ENERGY AND NATIONAL SECURITY OF PAKISTAN

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Abstract

Pakistan faces a myriad of internal and external challenges posing threats to its national security. In the modern era, all economic vistas are highly dependent on energy, hence energy security has become a vital factor that influences a state's economy, foreign policy and security policy. Pakistan's active participation in Belt and Road Initiatives has further accentuated the energy needs of Pakistan. Despite having diverse unexplored domestic energy resources, Pakistan relies heavily on foreign energy supplies which put huge burden on its fragile economy. Inadequate policy measures, global and domestic energy politics, short term planning, lack of political will and unsustainable energy mix are major grey areas in the energy security of Pakistan. This article explores the reasons of energy shortfall in Pakistan as well as requirements of energy vis-à-vis their impact on the national security, stability and economic development of the country.

Keywords: Energy Security, National Security, Economic Development, Energy Crisis, Energy Mix, Alternative Renewable Energy.

Introduction

Energy was and still remains a major concern for developed countries to sustain their economic growth, while developing states are far more affected. Quest to ensure energy security is omnipresent across the globe. Pakistan's development pace has been marred by the imbalance between demand and supply of energy, in the past few decades. For sustained technological advancement and survival, a continuous and reliable energy security is must. The world has realised that the vast and abundant natural reservoirs and deposits of energy are in no way unlimited and that more than half of the oil resources have almost depleted by now and if it continues at same pace then the world will run out of oil in next three decades.[1]

The energy choices made by the world have ramifications for economic growth including local and global environment. Economic development since the beginning of industrial revolution is fuelled primarily by non-renewable mineral resources extracted from the lithosphere. The wheel of industry has been running for the last couple of centuries through the relatively abundant and low-cost energy

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obtained from fossil fuels with the addition of fissile fuels such as uranium in the 20th century though on a very limited scale. The other alternative sources of energy such as biomass, wind and hydel power have been marginalised in the energy mix of the industrialized countries.[2]

For years, energy was considered as purely an economic issue determined exclusively by market dynamics, whereas, of late, foreign policy analysts view it from the security perspective linked with energy politics and resource management. Pakistan, like other developing countries with growing population and corresponding increase in demand of energy is also facing energy challenges. The country is blessed with gigantic potential of untapped hydel power, vast lignite coal deposits, unexplored hydrocarbons and huge solar/wind potential for cheaper power production. However, there are multiple grey areas that are restricting utilisation of these energy potentials and thus limiting self-sufficiency in energy sector. This ultimately is affecting energy security dynamics in particular and national security as a whole. This paper is aimed to evaluate existing energy security dynamics and challenges of Pakistan with its effects on national security in the overall ambit of comprehensive security construct.

Theoretical Perspectives

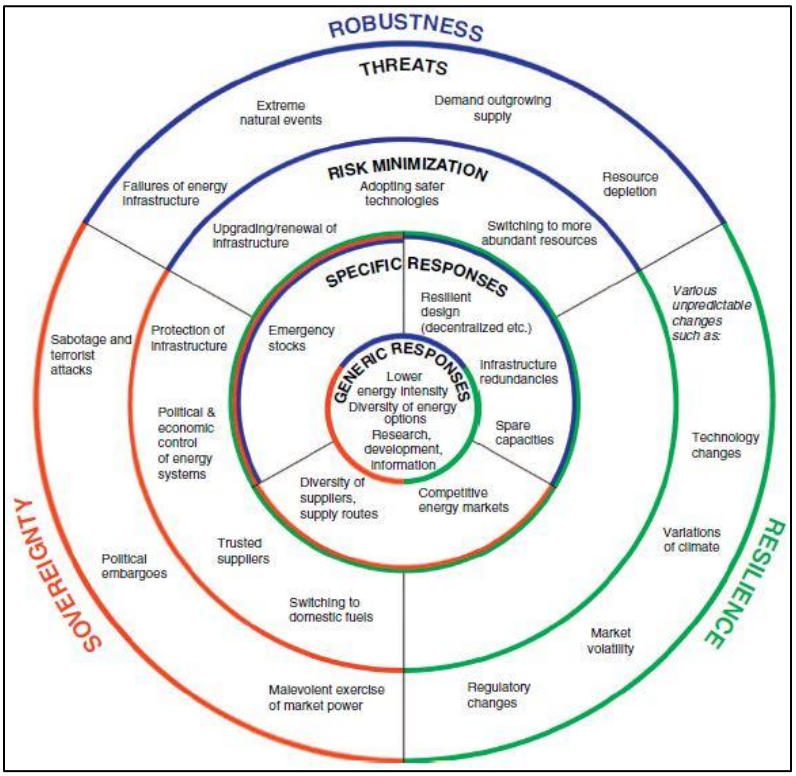
Energy security is a vital node between economic, environmental and national security that links many sectors - economy, governance, planning, international energy markets and diplomacy. In contemporary energy-striven world, energy security is a linchpin between economic, environmental and national security. Energy security is dependent on three key elements[3] of robustness, sovereignty and resilience.[4] Figure 1 explains this matrix of energy security.

