DOI: 10.31703/ger.2019(IV-IV).05
URL: http://dx.doi.org/10.31703/ger.2019(IV-IV).05

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Energy Security- A Threat Assessment for Pakistan.

Abstract *Security and provision of energy are the cornerstone of any country's sustainable development as well as the main drivers for economic and industrial growth. Countries, whether developed or developing, remain heavily reliant on energy resources, and energy security is gaining critical primacy for all concerned. Faced with a severe energy crisis for a long time, Pakistan has had to rely on oil-based expensive energy mix widening demand-supply gap, lack of integrated energy strategy and poor energy governance, despite being endowed with immense hydro, wind and solar energy potential. This study attempts to map Pakistan's vulnerability to the impacts and challenges pertaining to energy security that constrains its socio-economic development and stability. It further explores the need to involve local community and business sector in formulating adaptation strategies and bridging policy-practice gaps to restructure energy policy and systems by shifting energy mix in favour of renewables and improving energy governance.*

JEL Classification: H41, H54, O38, O43.

- **Vol**. IV, **No**. IV (Fall 2019)
- **Page:** 45 – 59
- **p-ISSN:** 2521-2974
- **e-ISSN:** 2707-0093
- **L-ISSN:** 2521-2974

Key Words: Energy Security, Pakistan, South Asia, Nonrenewable Resources

Introduction

Where on the one hand, rapid industrialization and increased economic interdependence have enhanced the demand and consumption of energy manifold, it has resulted in a corresponding depletion and exhaustion of natural and renewable sources of energy. ill effects of human practices on environment and climate change more drastically visible and severe than ever before, have resulted in irremediable loss and depletion of fossil fuel, thus making it imperative to seek viable, climate friendly, and clean sources of renewable energy generation that not only prevent further damage to our current and future environment but may also help contain or reverse the energy shortfall for good.

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According to a study by Iwaro & Mwasha, (2010, p. 7745),

If the current fossil fuels are utilized at the same rate, the current oil reserves are only going to last for another 40 years. As far as the gas is concerned it is only going to last for another 65 years. Bionomic fuel suggests that the current coal reserves are only going to last for another 155 years. If oil and gas reserves are continued to be utilized at the same pace, then more coal is going to be used to substitute energy resources.

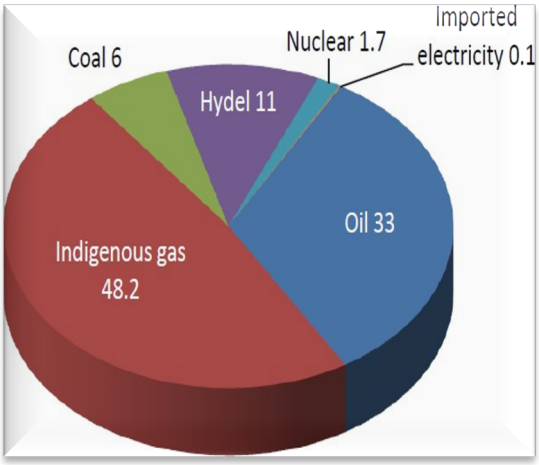
As the ten years mark has already arrived, despite the general realization of the impending doom, countries have not been able to bring about efficient renewable energy conservation policies, and continue in their quest to exploit and consume critical natural resources (fossil fuels), as the demand for energy keeps mounting. The twinning threat such ill practices bring about was raised in the historic 2015 Paris Climate summit, which deliberated intensively on the negative imprint of mismanagement, excessive consumption as well as indiscriminate exploitation of energy resources, without taking into effect the twining impact of climate degradation. Resulting in each member state promising a corresponding policy shift as well as policy adoptions to secure their future climate and energy security needs, yet there appears very little that has been put into practice.

Similarly, Pakistan having abundant renewable energy sources, remains heavily reliant on external sources for energy generation, coming across as a severely (energy) resource deficient country. There are several reasons for this, first and foremost being the rapidly depleting indigenous gas and oil reserves, an ever widening gap between the demand and supply, an enhanced physical security threat, where many a times, energy pipelines have been attacked or damaged by insurgents and terrorists, thus halting the supply of oil or gas for domestic as well as commercial xo summers. And last but not the least, the rising energy cost, which is proportionally affected by all the previously stated factors.

