaries and the Government. Later on for third phase, the government withdrew the financial support, although technical support continued to be provided free of cost. Unfortunately, after the withdrawal of the government financial support, the project did not progress any further till 1990. Pakistan again initiated working and development in this field and has installed nearly 1700 biogas plants remote areas through out in the country. These plants are successfully running and catering to cooking requirements of the villagers.

POLICY, PLANNING AND STRATEGY

This Board has formulated the policy for Alternative / Renewable Energy and has gathered comments on policy from all the stakeholders. The policy initiative for the development of RE technologies is directed towards creating, to the extent possible, a market based environment in which a level playing field is available to the introduction of this technology to meet the energy needs of the country. Apart from development of RE generation facilities, the emphasis is also on transfer of technology and research and development. All possible financial and fiscal incentives are provided for the promotion of these activities. The revised draft Ordinance / Act has been forwarded to the Cabinet Division after incorporating comments given by the entire stakeholders.

Wind

Short Term Plan (2005-2010)

The short term plan is to develop 880 MW by year 2010 from wind energy for national grid with out any investment from GOP. Only guaranteed Power Purchase Agreement (PPA) is required from KESC / WAPDA. The negotiations in this regard have already been initiated with both the utility companies. The Short Term Wind Power Installation Plan along with the identification of sites is given below in **Table 1**:

Table 1
Short term wind power installation plan 2005-2010 (MW)

Year	2006	2007	2008	2009	2010
Gharo	100				
		150			
			150		
				200	
					100
Cumulative (MW)	**100**	**250**	**400**	**600**	**700**

Medium Term Plan (2011 - 2020)

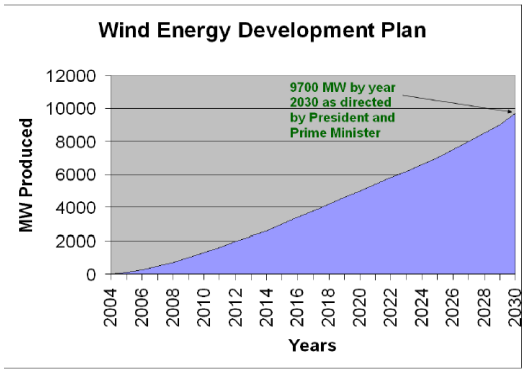
Keeping in view the current growth of wind energy in the world and also the interest of the international companies and investors to-date (Unsolicited proposals from GE ~400 MW; Access Energy America ~1000 MW, Vestas Denmark ~300 MW, Tenaga Group Malaysia ~500 MW, Tapal Energy ~250 MW),the Medium Term Plan to develop approximately 3000 MW by year 2020 is given below in Table 2:

Table 2
Medium term wind energy development plan 2011-2020

Year	Generation Plan (MW)	Cumulative of wind Energy in Pakistan
2011	200	700 (by 2010) + 200 = 900 MW
2012	200	1100 MW
2013	150	1250 MW
2014	200	1450 MW
2015	250	1700 MW
2016	250	1950 MW
2017	400	2350 MW
2018	400	2750 MW
2019	500	3250 MW
2020	500	3850 MW

Long Term Vision (upto 2020)

The high growth is expected and long term vision with minimum and maximum targets is as follows:



R & D Projects in Renewable Energy

AEDB has initiated different demonstration projects of alternative energy technologies with the help of private entrepreneurs. Some universities have also been engaged in research work in this field. These projects include research and development of renewable energy technologies like fuel cells, bio-diesel, fuel-ethanol, innovative lighting systems, fuel cell vehicles, bio gas etc. Several pilot projects have been completed in this regard. Research on fuel cells has been initiated with the involvement universities. Research in the field of bio-diesel has also been initiated and plantation of plants identified for extraction of bio-diesel is in progress.

In spite of the fact that recognition of the importance of these energy technologies exists in government circles, the country is not in a position financially to provide grants for these activities. So the support of international funding agencies is essential at this stage to help promote wider use of these technologies in the country by sponsoring the above research projects. These projects, if implemented, will not only 11 generate the market to boost the industrial and commercial activities, but also act as centers for education, training and dissemination of technology.

CONCLUSION

Government of Pakistan to coordinate, facilitate and promote Alternative / Renewable Energy technologies so as to achieve 5% share of power generation through renewable energies by year 2030. The Board has been engaged in initiation of pilot projects in alternative energy fields for demonstration of off-grid as well as on-grid transmission of power generated through these projects to the end users. In order to promptly develop renewable energy technologies in the country the Board has planned to attract private investors to invest in this field. Due to the expeditious efforts of the Board, large investments have been attracted through international companies. These companies are planning to initiate numerous projects in renewable energy field.

For indigenization of these technologies, the Board is promoting local industry to manufacture equipments related to renewable energies in the country. All investment in wind farms, micro wind and hydel turbine manufacturing and solar cells manufacturing is being made in private sector.

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