The development of reliable, continuous, affordable, and environmentally sound provision of energy services combined with a focus on energy efficiency and conservation is the only way of alleviating the various multi-level dimensions of energy security. The UNDP defines energy security as "the availability of energy at all times in various forms, in sufficient quantities and at affordable prices, without unacceptable or irreversible impact on the environment. These conditions must prevail over the long term".[5]

Strategic assurance of uninterrupted and abundant supply of energy for world powers and their allies emerged as a key element of national interests. Limited availability of oil and gas resources around the world have forced nations to geo strategically influence their presence in regions. Modern world conflicts, if analysed will expose the imprints of energy security. The concept of forward basing and military outposts is one good example of this concept. Nations are using military powers around the world to ensure uninterrupted, sufficient, and affordable access to energy,

which is thereby a manifestation of this geo-strategy and there are enough proofs of its linkage with energy security.

Figure-1: Matrix of Energy Security



Source: Aleh Cherp and Jessica Jewell, The Three Perspectives on Energy Security.

On the other hand, national security is the ability and freedom enjoyed by any sovereign state to make decisions without any external interference. A holistic concept of national security incorporates infinite varieties of securities i.e., human security, military as well as non-military security, economic security, environmental security, food security and of course energy security. In the 17th and 18th centuries, the industrial revolution in Europe and the USA required coal and other newly discovered hydrocarbons such as oil, gas and petroleum products. Therefore, European powers resorted to colonisation in many parts of Africa and Asia to gain access and control over the sources of these energies and other raw material for their industries. Construction of the Suez Canal and energy pipeline projects such as 4,196 km long Yamal-Europe pipeline that connects the natural gas reserves of Russia to Europe were undertaken to ensure uninterrupted supply of energy for their needs.[6] Subsequently,

a new definition of a nation's energy security emerged that encompasses continuous, affordable, sustainable, safe, reliable, and accessible availability of energy resources.

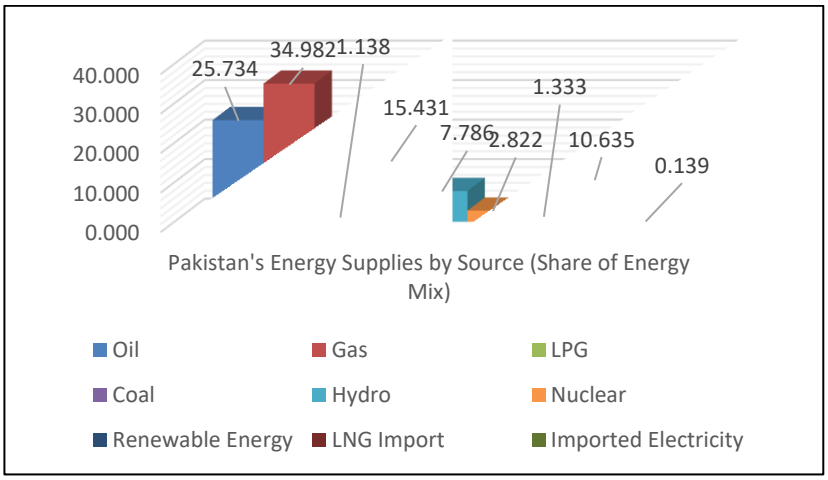
Energy Security Dynamics of Pakistan

Pakistan enjoys a strategic position because of its location at the crossroads of world energy resources. However, energy scenario in Pakistan is far from ideal as the country is not self-sufficient in energy resources and depends largely on imports. With the increasing energy demand and fluctuating energy prices, the import bill is continuously surging. For the last few decades, Pakistan is facing a severe energy crisis in the form of frequent power outages, increasing gas load-shedding, rising tariffs and disrupted supply of fuel. Considering energy to be a fundamental element of national security, Pakistan's current experience can best be described as energy insecurity. From the angle of geo-economics, heavy energy imports and volatility in the international market are a constant concern for the economic security of Pakistan. The energy crisis has not yet received the attention it deserves as exhibited by its reliance on ad hoc measures to deal with the problem and continuing with dependency on imports of oil and gas. Long-term and sustainable measures like investment in exploration of indigenous reserves, construction of hydropower projects, and focusing on alternative and renewable energy resources still wait for the sincere attention of policy makers. Consequently, energy crisis has been affecting independent foreign policy of Pakistan, as from the geopolitical perspective, energy security is critical for national sovereignty. Assurances of continuous energy supply at affordable rates from foreign suppliers are always accompanied by strings of conditions that often undermine national prestige. On the other hand, dreams for industrialisation and economic self-reliance are far from realisation as confidence of investors in the state has been faltering because the country has been unable to meet even the basic energy needs of its people.