Pakistan today stands as the fifth most vulnerable country, in terms of the effects of climate change and its impact on available energy sources. Yet, unfortunately there has been abysmal long term planning and instead there is witnessed a reactionary mindset towards energy and the environment within this broader issue making it highly problematic. Weak governance exacerbates Pakistan's other vulnerabilities - floods, glacier melts, water stress- especially given its two neighbors, India and China both are high carbon emitters, further complicates the future climate and energy profile. Being blessed with a range of ecological zones such as glaciers, high mountains, tropical forests, riverine belts, deserts, and coastal ecosystems, it should not be difficult for the country to still develop policy parameters for securing both its energy needs as well as prevent drastic effects of climate change.

Relying on the available energy mix which is highly dependent on expensive fuels, Pakistan pursues a combination of non-renewable and renewable means of production. Currently, 87 % of Pakistan's energy is sourced from non-renewable sources (33% oil, 48. % natural gas and 6 % coal) whereas 13 % of energy is sourced from renewable sources such as hydroelectric, solar, biomass, wind, ocean and geothermal energy - more specifically, hydropower, (Ministry of Planning, Development & Reforms, December 2015, p. 203) yet there still exists a deficit in energy production and consumption in Pakistan. Currently the total installed capacity is 34,282 MW which is nearly triple the figures five years back, which stood at 12000 MW subsequently. This means 73% of the country's population has access to electricity which is a significant improvement from

the last five years' figure of 61%. However, according to the International finance corporation, the figure stands at 64%, as the cost of energy per unit is very high and unaffordable for poor people, this includes the 20% of total villages, as 32,889 out of 161,969, are not connected to the grid.



Graph 1. Pakistan's Primary Energy Mix
Source: *Energy Yearbook 2015.*

As a result, the country has faced severe energy crises resulting in frequent and long power breakdowns, shutting down industrial units; badly affecting economic growth, creating social chaos and political instability. The energy crisis was generated by a variety of factors, such as shift from hydro to oil-based expensive energy mix, widening demand-supply gap and lack of integrated energy strategy and bad energy governance. In 2015 energy policy it was estimated that the national electricity demands would keep on growing rapidly, at about 10 per cent annually, due to rising population and economic development requirements (Energy Yearbook, 2015). With an annual growth rate of 1.49%, the country's population stands at an approximate 212 million (2018), it was estimated that the growing energy needs and consumption would enhance the energy demand to around 30,000 MW by 2020 (Syed & Chaudhry, 2014, p. 10). Encouragingly enough, most of the energy generation projects which will be discussed in greater detail in the successive paragraphs, underwent completion and resulted in an installed capacity of 34000 MW. However, the cost of energy, non-linkage to the national grid, non-expansion of the grid, due to higher linkage and distribution costs, heavy energy consumption, both by domestic consumers as well as industry has resulted in a 3 *Gigawatts (GW)* deficit between electricity supply and demand, which is a significant improvement from the 5 GWs deficit five years back (ADB, 2014). With an economy which remains heavily reliant on energy, the estimated cost of power crises is approximately Pak. Rs. 380 billion per year, which is around 2-3 % of the GDP.

According to official estimates, there is a potential of 1,250 MTOE of oil and natural gas in addition to 1,540 MTOE of coal and a potential of approximately 100,000 MW of renewable energy (56,721MW of hydro and 43,000 MW of wind). However, disproportionate reliance on imported oil, that is 85 % of the total supply, has been a

massive strain on the balance of payments besides making the current energy mix unfavorable (ADB, 2014). The energy crisis goes back at least two decades, when the state policies adopted an energy mix approach, tilting more in favor of importing furnace oil, rather than relying on the indigenous hydropower resources. As mentioned previously, this resulted in an increase in the overall cost of power generation, coupled with high proportion of line losses, correspondingly enhanced tariffs, in turn giving rise to The phenomenon of circular debt in the energy sector, whereby slippages in the payment of bills (particularly on the part of public institutions) trigger a chain of delayed payments for imported furnace oil, natural gas or other inputs to the thermal generation system, which in turn hamper the operation of the power plants and result in less than optimum capacity usage. (Aftab, 2014)

With increased economic and industrial consumption, the demand for energy in two decades is projected to surge up to 92 MTOE, for which the depleting resources certainly remain inadequate, as indigenous gas reserves are predicted to last another seventeen years only (Economic Survey 2018-19, p. 12). For this purpose, the need is to plan and build upon renewable energy resources, which will neither add to the already stressed energy resources, such as gas nor prove a drain on the economy, as in the case of export of expensive crude oil. With vast coal reserves in the Thar region and immense potential for harvesting solar and wind power, along with hydroelectricity generation, the future energy mix needs to cater to the rapidly altering and increasingly expensive international energy sources, the drastic impact of climate change on the renewable energy resources, ever increasing domestic as well as industrial consumer needs as well as future financial profile.

