Alternate Energy Resources for Pakistan: Sustainable Solutions for Fulfilling Energy Requirements

Mustafa Shakir, Izhar-ul-Haq, Mahmood Ashraf Khan, Shahzad A. Malik and Shahid A. Khan

Department of Electrical Engineering, COMSATS Institute of Information Technology, Islamabad, Pakistan

Abstract: Pakistan has been facing the problem of energy shortages and the problem has deteriorated under successive governments. A burning need of the hour is to devise proper strategy for utilizing the available resources and making Pakistan self-sufficient in energy requirements. Different segments of the society have discussed on the feasible issues and convergence of ideas to work on a joint mechanism with active involvement and support from the government along with guidance from scientists and academia is the way forward to derive a long term sustainable solution. Alternate energy resources have to be introduced at domestic and commercial level thus promoting viable energy efficient solution across the country. Roughly the requirement is around 6000 MW which has to be added to the national grid. With the blatant needs of energy, Pakistan has the right to exercise the use of nuclear energy for meeting its demands and keeping the civil nuclear agreements going on in the world. Many energy sources are environmental friendly, they provide an alternate safe source helping to keep pollution within certain levels as required by the world standards. Coastal areas of Pakistan are a huge resource for utilizing wind energy potential to its maximal level. Pakistan has the potential to generate 3 million megawatts electricity through solar energy. The need of the hour is to build small scale hydro dams in Pakistan since other power generation sources are difficult to be implemented in remote areas. We would explore the available resources for maximal benefit and utilization.

Key words: Alternate Energy • Geothermal • Hydal • Nuclear • Renewable Energy • Solar • Wind

INTRODUCTION

Renewable energy and alternative energy are the energies produced from natural resources such as sunlight, wind, geothermal heat which are naturally renewable as they can be replaced and reproduced naturally. Pakistan has at different levels initiated steps to calculate the required energy and maximum potential generation capacity from abundant resources, the costs associated with these options and whether every available energy option generates pollution which should fall below tolerable level and analyzing all the hindering factors which could slow the development and implementation plan as all these phases are intertwined and related (Figure 1).

Some environmental groups are opposed to the idea that nuclear energy is renewable because it produces pollutants and the process of extracting uranium is also involved. But countries having nuclear industry support

Corresponding Author: Mustafa Shakir, Department of Electrical Engineering, COMSATS Institute of Information Technology, Islamabad, Pakistan.
it as renewable source since it does not produce greenhouse gases. Exploring nuclear energy to fulfill the needs of the sector is also a considered option. Pakistan has 30 years of running and maintaining nuclear reactors. The initial costs are related to installation but afterwards it is cost efficient to keep them running at maximum capacity. Nuclear plants have long life and requirements for uranium are also optimum. The use of nuclear energy would also be helpful in lowering carbon emissions. China has planned to build 30 new plants thus contributing 300 GW of power against its requirement which is an impressive development. Pakistan can reduce its dependence on foreign energy sources by developing nuclear resources. The target set by Atomic Energy Commission is production of 8000 MW power by 2020. There are abundant uranium deposits in Pakistan able to be refined by centrifugal method at bearable costs. According to estimations Pakistan is able to generate 50000 MW from nuclear reactors.

The lowest cost options available are coal and hydro. Pakistan has adequate generating capacity from hydro and coal resources. Climatic changes are also a problem and using coal and gas resources one has to keep the potential effect of increased pollution levels on the environment of Pakistan and the world in general. Pakistan can produce 45000 MW from Hydro power. Water generated power energy fulfills 20 percent requirements of the world. At times of lower than normal usage requirements, excess electrical capacity can be used for storage of electricity for later usage. The three gorges dam project in China is an important example of hydroelectric power generation and its 26 generators supported by system of dams can generate around 20 gigawatts of power Pakistan’s energy crisis has increased due to increased energy demand, large population and industrial growth. The country has to properly utilize its available reserves of Thar coal which exceed the oil reserves of Saudi Arabia and Iran. Similarly the hydal power should be utilized according to the proper potential of generation up to 45000 MW. The prevalent energy crisis has severely affected the economy and state affairs and earliest possible steps at the right time can be a springboard for this resource rich country. Many thermal plants use oil as fuel which is costly and not environment friendly as well. So the government is focusing on means to time efficient solutions for sustainable development and the alternative energy development board is facilitating the renewable energy projects throughout Pakistan.

Until recently the primary sources of Pakistan’s electricity generation were through hydro, oil/diesel generation and natural gas and the percentage generation of each has been shown in Figure 2. Natural gas contributed about 50 percent, hydro around 30 percent, oil/diesel around 16 percent and nuclear power contributed around 4 percent of the generation capacity. Coal and other renewable energy resources contributed almost negligible share of the generation capacity.