Pakistan's Energy Profile

Pakistan's primary energy mix comprises natural gas, oil, hydropower, coal, nuclear, alternative renewable energy sources and a small percentage of imported electricity. According to latest report by National Electric Power Regulatory Authority (NEPRA), Pakistan's primary energy supplies in the FY 2018-19, remained 83.81 Million Tons of Oil Equivalent (MTOE) with annual growth rate of -2.8%. As Figure 2 shows that oil and gas account for the larger share of 61% in energy mix.[7]

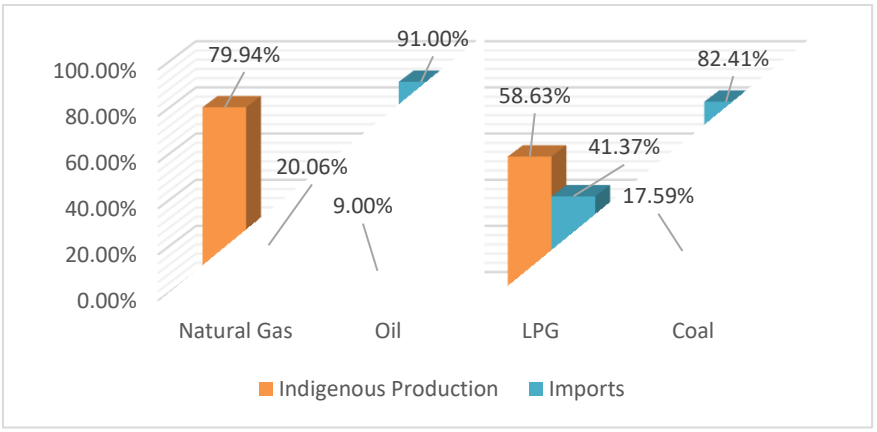
Figure-2: Pakistan's Energy Mix (2018-19)



Source: National Electric Power Regulatory Authority, 2020.

According to latest data available, in FY of 2017-18, out of total supplies of 86 MTOE energy, Pakistan indigenously produced 46 MTOE and imported 41 MTOE which is 54% and 46% respectively. Pakistan imported 91% oil (crude & refined products) 20% gas (LNG), 82% coal and 41% LPG to meet energy requirements.[8]

Figure-3: Pakistan Domestic & Imported Energy Mix (2017-18)

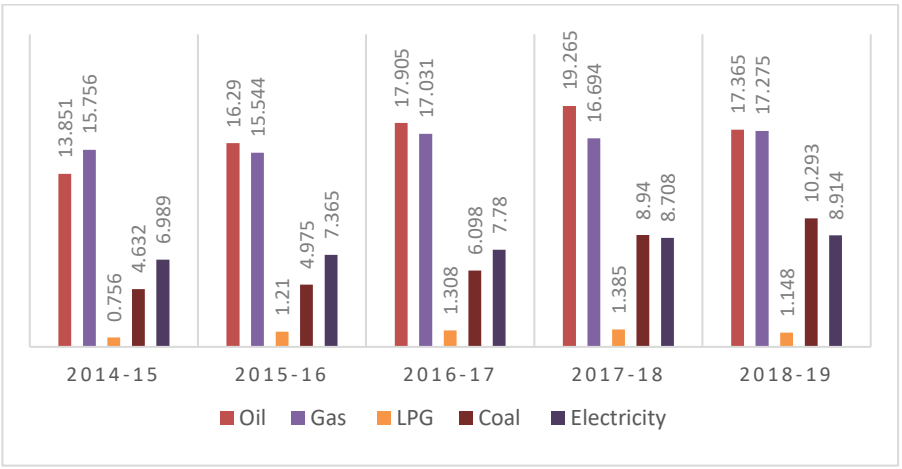


Source: Hydrocarbon Development Institute of Pakistan, 2018.