The planning commission of Pakistan through its *Medium-Term Strategic Framework (MTDF)* provided an analysis of the country's sources of energy and how this mix would cater to energy security by the year 2030. Accordingly, the crude oil reserves stand at an estimated 27 billion barrels including 300 million barrels proven reserves. However, against a level of consumption of 100 million barrels, the available level of production stood at 22.6 million barrels, which is even less than one fourth of the requirement. The indigenous natural gas reserves stood at 8 trillion cubic meters including the proven reserves of 0.8 trillion cubic meters. Of these 93 million cubic meters per day are produced against the daily level of consumption of 82 million cubic meters (UK Essays, 2013). The coal reserves stand at 185 billion tonnes including the proven reserves of 3.3 billion tonnes. Used primarily by industrial consumers, the level of consumption is 6.1 million tonnes against production level of 3.3 million tonnes (NEPRA, 2004). Estimated at 185 billion tonnes, most of Pakistan's coal reserves are located in the province of Sindh, this includes the much talked about and promising 176 billion tonnes of Thar coal, which has yet to be mined and brought into usage. The overall mineable reserves of coal are estimated at 2 billion tonnes.

Additionally, the country has an estimated hydel potential of 46,000 MW, with only, 6459 MW as installed capacity. Catering to a sizeable bulk of power generation, the hydel provides about 29853 GWH, out of the total power generation mix of 83755 GWH. With immense potential for hydel generation, Pakistan's reliance on imported fuel and coal has proved extremely cost intensive, compounded further with the widening gap of payments. Furthermore, the rapid decline and depletion of oil and gas reserves would become critical unless new discoveries are made or new markets are explored. However, much depends on the complementing factor of financial resources and capacity to sign

new deals. According to the aforementioned planning commission study, "the oil sector has all along been heavily dependent on imports of about 85 percent of the national requirement. Annually about 7.8 million tonnes of crude oil, 5.2 million tonnes of oil products and 2.8 million tonnes of coal are being imported at a cost of around $ 3 billion." (Govt of Pakistan, Ministry of Planning, n.d.) The following table provides a short, medium to long term profile of the country's energy mix and demand projections.

Table 1. Energy Mix & Demand Projection (2004-2030)

	Current		**Short Term**		**Medium Term**				**Long Term**			
	2004		2010		2015		2020		2025		2030	
Total MTOE	50.8		79.39		120.18		177.35		255	.37	361.31	
Oil	15.20	30%	20.69	26%	32.51	27o/o	45.47	25.7o/o	57.93	22.7%	66.84	18.5
Natural Gas	25.45	50%	38.99	490/0	52.98	440/o	77.85	44o/o	114.84	45o/o	162.58	45%
Coal	3.30	6.5%	7.16	9%	14.45	12°/o	24.77	14.0%	38.28	15%	68.65	19%
Hydrogen	6.43	12.7%	11.03	13.9%	16.40	13.6°/o	21.44	12.1%	30.50	12%	38.93	10.8%
Renewable	0.00	0.0%	0.84	1.1%	1.60	1.3%	3.00	I.70/0	5.58	2.2°/o	9.20	2.5o/o
Nuclear	0.42	0.8%	0.69	0.9%	2.23	1.9%	4.81	2.7%	8.24	3.2%	15.11	4.2%

Source: Ministry of Planning, Development & Reforms, Govt. of Pakistan.

