

Current Energy Crisis of Pakistan: Status, Impact and Potential Solutions

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Abstract— Energy plays an essential role in the development and economic growth of a country. A balanced energy sector leads to social development and political stability. An efficient use of available resources as well as harnessing of environmentally friendly new resources is imperative for sustainable energy development and economic stability. Alternative and clean energy resources are required to meet electricity demand and to fight against the adverse environmental problems.

This research is carried out to analyze the current energy scenario of Pakistan and to identify potential solutions. Pakistan has a vast potential of renewable energy that could be utilized to overcome the energy shortage. However, unfortunately, due to lack of proper energy policies and infrastructure, this vast potential remains underutilized. Discontinuity and reversal of various national energy policies has also compounded the problem.

In power sector, increased generation costs due to increased dependence on thermal generation and high line losses have resulted into increased tariffs for the consumers. This, in turn, has increased the circular debt in the energy sector. Disagreement between various provinces on construction of large dams as well as water distribution disputes with India, are key factors that have reduced the share of cheap hydropower in the national grid.

The establishment of a strong energy sector utilizing indigenous energy resources is must for a prosperous Pakistan as economic growth and energy availability are interlinked. Energy Intensity, Energy Diversity, Energy Import Dependence, and Energy Transportation determine energy security. The paper analyzes current energy crisis of Pakistan in the light of above mentioned energy security parameters and explores the potential of renewable energy resources as a worthwhile alternative to fossil fuels. The analysis is based on realistic data collected from various authentic sources.

Index Terms— Pakistan, Energy Crisis, Renewable energy sources, Economy.

I. INTRODUCTION

ENERGY is lifeblood of economy. Today, the top most challenge is how to maintain a sustainable economy without destroying natural resources. Energy plays a vital role in providing fundamental community. It helps in providing fundamental community services. Balance energy sector ensures Social stability, Economic growth as well as political stability. Energy resources are depleting due to rapid population growth. Furthermore, current human lifestyle has severely affected ecosystem. Renewable and green energy resources are

required to meet power demand and protecting environment from degradation as well as it is a valid option to have a sustainable energy sector.

Pakistan is facing energy crisis from past two decades, there is big gap in energy supply and demand, which is increasing day by day. Like developed countries Pakistan is far behind and this shortage of electricity is serious matter, since it has severe outcomes as far as national security and integrity is concerned. The people distraught with state of the society as well as their own life are an easy prey/ may fall in hands of anti-state elements and involve in disruptive activities - Menace of terrorism.

In order to overcome the energy shortage in any country the major step is to diversify energy resources. [1]Pakistan is located in a region of great geostrategic importance. Solar isolation is high in this region. Solar irradiance in Baluchistan and Northern Sindh is enough to generate electricity in off-grids areas. Additionally solar energy can also be used for other applications. [2, 5] Pakistan's energy sector is highly dependent on fossil fuels but at the same time, Pakistan has limited resources of oil and fossils fuels. To meet energy demand Pakistan imports fuel, this import of fuel is ultimately causing and continuous increase in debt. [3]To combat energy demand as well as to protect environment from degradation, renewable energy system and alternative resources are required for energy generation. Pakistan possesses huge renewable energy potential. Hydel potential is estimated to be over 60,000 MW whereas wind power potential is 50,000 MW just in the south of Pakistan. Moreover, solar irradiance in Baluchistan and Northern areas is estimated to be 7-7.5kWh/m², which is enough to generate electricity for domestic purpose [4-8].

Energy shortfall has affected a number of people as urban areas are facing load shedding of around 11-12h while this shortfall increases by 4-6h in rural areas [9]. This critical situation of power sector and energy demand-supply gap has triggered the need to identify the actual cause behind this shortfall [10] Many research are busy in identifying the cause and searching for best suitable solutions for the problem. Studies have analyzed the shortcomings in reforms and inadequacies in policymaking and technical aspects [11, 12].

As mentioned above shortage of electricity has severely hampered the economic development of Pakistan and has made the life of a large chunk of population miserable. Life without electricity can be understood by imagining:

- Load shedding in industries, reduced working hours/ lying off employs.
- Inaccessibility of water for irrigating lands from ground water through tube wells due to long hours of load shedding.
- As Pakistan is an agro economic state this is one of the major reasons behind unsustainable economy. This ever-growing crisis has forced people traditionally associated with agriculture to leave their parental occupation and look for jobs in other sectors.