Moreover, Pakistan's total energy consumption in FY 2018-19 was 54.996 MTOE.[9] Pakistan's energy consumption is expected to grow by 70% in the next 10 years. Expected incremental power generation from indigenous Thar coal and renewables will only cater for 15-20% of energy demand. Remaining 80-85%

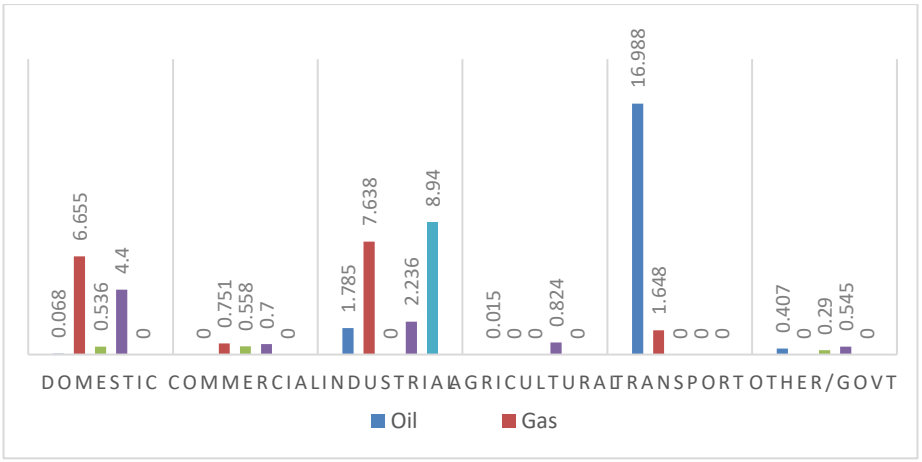
incremental demand to be met through imports, resulting in additional impact of USD 6-8 billion on balance of payments.[10] Below Figure 4 and Figure 5 shows the Pakistan's energy consumption by source and sector.

Figure-4: Pakistan's total Energy Consumption by Source (MTOE)



Source: National Electric Power Regulatory Authority, 2020.

Figure-5: Pakistan's total Energy Consumption by Sector (MTOE)



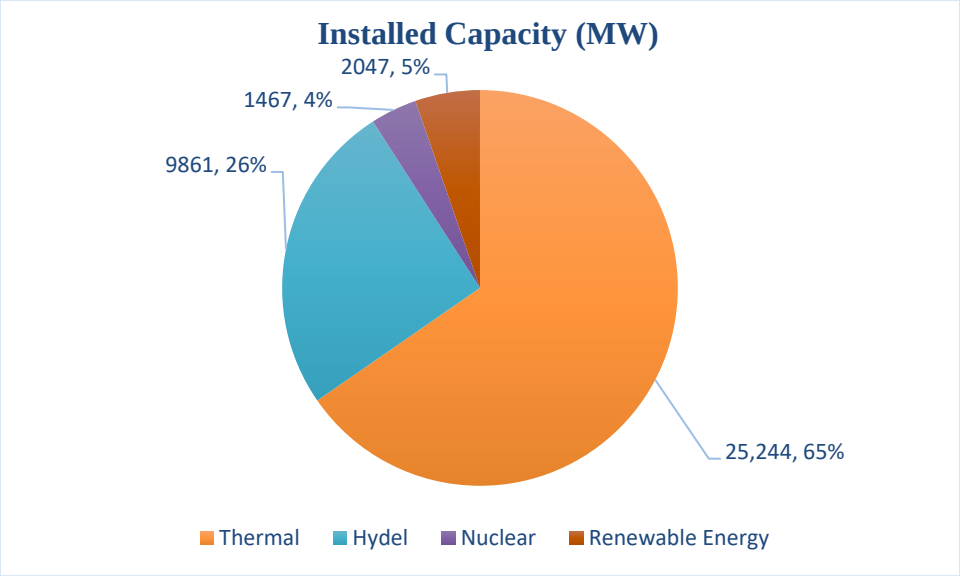
Source: Hydrocarbon Development Institute of Pakistan, 2018.

Pakistan's Energy Resources

As of June 30, 2020, total installed power generation capacity in Pakistan stands at 38,719 MW, of which 35,735 MW is connected with National Transmission &

Despatch Company (NTDC) system whereas 2,984 MW is connected with K-Electric Limited (KEL) system.[11] The distribution of installed capacity by source is shown in Figure 6 below.

Figure-6: Pakistan's Total Installed Power Generation Capacity (as of 30th June 2020)



Source: National Electric Power Regulatory Authority, 2020.