Given the energy profile and rising needs, the expected growth rate is projected to be 7.4 percent per annum. To meet future requirements with indigenous resources, domestic exploration, if feasible, needs to be enhanced, which as pointed out before, may not be entirely possible, given the depleting resource base. At the same time, there is a drastic need to diversify energy supply options, as well as explore the potential for alternate energy provision. The governmental approach in this regard has been,

- enhancing the exploitation of hydropower,
- exploration and production activities of oil, gas and coal resources,
- increasing the share of coal and alternate energy in overall energy mix, and
- Optimizing the utilization of country's indigenous resource base to reduce dependence on imported fuel through an institutionalized strategy,
- creating an environment conducive to the participation of the private sector, as well as technically skilled human resource and expertise; and
- lastly, to develop the energy scenario in the context of regional perspective.

Structure of Energy Sector

The country's power sector has traditionally been run by two main public sector entities, namely the *Water and Power Development Authority (WAPDA)* established in 1958 and the *Karachi Electric Supply Corporation (KESC)*, operating even prior to the formation of Pakistan, as early as 1882 under the *British (colonial) Indian Companies Act*, but nationalized in 1952. The KESC resurfaced in 2005 as a private entity *K-Electric*, to boast its work efficiency. To break the monopoly enjoyed by such public sector entities, which were now suffering from incompetence, malpractices, poor service delivery as well as poor service provision resulting in massive power shortage. The private investment was encouraged in the energy sector and an *Independent Power Projects (IPP)* policy was launched in 1994. To facilitate and encourage more such investment, the *Private Power and Infrastructure Board (PPIB)* was set up to provide a one window

support to the investing private sector. Furthermore, the *National Electric Power Regulatory Authority (NEPRA)* was established in 1997. The NEPRA in its mission statement, laid out its aim to,

Develop and pursue regulatory framework, which ensures the provision of safe, reliable, efficient and affordable electric power to the electricity consumers of Pakistan; we shall facilitate the transition from the protected monopoly service structure to a competitive environment where several power sector entities function in an efficiency oriented or market driven environment and shall maintain a balance between the interests of the consumers and service providers (as well as the government).

The government besides launching the IPPs, reorganized the WAPDA into nine *distribution companies (DISCOs)*; four thermal *generation companies (GENCOs)* and a *National Transmission and Dispatch Company (NTDC)*, that is responsible for transmission lines and grid stations of 220 kilo v and above. However, the hydroelectric power development and operation functions remained with WAPDA. In 1998, *Pakistan Electric Power Company (PEPCO)* was established to facilitate the restructuring and re-organization of WAPDA and the companies. Furthermore, through an Act of Parliament, the federal government in May 2010, bestowed upon the *Alternative Energy Development Board (AEDB)* setup in 2008, to facilitate alternative/renewable energy projects, develop and implement off-grid electrification programme of rural areas and to introduce *alternative and renewable energies (AREs)* at an accelerated rate. These policies, programs and projects were sanctioned to the private sector to assist and facilitate fast paced development and generation of ARE to achieve sustainable economic growth. The government aims to generate 5% of total national power generation capacity through renewable energy technologies by the year 2030. In addition, under the remote village electrification program, AEDB has been directed to electrify 7,874 remote villages in Sindh and Balochistan provinces through the ARE technologies (AEDB, n.d.).

Problems and Impediments

Until recently, Pakistan has faced a critical energy crisis due to a host of reasons, some being generic to a growing economy with a huge population and slow paced infrastructural growth, and few being unique to the country. Such as, misallocation of resources and funds. Incompetence of exploration sector, rapid increase of oil prices in the international market, less dams and power wastage. This had in turn given rise to a host of problems, such as rapid inflation, widening trade deficit, depreciation of currency. severe power outages attributed primarily to energy shortage, impacting the poverty index negatively, due to unemployment and decrease in industrial activity. Despite the reorganization and a serious attempt to increase the efficiency and power production, there appeared many problems, such as slow development of indigenous resources as well as power generation and storing reservoirs such as water dams, coal reservoirs etc. gaps between implementation strategy and capabilities, financial constraints, slow progress and pace of the private sector. Furthermore, an ad hoc approach in the management and identification of important aspects such as load forecasting, project identification, tariff regime and future investment requirement, gave rise to poor coordination and rivalry amongst different stakeholders and institutions, thus negatively impacting the competitive development of power sector." (Energy Yearbook, 2015)

The effects of transition of power generation sector from the cost effective, efficient,

and renewable hydel power, to the more expensive, experimental and non-renewable energy mix options, has immediately been visible through increased import bills, and delay in development of indigenous resources. For a country, which is already stressed financially, this proved a major strain and with external financial donors, seeking an end to subsidies provided to domestic and industrial consumers, the power sector has impacted the industrial growth in the most drastic fashion. Although there is already a reversion to hydropower, but it will take considerable time to correct the situation as the gestation period for hydro based generation is relatively long.