This research is part of a research on renewable energy system protection. It is carried out to highlight the performance of Pakistan's energy sector until date and to get an overview that where we stand today and what do us actually need. In other words, this research is carried out to create awareness among people about renewable energy and its benefits concerned with energy sector as well as environment. The energy gap scenario in 2018. The fact that in spite of available generation capacity why we are unable to meet demand? An overview of reforms made in organizational structure as well as in energy policies is also presented. The paper focuses on analyzing potential solutions for current energy crisis of Pakistan. The purpose of this research is to find out the reasons behind the current energy shortfall and the potential of renewable energy resources as a worthwhile alternative to existing energy scenario.

The recent improvements in energy sector of Pakistan in order to overcome the energy shortage have been discussed. This paper has been divided into different sections. In Section I present an introduction to the problem under consideration. In Section II background details about the energy scenario and power sector, increasing energy cost and addition in capacity. Steps taken to modify the organization setup and infrastructural reforms in power sector are discussed in Section III. A quick overview of Pakistan's energy policies is presented in Section IV. Section V describes the summary of power generation and nature of energy crisis and potential solutions to attain sustainable power sector. In Section VI conclusion is presented while Section VII & VIII are dedicated for acknowledgement and references.

II. CURRENT ELECTRIC POWER STATUS OF PAKISTAN

A. Country Profile

Islamic republic of Pakistan enjoys an interesting position of geo-strategic significance. It is situated between the latitudes 24.50° and 36.75° North and longitudes 61° to 75.5° East. Pakistan is 36th largest country in the world. The total area of Pakistan including FATA and FANA is approximately 803950 square km (land 778,720 km² & water 25,220 km²). It has five provinces namely Baluchistan, Gilgit Baltistan, Khyber Pukhtoon Kha, Punjab and Sindh. Pakistan is bordered by Afghanistan on the northwest, China on the northeast, India on the east, Iran on the west and Arabian Sea on the south. As far as climate is concerned, Pakistan has four seasons; winter, spring, summer, autumn. This overview of Pakistan's geographical significance clearly indicates that this country can lead to a better land by properly managing its resources.

B. Background of Pakistan's Power sector

As mentioned above economy and development of an agro economic state is directly linked with electricity. In Pakistan primary energy resources are present in abundance, however with rapidly increased population, of 207,774,520 as per results of 6th population & housing Census 2017 [8], and urbanization during last few decades has drastically effected the energy sector of Pakistan. Lack of planning is also one of the major issues. Prosperity of any country is measured by energy consumption per capita; when it comes to Pakistan per capita energy consumption is just 452 kWh, which is around 1/4 of world's average. At the time of independence, generation capability of Pakistan was just 60MW to serve the population of 31.5 million while 4.5 units was per capita consumption at that time. WAPDA was created in 1959 twelve years after independence leading power generation to increase by 59MW. This increase power generation lead country to enter the phase of development [9, 13].

Power development was a big task under WAPDA's consideration for executing hydel and thermal generation projects which could withstand rapidly increasing power demand. WAPDA had chosen a professional approach to find solution of diverse problems. An overview progress in energy sector of Pakistan during first five years after taking charge in 1964 is as below.

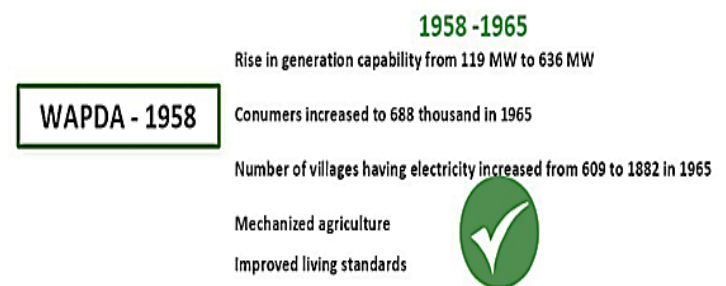


Fig. 1. WAPDA Progress First Five Years.