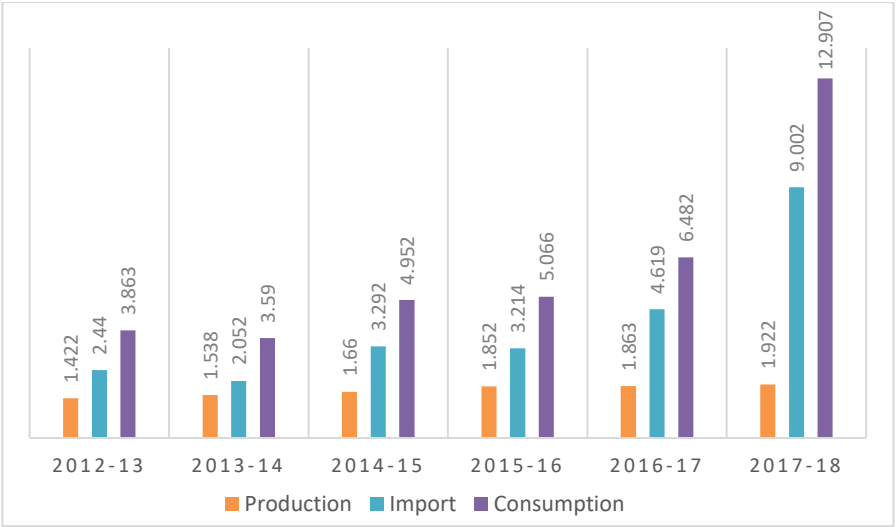
a) Oil and Gas

Oil and gas are the main energy sources of Pakistan. According to latest report, in FY 2018-19, a combined energy supply of crude oil, refined petroleum products, LNG, LPG, and natural gas accounts for 76 percent of the energy supply, of which 25.7 percent is of oil, 45.6 percent is of gas including LNG and 1.1 percent is of LPG. Bulk of this, is imported as indigenous exploration and production is still underdeveloped despite huge potential.[12] As per FY-2018 estimates, the Annual Compound Growth Rate (ACGR) of gas and oil in Pakistan was only 5.1 percent while the production of natural gas saw a decline of 0.8 percent in the same period.[13] In total, Pakistan has 254 oil fields, 70 associated and 240 non-associated gas fields. However, most of these are small and are depleting. The Sui field, which accounts for 25 percent of the supply, is on the decline. The shortfall in gas is expected to reach 6,611 Bcf/D by FY 2029-30.[14] In contrast, consumption is continuously rising. This gap between demand and indigenous supply is going to deepen further as local gas reserves are fast depleting while consumption is on the increase.

b) Coal

Pakistan is a coal-rich country, with total 7775.5 million tonnes of measured reserves. Out of measured reserves, it is currently producing 4.3 million tonnes of coal. The average consumption is almost 17.9 million tonnes.[15] This huge potential has not been harvested for decades due to insufficient financing, underdeveloped infrastructure and lack of modern technical expertise. However, there are other more serious concerns as well; the quality of coal especially in the Thar is not very economical for power production. In addition, the environmental pollution that it is going to cost will further deteriorate the already threatened safety levels as coal pollutes the environment like no other fuel does. Figure 7 shows the year wise statistics of coal production, consumption and import.

Figure-7: Coal Statistics Year Wise (MTOE)

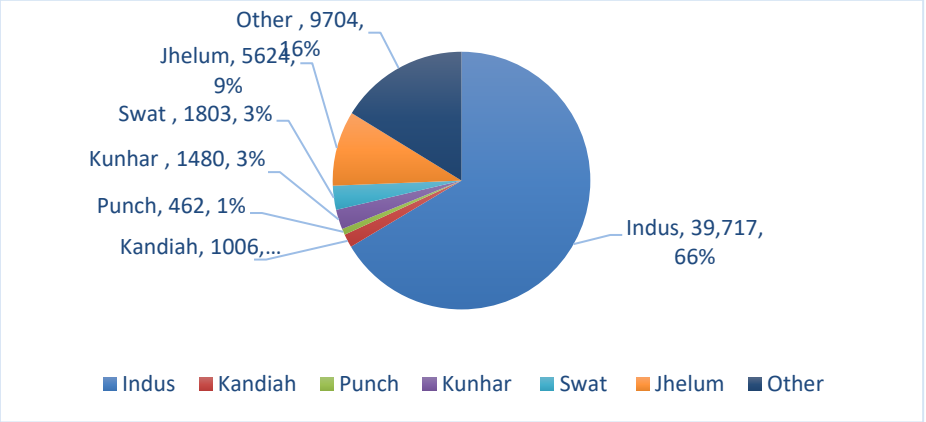


Source: Hydrocarbon Development Institute of Pakistan, 2018.

c) Hydropower

Hydropower has traditionally been the prominent source of energy in Pakistan. Pakistan has total of 60,000 MW (approx.) of hydropower potential.[16] Distribution of this exploitable potential of different water resources in Pakistan[17] is given below in Figure 8.

Figure-8: Exploitable Hydropower Potential of Water Resources in Pakistan (MW)



Source: Ministry of Water and Power, Government of Pakistan.

As of June 2020, Pakistan has been able to exploit only 11 percent of total hydropower potential so far. Pakistan has total 9,861 MW of hydropower generation installed capacity which is connected with Pakistan Electric Power Company (PEPCO) / NTDC, developed by Water and Power Development Authority (WAPDA) and Independent Power Producers (IPPs).[18] Currently, hydropower is contributing around 25 percent to total installed power generation capacity in the country. However, the existing installed capacity remains far below the country's economically and technically viable potential, including the significant potential for development of small-scale run-of-river hydropower projects. The share of hydel & thermal power generation was 65% to 35% during the years 1960-70 which has almost gone reverse in the power system due to non-construction of any mega hydel project.