Enlisting the problems faced by the power generation and distribution structure, there are several which any power sector would face universally, such as:

- A lopsided and inefficient subsidized tariff structure, which provides relief to domestic and agriculture consumers, yet many in the industrial and commercial sectors who are outside the subsidy bracket, consider it a smokescreen for theft and pilferage.
- There is incurred annually a huge loss in revenue due to high transmission, distribution, auxiliary losses and pilferage.
- Lack of and where available overloaded transmission and distribution network, which can be made better through computerized information and adjustment of load capacity and positioning.
- Poor and old equipment and infrastructure leading to lack of conservation and wastage of energy, which is approximately 20% of the total consumption.
- There is also an exclusion of local stakeholders in the shape of engineering industries, which is costing heavily in terms of importing electrical engineering and auxiliary power products required; which ends up adding to the overall financial cost.
- Overloaded preexisting infrastructure, transmission system as well as grid stations, leading to high distribution losses, transmission line constraints, poor quality of service and various other problems related to quality and stability of the setup.
- Slow pace of exploration, drilling activities and infrastructure development in the oil and gas sector.
- Neglect of the Coal sector, due to lack of capability and proper institutional setup.
- A very costly energy mix transformation, as most of the power generated is through imported furnace oil, which is much more expensive than hydro power. According to the governmental assessments, electricity produced through hydropower costs around Pak. Rs. 1 per unit in comparison to that produced through furnace oil which costs Pak Rs. 12- 17 per unit, and through diesel run power plants, Rs. 23 per unit. (Qazilbash, 2015).
- The heavy dependence on imported energy generating resources has given rise to a somewhat unique notion of circular debt, implying a trigger off chain of delayed payments, that has a direct impact on the running of power generating plants and adding to external dependency and delays. But much depends on timely payments as well as accurate assessment of electricity cost and timely payment of tariffs as well as power generation costs by all concerned.
- Political nature of hydel energy in the country.
- Last but not the least has been the overall security situation, which has made

energy pipelines, infrastructural development, foreign investment and resource input of any nature, whether financial, human or infrastructural extremely risky and difficult.

The (Renewable) Energy Mix

As mentioned previously, energy and economy run hand in glove. If we look at Pakistan's economic performance over the decades, it has never been a steady one. In the recent decades, a third *E* added to the equation, makes this factor all the more complicated, and that is the menace posed to a steady and stable *economy* and undeterred *energy* provision by the threat of *extremist* violence and militancy. As the global political dynamics underwent a shift and the return to democracy brought technocrats, industrialists and traders into mainstream politics, there was witnessed a steady growth in economy and gradually policies were made commerce friendly. Correspondingly, a growth in economy, seeks a parallel demand for energy. With an environment conducive for investment, the period witnessed a fast-paced industrialization, which was not matched equally with infrastructural development and the required energy needs. Pakistan being a country with limited indigenous energy resources, came under immense stress resulting in importing large quantities of oil and related products primarily from the oil rich Middle Eastern Emirates and Saudi Arabia.

Of the total installed power generation capacity of almost 34,282 MW, the total demand from residential and industrial sector stands at nearly 25,000 MW. However, the transmission and distribution capacity is not beyond 22,000 MW approximately (Rehman, 2018). This leads to a deficit of about 3,000 MW when the demand peaks, which despite the high installed capacity cannot be transmitted (Bhutta, 2019). Coupled with an ever-increasing demand at the annual rate of eight percent per year, placing Pakistan's per capita electricity consumption at one-sixth of the World Average. According to the International Energy Agency, the world average per capita electricity consumption is 2730 kWh compared to Pakistan's per capita electricity consumption of 451 kWh, and by year 2025, the electricity demand will reach 49,078 MW (Gishkori, 2011).