WAPDA played its role perfectly it would not be wrong to say that WAPDA had expertise in its tasks of accelerating power development, dealing mega hydel generation projects and installation of high voltage transmission networks. However, after 1990s, some difficulties were seen in management, lack of interest and negligence by government all resulted in supply demand deficit. As on May 27 2018, current demand of electricity is 22347 MW while generation available is 20500 MW, which clearly indicates that energy shortfall in country, has reached to 1847 MW [10]. Overage transmission and distribution lines and no up gradation until date has also caused increased losses. Political instability, infeasible policies, heavy reliance on subsidies and inefficient revenue collection all these factor summed up to huge power crisis.

C. Organization's Infrastructural reforms

WAPDA was developed in 1958, after this, an institutional development started in 1994, with the induction of Private Power and Infrastructure Board (PPIB). The purpose of PPIB was to promote as well as facilitate private sectors in starting

power projects. After PPIB, power sector regulator NEPRA was establishment in 1977 and this organization was made responsible to regulate the power sector by ensuring the smooth operations (Rauf et al., 2015). Followed by NEPRA, in 1998 NTDC was established with an objective to manage the electricity transmission among public as well as private sector. To lessen the burden of WAPDA and NTDC, PCRET and AEDB were developed in 2001 and 2005 respectively, to enhance pace to develop renewable energy mix in country. Similarly CPPA-G was developed in 2015 and in 2016 NEECA was developed. The motif behind establishing all these departments and change in organizational infrastructure was to promote renewable energy in the country. Major changes are shown in Fig. 2.

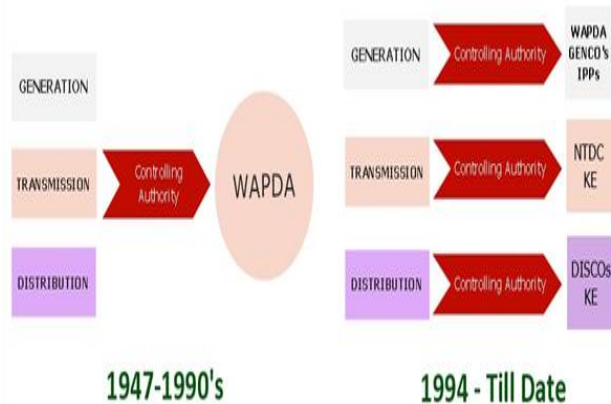


Fig. 2. Power Sector Infrastructural Reforms.

III. ENERGY POLICIES OF PAKISTAN

Government of Pakistan has devised, as a part of reform program, power policies in last two decades. Total five policies were introduced in years 1994, 1996, 1998, 2006, 2013 respectively. Although there is increase in power capacity but this is not enough to meet the requirements. Out of all the proposed policies, the power policy of 2013 is specifically aimed to eradicate the electricity shortfall alternative energy sources. Salient features of the power policies have been presented in following Fig. 3.

IV. SUMMARY OF INSTALLED GENERATING UNITS

There was insignificant impact of power sector development on sector of electricity generation. There was inefficient and insufficient addition in installed capacity and end result is inappropriate fuel mixing. Consequently, deficiency of increase in supply demand because high cost of generation. Given below is the table of summary regarding Installed Generating Units. It has been inferred that there is requirement of serious revolution in preexisting power sector for its electricity production, distribution and transportation sectors. Though, for escalation in respective sector, a different level of efforts required. The power sector review shows that over the period of last few years the performance of electricity generation and distribution has reduce greatly.