The imbalance between hydel and thermal has increased the demand of imported fuels and severely affecting country's foreign exchange. The high tariff rates of IPPs are consuming major share of revenue and have also caused immense increase in overall electricity tariff rates.[19] The construction of hydropower projects remain neglected due to lack of political will and politicization of different hydropower projects. Controversy over Kalabagh dam halted development on other hydropower projects as well. Presently, as table 1 shows, around 30,428.07 MW (approx.)[20] of hydropower projects are at different stages of development under the China Pakistan Economic Corridor (CPEC) and non CPEC domains that are likely to be completed by 2025-30.

Table-1: Under Development Hydropower Capacity

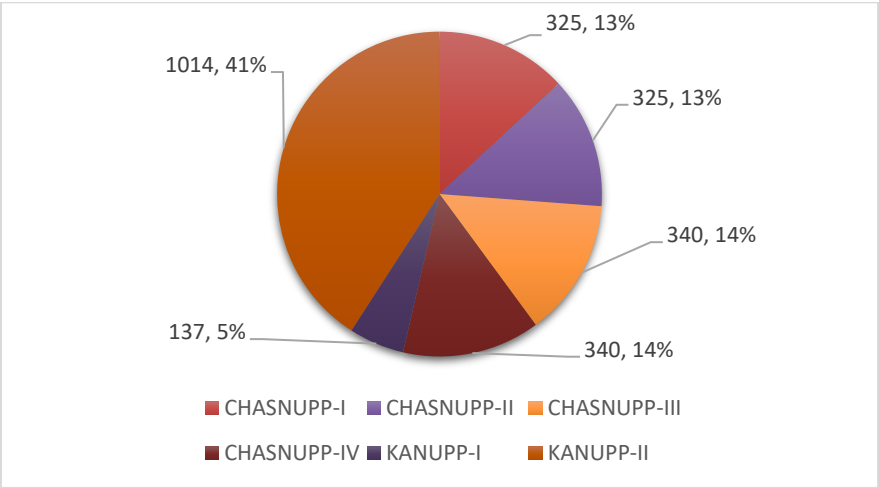
Sr. No.	Project Name	Power Generation Capacity (MW)
Hydro Power (Under Construction)		
1.	Dasu	4,320
2.	Keyal Khwar	128
3.	Kurram Tangi	83.4
Sub Total (A)		**4,531.4**
Hydro Power (Ready For Construction)		
1.	Bunji	7,100
2.	Harpo	34.5
3.	Mohmand Dam	800
4.	Tarbela 5th Extension	1,410
Sub Total (B)		**9,344.5**
Hydro Power (Future)		
1.	Basho Hydropower Project	40
2.	Chitral Power Enhancement	5
3.	Dudhnial Dam Multipurpose Project	960
4.	Hingol Dam Project	1.37
5.	Lower Palas Valley	665
6.	Lower Spat Gah	496
7.	Middle Palas Valley Hydro Power Project	398
8.	Middle Spat Gah Hydro Power Project	489
9.	Murunj Dam Project	12
10.	Patan	2,400
11.	Phandar Hydro Power Project	80
12.	Renala Power Rehabilitation	4.4
13.	Shyok Dam Multipurpose Project	640
14.	Tank Zam Dam Project	25.4
15.	Thakot Hydro Power Project	4,927
16.	Tungas Hydro Power Project	2,200
17.	Upper Palas Valley Hydro Power Project	157
18.	Upper Spat Gah Hydro Power Project	252
19.	Yulbo Hydro Power Project	2,800
Sub Total (C)		**16,552.17**
Total Hydropower Capacity (MW) = Sub Total A+B+C		**30, 428.07**

Source: Water and Power Development Authority (WAPDA), 2021.

d) Nuclear Power

Nuclear power is competitive compared to other electricity generation options, but requires high initial investments, huge industrial infrastructure and sophisticated technical expertise for its development and operation. Pakistan started developing nuclear energy in 1960s and currently producing 1,467 MW plus 1,014 MW from Karachi Nuclear Power Plant–II (KANUPP-II) making total of 2,481 MW of nuclear energy; contributing around 6 percent to total installed power generation capacity in the country.[21] Karachi Nuclear Power Plant – III (KANUPP-III) with capacity of 1,014 MW is under construction and will be operational in 2022.[22] However, Pakistan is targeting 8,800 MW of tangible nuclear power generation capacity by 2030.[23] The Figure 9 below shows the current installed capacity of nuclear power plants in Pakistan.