Thereby making the country's existing energy mix highly expensive due to its dependence on imported fuel. Even though Pakistan is an immensely resource rich country, with enormous hydel, coal as well as oil reserves as well as alternate and renewable energy generating resources. However, where on one hand hydel power has become a controversial political question, with different opinions raised and discussed endlessly over size, allocations, royalties, placement, and location of water reservoir dams. Since the late 1980s, very less exploration in terms of discovering and drawing feasibility studies of new oil fields has been carried out. As mentioned above, in the overall energy mix, gas accounts for 48 per cent, oil 33 per cent, hydel 11 per cent, coal six per cent, nuclear two per cent and a small fraction from imported electricity.

Stuck in the similar dilemma of over-reliance on imported petroleum and oil products for commercial, industrial and domestic consumption, the import percentage of these products has been sufficiently high making this issue all the more critical. As the gap between demand and supply as well as production and consumption of oil widens, with a corresponding increase in energy needs and consumption, putting immense pressure on the growing economy of the country (Ahmed & Jha, n.d.). To reduce reliance on costly imports, and reduce the widening gap between consumption and

production, the country has to explore and exploit its abundant and naturally endowed renewable energy resources. Located in a geographical stretch, Pakistan has a huge potential for solar as well as wind energy. However, the country faces problem similar to what other developing countries are undergoing when it comes to successful implementation of renewable energy systems. Such as, lack of technological resources, poor financial support, successive governments' lack of support and incentives. Amongst the various alternated and renewable energy sources, the cheapest and foremost is the *Hydro power*. However, a well-planned and strategized investment into harvesting solar as well as wind power can be the basis of clean, pollution free, climate friendly and relatively cheaper (long term) source of energy generation and bring about sufficient economic dividends.

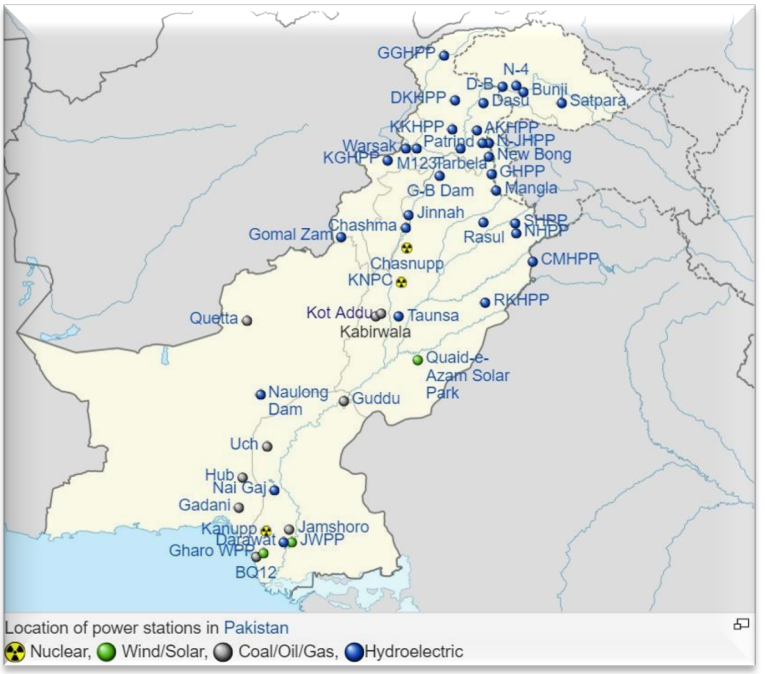


Figure 1: Various Alternate & Renewable Energy Power Projects in Pakistan
Source: Pakistan Report

Hydropower

Considered as one of the cheapest sources of power generation, hydro power has low running costs, although there is an initial requirement of huge capital investment (Hassan, 2002). There is a potential for generating 50000 MW of power through this source, however, since the last 50 years, not more than 4800MW has been extracted from mega-hydel plants and the rest is still to be extracted and utilized (Kazi, 1999). Tarbella and Mangla dams are the two biggest sources of hydel power for the country and hold the capacity of 3046 MW and 1000 MW, respectively. Besides these two mega projects, there also are the Chashma, Mirani, Ghazi Barotha, Warsak, Gomal Zam and many other smaller dams.