Nuclear Power Generation: Pakistan’s nuclear power plants Chashma 1, Chashma 2 and Kanupp can generate 300 MW, 350 MW and 125 MW of power approximately. For baseload generation nuclear and hydro resources are generally used. In coming years nuclear generation is expected to increase at a steady growth rate. To meet the high level requirements Pakistan has to access advanced nuclear supplies from western countries. Effective governance and cooperation between important important sectors is vital for nuclear development and infrastructure.

Natural Reserves in Sindh and Balochistan: Clean coal are also of vital importance for energy generation as Pakistan has 185 billion tons of coal reserves and this huge resource has to be put to use properly. In Sindh the coal reserves are as high as 850 trillion cubic feet. There are huge oil and gas reserves in the barren land of Balochistan. Natural gas in Balochistan could also be used for generating power and it would serve a good contribution to solve load shedding prevalent in the country. Without any proper strategy and vision we are
reduced to putting huge gas reserves only for domestic benefit. Thar coal is one of the huge assets having potential to overcome power crisis. It is adequate to provide required power for the country for next 100 years. Proper mechanism to extract coals is need of the hour as the country has to maximize the efficiency of gaining economic and social benefits from its existing coal reserves.

**Geo Thermal Power:** 100000 Megawatts of electricity can be generated through geo thermal power [1].Geothermal energy is extracted from sun heat and this energy is present in earth due to the constituent materials, minerals and absorption of sunlight. USA has the largest geothermal power plant in California. The initial cost of setting up geothermal power plants is high but it is cost effective due to no running cost of fuel etc. Heat from the earth flows to the upper layer of earth. The geothermal energy is due to decay of materials and is present in the upper layer of earth as well which absorbs large amounts of sunlight in summer [2].

**E thanol Technology:** Ethanol Technology can also be used to contribute for solving power crisis. One ton of household could be able to produce 2MW power and 83 litres ethanol. In Pakistan the production rate is 55000 tons/day waste and 23 million litres ethanol. There are 90 sugar mills in the country able to be put to use in overcoming energy crisis [3].

**Solar Energy Potential:** Solar energy is also viable alternative as Pakistan has potential of generating 3 million MW electricity from the sun. The market situation is that only private vendors are importing solar panels and contributing their role for making this mode more common. Pakistan has made another stride by inaugurating the solar power grid power plant in Islamabad through a project financed by Japan International Cooperation Agency under cool earth partnership. Under this project photovoltaic solar systems of 356.16 kW overall have been installed at premises of Planning Commission and Pakistan Engineering Council (PEC) and these systems would provide adequate electricity for both buildings. The extra electricity can be sold to Islamabad Electric Supply Company (IESCO) [4].Also there have been developments regarding solar power plant in Bahawalpur having capacity of 50 MW. Solar alternate has the advantage of being environmental friendly and safe option compared to oil, gas and coal which pose environmental hazards as well as being costly. With average of 8-9 hours of sunshine and annual insulation values of more than 1700 kilowatt hours per square meter, Pakistan’s climate is ideal for this mode to be implemented [5].

An advantage of solar technology is that in addition to having low cost it can be expanded in different stages. Initially the productivity might be low but with step wise implementation of further plants there is room to add and develop the generating capacity of solar farms.

**Prospects of Wind Power Generation:** Pakistan can produce up to 50000 MW of power through wind and till now it is still to be properly introduced to have maximum utilization. The Government has defined a target that at least five percent of total national power generation capacity (i.e. 9700 MW) would be produced through renewable energy resources like wind energy by the year 2030. Pakistan has extensive coastal area of about 1100 kilometers having windy environment throughout the year so wind power can be produced throughout the year. Wind power plants are being set up in Jhimbir, Gharo, Keti Bandar and Bin Qasim in Sindh. The Gharo Jhampir Keti Bandar Wind Corridor, which extends to 60 Km along the coastline of Sindh Province and more than 170 Km deep into the hinterland alone has a potential to generate over 60,000 MW of electricity. In 2008 a Turkish company helped Pakistan to complete first windmill and through five wind turbines upto 6 MW of electricity would be produced. The project would be expected to deliver 56 MW by the end of 2012 and is being completed by the company called Zorlu Enerji which would further invest in wind power to generate 200 MW [6].

**Hyd al Power Generation:** Through hydro resources Pakistan can generate 45000 MW. Kalabagh dam if constructed can generate upto 4000 KW and Bhasha dam can generate upto 4500 MW. Pakistan is also resource rich in terms of hydral power but till now fifteen percent of hydro power is being utilized. Tarbella dam has generating capacity of 3478 MW, Ghazi Barotha 1450 MW, Mangla dam 1000MW, Warsak dam 243 MW and Chashma Dam 184 MW.Power station located at Azad Kashmir is expected to have capacity of 969 MW and the project was started in 2008.The Neelum Jhelum Hydropower plant is also run-of-the-river hydroelectric power scheme which will divert water from Neelum River to power station of Jhelum river [7].
Fig. 3: Zorlu Wind Farm in Jhimpir, Sindh.