Figure-9: Installed Capacity of Nuclear Power Plants in Pakistan (MW)



Source: National Electric Power Regulatory Authority, 2020.

Major Causes of Energy Crisis in Pakistan

a) Governance Structure

Currently there are numerous agencies working under two different ministries for energy development, transmission and regulation with their own terms of reference, policies and strategies without any efficient system of coordination. Since June 2017, two regulatory authorities have been put under control of two different ministries i.e., NEPRA under Water and Power Division and Oil and Gas Regulation Authority (OGRA) under Petroleum and Natural Resource Division. These regulatory

authorities are working in highly centralised manner under considerable political influence on pricing and tariffs.

b) Policy Issues

Absence of an energy policy to provide guidance for improved monitoring, evaluation, and decision making by the government for the secure supply of energy accentuates lack of integration in energy policymaking and implementation as there are separate bodies for policy making, planning, developing a legal and regulatory framework for each fuel mix.

c) Barriers for Hydropower Projects

Over the years, a strong inclination has been observed towards promoting IPP and generation through thermal sources, while ignoring the hydel sector resulting in fall, in the ratio of hydel energy in the overall energy mix. In the past three decades the policies has been focusing more on short term quick solutions.

d) Heavy Reliance on Imported Fossil Fuel

Heavy reliance on imported fossil fuels particularly oil and LNG has been the trend in our energy profile. Oil and LNG worth $824.872 million,[24] were imported in FY 2020-21 which is nearly 15% of the entire import bill.[25]

e) Depletion of Indigenous Gas

Share of indigenous natural gas has reduced from 43% of energy mix in 2014 to 34% in 2019 as Pakistan's depleting reserves are sufficient only to sustain current levels of gas consumption of (17.2 MTOE) for the next only 25 years.[26] Indigenous supplies are expected to decline by approximately 50% in the next 10 years, which will have to be covered through LNG imports in addition to catering for incremental demand growth.

f) Shale Gas Exploration

According to a report published by US Energy Information Administration (EIA), Pakistan has estimated fresh recoverable shale gas reserves of 105 Trillion Cubic Feet (Tcf) and more than nine billion barrels of oil in Pakistan.[27] Shale gas had seen tremendous developments in a couple of other countries.

g) Independent Power Producers (IPPs) Issue

Introduction of IPPs in energy sector had considerable implications on power sector that raised the prices of power and shifted Pakistan energy mix in favour of oil

and gas. In addition, the inexpedient agreements with IPPs allowing them to set high tariffs and inessential guarantees also aided to the power crisis in Pakistan.

h) Transmission and Distribution Losses

Pakistan ranks 14 out of 131 countries of world in T&D losses. T&D loss of one percent can incur deficit of approximately twenty billion rupees over national treasury.[28] These T&D losses are both technical and non- technical/commercial, both arising mainly due to poor administration and poor governance.

i) Fuel Storage Capacity

Pakistan is importing 80% of crude and refined oil products through 17 Oil Marketing Companies (OMCs) which have to maintain 21 days stocks but most of the time their stocks are not more than 10 to 13 days due to financial constraints and lack of storage infrastructure. Even 21 days stocking level is not enough as Pakistan is highly dependent on oil from Middle East which is a volatile region and crisis in the ME can make country's supply chain further vulnerable. Moreover, due to unpredictable international oil prices, Pakistan keeps suffering from oil price shocks.

j) Issues in Oil Refining Sector

Currently, there are five major oil refineries in Pakistan whose combined capacity is about 417,400 barrel per day (BPD).[29] In Pakistan all the refineries are of old hydro skimming technology, which produces 30 to 40 % furnace oil and low standard fuels. Converting these refineries from hydro skimming to deep conversion is need of time apart from increasing refining capacity.

k) Indigenous Sources of Energy

Pakistan is an energy deficient country despite having sufficient natural resources and potential. Coal is still used as a major source of power generation in world and Pakistan has huge untapped coal reserves. Furthermore, the renewable power generation potential of Pakistan is also enough for satisfying the energy demands.

l) Offshore Hydrocarbon Exploration

Pakistan has huge potential of hydrocarbons in its offshore area. Though drilling done in Kekra-1 block,[30] was not successful but still there is a good potential of hydrocarbons production in Pakistan offshore area.

m) Inappropriate Energy Mix and Share of Alternative Renewable Energy Resources

There is a high reliance on expensive imported oil with very less power generation from coal despite huge potential to generate 4000 MW of electricity by utilizing only 1% of total Thar coal reserves alone.[31] Alternative energy resources including solar, wind and biogas options are ignored too.

n) Circular Debt

Government policies, failure to recover T&D losses, overstaffing, delays in payments, inefficiency in collection of revenue, and inappropriate allocation of subsidies are issues of paramount importance that are responsible for lingered circular debt in country.