Hydropower dominated Pakistan's energy mix from 1960s to 1980s but due to shift

to oil-based power in the 1990s, it fell from 60 per cent in 1962, to 30 per cent in 2009-10. It is estimated that the national demand for electricity would keep on growing rapidly, at about 10 per cent annually, due to rising population and economic development requirements. For the year 2020. the demand was expected to touch around 30,000MW, though. Estimated cost of power crises to the economy is approximately Rs. 380 billion per year, around 2 percent of GDP. Unfortunately, construction of dams has also been a matter of political rift amongst the center and the provinces, as well as the controversy as to what is better, smaller and more reservoir dams or large-scale projects. The construction of *Kalabagh* dam which has become a moot point for decades is one such glaring example, whose timely construction could have not only fulfilled major power generation needs and help strengthen economy, but also saved precious rain and river water, which is now lost as a result of having no reservoirs, even smaller ones to help catch and harvest this downflow.

However, there are under construction projects such as Diamer Bhasha, Dasu, Taunsa, Neelum Jehlum hydropower plant and many others which can and will contribute to enhancing and improving the hydroelectric power generation. According to energy experts, if an honest effort is done to establish hydro power as a (primary) source of energy in our country, that even the recoverable potential in *micro hydropower (MHP)* up to 100KW is roughly estimated to be 300MW on perennial waterfalls in northern Pakistan (Hassan, 2002). One can thus safely estimate as to what bigger and mega projects can potentially generate. In the recent decades, both private as well as public sector entities are now actively investing in the hydroelectric sector, in various capacities, which will bring greater relief in future.

Solar Power

Pakistan's geographic location blesses it with immense natural energy generation sources, amongst which solar power is one such asset, abundantly available. The last two and a half decades have seen substantial investment as well as developments in this field, and at present the solar energy, though not as mass scaled, as envisioned, is still being used for various purposes. According to a study, if only about 0.25% of the Balochistan province which is about 0.1% of the total landmass, is covered with solar panels with an efficiency of just 20%, the electricity generated would be sufficient for the entire country (Katz, 2017).

At the moment, there are small scale, stand-alone units being run by photo voltaic power such as rural telephone exchanges, repeater stations, highway emergency telephones, cathodic protection, refrigeration for vaccine and medicines in the hospitals etc. however in order to encourage, promote and prove the credibility of this sector, the entire parliament building of Pakistan was converted entirely to solar power energy. Thus, becoming the first such parliament building in the world to be solar powered (Dawn, 2016). Other projects such as converting big scale public parks in the country to solar power are being worked upon.

The percentage of the rural population, which lives away from the national (power) grid is about 70%, therefore the Alternate Energy Development Board (AEDB) has initiated pilot projects by setting up 100 solar homes to exploit solar energy. Both the private and public sectors are actively involved in the advancement and upgrading of photovoltaic activities, by not only trading but also the production of photo voltaic products and appliances. At present there are around 12 solar power generation projects

underway, with the Quaid-I- Azam solar park, which was completed by the middle of 2015, a year ahead of its date of completion, has so far been the biggest project with 100 MW power generation capacity.

Wind Power

With a 1000 km wide coastline, like solar energy, Pakistan has a huge potential for wind power generation as well. One of the fastest growing technologies, wind energy has been very effectively used for decades in many developed countries. Pakistan fortunately has high wind speed zones near major city centers, near the Islamabad capital territory it ranges between 6.2 to 7.4 metres per second, in Karachi it is between 6.2 to 6.9 metres per second and various wind tribunes which are available in the neighboring countries require a speed of 3-4 metres per second to start turning. The province of Sindh and Balochistan have sufficient wind to power not only every coastal village, but the Gharo - Keti Bandar corridor in Sindh alone has the potential to produce 40-50,000 MW electricity, out of a total potential of 150,000 MW (Pakistan & Gulf Economist, 2015), which can even be exported to the Asian neighbors.

Additionally, the presence of rivers and lakes in the country ensure an uninterrupted flow of wind which is further helpful in the production of continuous electricity. The AEDB has already installed a number of micro tribunes for small scale domestic units and at the moment around 33 winder power projects are under completion with public private interaction, of which the Jhimpir Wind Energy Project and the three Gorges Wind Farm, Foundation Wind Energy and Sapphire Wind Power ltd are already operational. Wind power projects of 100 MW are being initiated on BOOT (Build, Own, Operate and Transfer) basis, at Keti Bandar and Gharo in Sindh (Hamid & Attique, 2011).