The alternative energy development board (AEDB) is also working with Aga Khan Rural Support Programme (AKRSP) to install 103 Mini/micro hydro power plants at Chitral and Gilgit Baltistan [8].

Gilgit Baltistan has adequate resources and potential generation capacities of Diamir Basha Dam and Bunji are 4500 MW and 5400 MW respectively. The potential capacity of this area is up to 31000 MW [8]. A large number of micro power stations have been set up in the area. The generation capacity of hydroelectric power stations is severely affected due to lesser flow in the winters which gives rise to acute shortage of power. Some diesel power generators can be used to supplement the low hydral generation but this comes at higher costs due to diesel transportations from Karachi to Gilgit. Thus hydral power generation is a significant source of power generation and viewed as viable solution in overcoming Pakistan’s energy crisis.

Pakistan should attain self-sufficiency in its development plans regarding generation of power along with keeping international standards and requirements in mind regarding climate change. It is a fact that only renewable technologies would not be able to fulfill the demands of energy deprived country but it can certainly contribute to less dependence on imported fuels. The impact on national economy would be positive. There are also efforts to increase nuclear power generation. Since Pakistan has experience of maintaining nuclear plants so it is a better method of being self-reliant and secure rather than depending on imports from nations with which have fluctuating relations. Pakistan has also called for access to equipment from nations having nuclear installations and facilities for progression in the economic prospects. The carbon levels emitted are lesser compared to other power generation means.

**Advantages in Adopting Alternate Energy Resources:**

The energy demands of Pakistan are expected to increase many fold in the coming decades. So coordinated work between relevant companies to assign the target expected to be accomplished from various sources like wind, solar, hydral power by maintaining the database and requirements in terms of equipment dealers and contractors is necessary as energy requirements would surge to 100,000 MW by year 2030.

Fig. 5: Energy demands (MW) year wise
The alternate energy sector would help in attaining greater self-reliance for smaller companies and promotes a competitive environment for developing energy efficient tools and mechanisms. Keeping the danger levels of pollution in mind, alternate energy resources enhance efficiency of saving nature and contributing a healthier environment.

The designing of energy efficient devices is coming up as a novel area to provide sustainable fuel systems for the future and in this regard many job opportunities are mushrooming along with the positive impacts on the economy. The manufacture of renewable energy equipment is developing in Pakistan and providing a growth environment for scientists and engineers of local base and pleasant environment for overseas companies to invest in the country.

**Challenging Factors for Adoption of Alternate Energy in Pakistan:** To implement the alternate energy options effectively we have to consider many things mobility of the masses and this can be achieved by constantly occurring campaigns from the media. Public participation is necessary at every level and the nation has to find the solutions in least possible time. This can be ensured by discussions at every platform and providing maximum information to public circles about setting up of renewable energy plants in order to encourage the use of sources like solar energy at household level. The renewable energy industry is expensive due to large funding requirements for its development. Pakistan has to devise effective strategy for affordable and sustainable development to provide a proper growth environment to the industry. The need for highly skilled manpower is also urgent which can be catered through research and development projects at academic and industrial level. The universities have to provide maximum scope for improving the performance of energy sector and by introducing new areas to students, researchers who would at a later stage become a changing factor for the prevailing situation of energy crisis. Training sessions and joint efforts of industry and universities would be helpful to hunt and troubleshoot problems thus approaching towards long ranging solutions. For the renewable technologies to last we should have self-sufficient local industry in order to have low cost available products and thus maintenance costs would also be optimized. The government has to create a consumer friendly environment and encourage the market forces by implementing minimum taxes on the renewable energy products. The implementation plane has to be executed phase wise with clear sense to achieve targets so that maximum utilization of alternate energy resources can be achieved.

**CONCLUSIONS**

Pakistan is trying to improve the nuclear power generation which is also seen as relatively environment friendly and effective step to fulfill the requirements of the nation. Nuclear energy would be also a source of self-dependence and stability for Pakistan in the times when relations with other nations are turbulent. Nuclear equipment to be procured from western nations is also the right of Pakistan now when India has entered into pacts with the U.S over the use of safe civil nuclear energy. Pakistan would be able to meet its electricity needs by 2030 if nuclear power plants are developed properly. Installing power factors to improve efficiency can also lead to less usage of electricity and saving energy. Pakistan is resource rich in solar power and with plentiful sunshine throughout the year this is also a viable alternative energy mode to be explored and implemented. There are huge aspects of wind power generation at extensive coastal areas of Pakistan. Hydial power generation is a significant source of power generation and viewed as viable solution in overcoming Pakistan’s energy crisis in the years to come.

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**Glossary:**
PPEC Pakistan Engineering Council
IESCO Islamabad Electric Supply Company
WAPDA Water Resources and Power Development Authority
AEDB Alternative Energy Development Board

**REFERENCES**