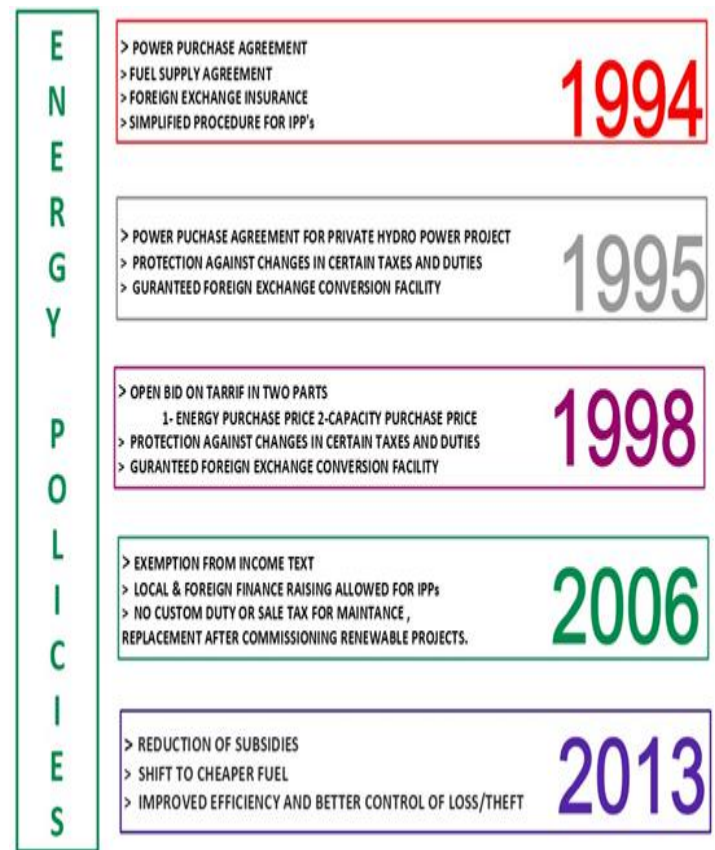


Fig. 3. Overview of Energy Policies of Pakistan.

In current scenario Pakistan need short term based energy projects to add units to national grid. As it's a known fact that Pakistan is blessed with great potential of renewable energy resources which may be utilized to eradicate the power deficit. Some renewable energy projects are under construction process and a combine data of all projects is given below:

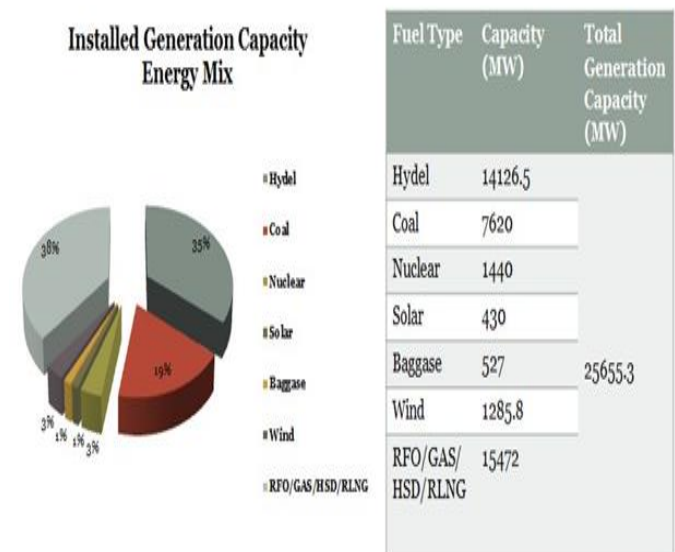


Fig. 4. Energy Mix - Current Capacity, Considering Fuel Type.

Hydel generation no doubt is a better and valid option to overcome the current situation but it can be seen in Figure 3 that

hydel power generation has drastically reduced in year 2018. The statistical analysis as shown in figure 5 clearly indicates that there is a deficit of 5000MW (approx.). Analysis is made over last five years i.e. 2013-18. while figure 6 presents the demand pattern comparison in year 2013 and 2018.

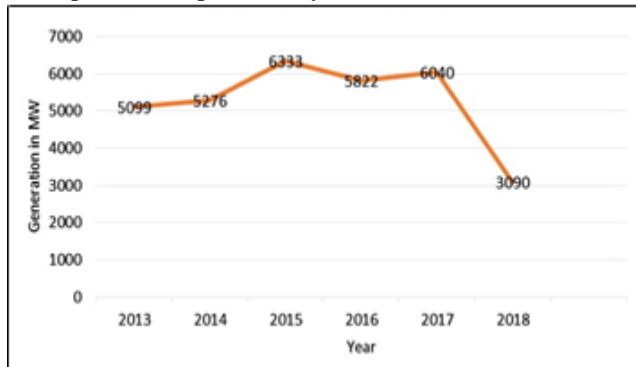


Fig. 4. Hydel Generation 2013-18.