Table 2. Potential Power Generation Plan 2005 - 2030

Year/ Energy Mix	Hydel	Coal	Oil	Gas	Renewable	Nuclear	Total	Cumulative MW
2005	6460	160	6400	5940	180	400	19540	
2010	1260	900	160	4860	700	-	7880	27420
2015	7570	3000	300	7550	800	900	20120	47540
2020	4700	4200	300	12560	1470	1500	24730	72270
2025	5600	5400	300	22490	2700	2000	38490	110760
2030	7070	6250	300	30360	3850	4000	51830	162590
Total	32660	19910	7760	83760	9700	8800	162590	

Source: Energy Year Book 2016

Besides the aforementioned resources, Pakistan also relies on coal as well as nuclear. Other sources include liquid petroleum gas (LPG), as well as a very minute portion comprising geothermal energy. As mentioned in the preceding para, Pakistan has estimated coal reserves of over 185 billion tonnes, however being low quality, it is not very feasible in terms of environmental protection as well as its impact on climate change. Thereby reducing its overall share in the energy pool to less than two percent,

of which nearly 90% is used by brick kilns and 10% for power generation. Most of the coal used in the cement industry is imported from different countries. Pakistan also produces electricity through nuclear power, through the three operational nuclear power plants, namely, the *Karachi Nuclear Power Plant (KANUPP)* commissioned in 1971, with a capacity of 137 MW; later to be followed by the two *Chashma Nuclear Power Plants* with capacity of 325 MW of each plant. At present the share of these three plants in the overall mix is a mere 2.3%, however the Pakistan Atomic Energy Commission has planned to increase the nuclear power capacity to 8800 MW by the year 2030.

Conclusion and Recommendations

Any country in the contemporary world is faced with the twin dilemma of pursuing its development needs and striking a balance to protect and secure its environmental security. Pakistan, with a rapidly growing population and economy which is gaining a fast pace has similar issues and concerns. Despite the measures being undertaken, the country still faces an energy crisis. With 50% of the energy needs being fulfilled by gas, there is a natural increase in demand and consumption of gas, with similar demand and supply gap which appears to be widening in the electricity and oil sector. The government has undertaken several measures from the immediate, short term such as seeking to regulate and manage load sharing through load shedding to long term measures of seeking viable, sustainable energy mix options. The best resource available to the country is harvesting and developing its renewable energy resources, amongst which, hydropower is the cheapest, safest and efficient source, which can help in managing and securing water needs as well. The need is for respective governments to realize the looming threat of energy deficiency, lack of renewable resources and environmental depletion if appropriate preemptive and preventive measures are not timely undertaken.

Not only measures such as seeking better renewable resources for energy generation need to be south, but supported by long term environment friendly policies and implementation strategies as well. There is a need to develop civic culture and responsibility when it comes to consumption of energy. Laws and regulations should be made for energy efficient practices and infrastructural development, appliances and future investment must cater to energy efficient policies. The existing infrastructure of transmission and grid stations is overloaded, which needs to be expanded and made more stable and distribution network increased. And in this regard, concrete measures be undertaken to prevent power theft and line losses. Any energy generation plan or strategy must be compliant to climate and environment protection policies, which will help build a future energy sector that secures environmental concerns, faced by the country.

For foreseeable future, the country will remain reliant on the energy mix that it has heavily invested in, however, there should be a gradual shift towards renewable energy generation plans and for this the federal as well as provincial governments need to join hands. Villages and areas outside the national grid can easily benefit from solar or wind power, which should be encouraged. The private sector should be encouraged to invest more in these areas, with a provision of jobs and vocations to local stakeholders. In case of non-availability of targeted and compatible human resource, educational institutions and technical training centers need to be roped in for developing the necessary human

resource capital.

The energy crisis which became critical for more than a decade beginning 2007, has proved a massive drain on economy and the country's growth and development. By taking well strategized and articulated actions, which do not deplete the fragile environment, we can very well through well-paced measures not only overcome the crisis, improve and sustain the economy, but also secure the environment. The best solution is to invest heavily in renewable sources of energy and to adopt as well as adapt to practices and policy frameworks that are both climate friendly and energy efficient. Thus, leading to energy conservation that can in turn bring about as well as reinforce sustainable development that will go a long way in benefitting industry, economy, as well as environment.

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