V. NATURE OF ENERGY CRISIS OF PAKISTAN

Current energy crisis may be overcome to a great extent by doing away with the circular debt that will enable WAPDA to get electricity from IPPs as per demand. This is possible by reducing line losses via making transmission and distribution system efficient, reducing electricity theft through use of latest technologies, better management and by the help of law enforcing agencies which ensure the implementation of the power policies. Recovery from defaulters/consumers may be ensured by use of prepaid meters as well as with the help of local bodies.

Forced load shedding due to either lack of generation at peak load or due to over stressed transmission and distribution system. High electricity prices due to large thermal power content. Peak load is supplied from IPPs that mostly run on diesel or petrol causing burden on nation's economy.

Inability of IPP's to supply national grid because of non-recovery of dues as WAPDA is unable to handle it. Circular debt has reached to 500 billion (approx.). Large theft and huge line losses are the reasons that WAPDA is not able to recover full amount of power supplied to consumers. Additionally, WAPDA is also supplying 550 MW to K-Electric which is a private subsidy. Meanwhile up gradation in power network transmission and distribution lines is the need of our and to get rid of forced load shedding that is done to protect lines from over stressing.

Supply of electricity at cheap prices can be ensured by increasing share of hydel power in total power generation. Moreover, check on energy theft and recovery from utility defaulters may help the government to reduce the unit price

A. Potential challenges for the completion of proposed future generation

This research is carried out to provide an overview of reforms of power sector and historic performance of energy sector till date.

- It has been seen that infrastructural reforms and power policies were primarily introduced with anticipation of better power system but the aim remained unachieved as power sector crisis increasing rapidly due to number of reasons.

- A number of hydel projects are on hold because of lack of funds, dispute with India and internal politics. Taking into account current scenario small hydro power projects seem to be a good option.

- We need to shift our energy generation from thermal to hydel, wind and solar as thermal energy generation relies on oil, coal and fossil fuels. All these resources for thermal generation are depleting causing higher operating costs. On the other hand Nuclear, wind and solar energy generation can be chosen as better substitutes.

- Energy is technology's lifeblood, a clear action plan is needed to cope with this growing crisis as well as it's equally important to address the issues that mar the implementation process.

- New technology is growing and coming up with new options like 5G, innovative solutions can be provided for assistance in production, transmission, distribution and usage of energy. It's just the start of 5G that's why there is a great deal for energy companies to operate efficiently and to improve customer services. Device to data processing, net metering, monitoring and automation is possible using IOT.

- Its need of hour to give great attention towards protection system upgradation as per network topological changes for smart grid.

- Machine learning and efficient communication network for reliability and security of power system is another research line where feasible outcomes can be achieved.

- Present network is inadequate and need maintenance as well as it has limited capacity. Therefore, consideration towards the T&D network is the need of hour so that energy can be transmitted effectively.

- Theft in power sector is also a big deal, controlling theft, improving consumer service and installation of smart meters in all distribution companies is compulsory.

- Projects planned in CPEC must be completed timely to shield afflicting power sector of gray:

VI. CONCLUSION

A. Pakistan's current energy gap clearly indicates that dependence on fossil fuels is a distressing situation for the nation's economy. Dependence on oil and fossil fuels should be minimized and environmental friendly, green energy sources should be adopted and promoted for power generation. Furthermore when we talk about green energy solutions this means we are talking about Distributed energy generation, which on the other hand is not an easy task. Distributed generation needs a highly optimized protection system and a secure network, which is another research area and its need of hour to give great attention towards protection system upgradation as per network topological changes for smart grid. Better optimization and reliable protection system, which will ensure the risk minimization while taking into account cost constraints is required.

Urgent actions are needed to address the problems in Pakistan's electricity sector:

- ☐ Planning and policy's implementation.
- ☐ Advanced research infrastructure
- ☐ Inadequate primary energy sources

□ Imbalance of the primary energy mix.

The most important query under debate is that whether Pakistan has ability to move on to a sustainable development pathway. The answer is that Pakistan's government can make firm policies on grid connectivity, loan incentives, licensing and other relevant issues. Last but not the least, political will as well as cooperation of people is important for the sustainable development of renewable sources of energy. The plan is quite simple. Introduce data-driven planning, inject expertise. In addition, there you have it, there shall be light!

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