o) Undue Subsidies

The imbalance between electricity price per unit and per unit cost of supply is covered through subsidy. Despite paying heavy subsidies for helping the poor households, the major portion of these subsidies benefit richest households in country.

p) Lack of Financial Resources

Availability of technical, financial or human resources is crucial for the success of any policy or project. Lack of financial resource is also responsible for poor infrastructural development and inability to solve the circular debt issue of Pakistan.

q) Non-Development of Human Resource

Inadequate focus on development of human resource has created lack of skilled manpower in energy sector. Resultantly, inefficient and irrelevant persons at crucial positions have deteriorated the sector performance. The short-term solutions were adopted by highly paid consulting foreign agencies and experts causing further stress on national treasury.

Way Forward

Pakistan despite its relevance to the energy security of the region and beyond, has not been able to solve this crisis due to different roles and policies of the multiple energy bodies and organizations in the country. The current situation demands strict implementation of the following steps to achieve energy security in Pakistan.

a) Improving Energy Governance by Establishment of National Energy Authority

There is a need to establish a single National Energy Authority (NEA) to oversee all institutions in the energy sector. NEA must have the power to coordinate the efforts of all the sectors, relating to drafting and implementation of a single energy policy.

b) Energy Security Policy

Pakistan has to come up with a clear long-term, consistent, and rationale policy for the energy security of Pakistan; therefore, a centralised comprehensive policy to address existing energy sector issues, is required to be formulated. There are following recommended key policy goals.

1) Realistic and Objective Oriented Approach in Formulating Policy. Policy making should be realistic based on actual potential and affordability. Tendency to make false promises by political parties be curbed. Objectives and goals of policy should be attainable and practicable.
2) Achieving Robustness, Resilience and Sovereignty. Main policy goal for ensuring the energy security of Pakistan should concentrate on robustness, resilience and upholding **s**overeignty focusing on reduction in imports and more reliance on exploiting local resources.
3) Ensuring Efficient Energy Consumption Policy. To reduce the demand and supply gap, the policy is to focus on both increasing supply and decreasing consumption by minimizing distribution losses and other wastages.

c) Formulation of Integrated Energy Policy

Integrated energy planning is to be followed with four key considerations.

1) Minimize Burden on Balance of Payments. Indigenisation is to be pursued ensuring national energy security. For instance, Thar coal may also be explored for its potential of conversion into other energy forms for use in other industries.
2) Maximize Storage Based Hydro Projects. Under-development hydropower projects should be completed without any further delay. Other multiple projects with over 25,000 MW that are at feasibility / engineering stage with WAPDA should be expedited.
3) Exploit Solar/Wind Potential. Best use of solar is at small scale domestic application whereas wind potential should be harnessed through large scale wind farms. Local solar assembling and manufacturing industries need to be encouraged and developed.
4) Exploit Local Hydrocarbon Resources. Adequate incentives should

be provided in the policy framework for expeditious development of shale gas/oil potential. Unexplored areas where 3D seismic surveys have been completed must be opened for gas and oil exploration.

d) Ensure Competitive Tariffs

1) Natural Gas Tariff. Captive power plants receive selective advantage in terms of gas allocation and pricing. In current power surplus situation, captive power plants must move to national grid. Gas pricing to captive power plants must also ensure levelized cost of power generation at par with new RLNG based power plants.
2) Power Sector Tariff. Reduction in T&D losses from 20% to 10% in the next 5 years can reduce the consumer tariffs by around 1-1.5 cents/kwh. DISCOs should be allowed recovery of capital investment for investment in replacement/upgradation of technology required for reducing T&D losses.

e) Energy Efficiency and Conservation

1) Hybrid / Electric Vehicles**.** Hybrid & electrical vehicles should be promoted/incentivized in the new Auto Policy including installation of battery charging stations.
2) LED Lightening**.** LED bulbs are approximately 50-80% more efficient than other alternates. Import duties and sales tax on LED bulbs should be removed and industry be incentivised for local manufacturing.
3) Building Codes and Commercial Shopping Centres**.** There is a need of creating awareness about energy conservation and using day light hours. Pakistan can save up to 1,100 megawatts of energy if its industries and households – the two main energy consuming sectors try to change their behaviour about energy conservation.

f) Revising Independent Power Producers (IPPs) System

1) Energy efficiency Tests of IPPs. To analyse efficiency of installed IPPs, energy efficiency tests of every IPP be conducted at priority. IPPs to enhance their production and those with less efficiency may be decommissioned.

g) Building a Balanced / Diversified Energy Supply Mix

The desirable energy supply mix can generate a gross installed capacity of 118,268 MW of power by the year 2030 in which indigenous energy resources of Pakistan as a whole represent 80.7 percent. The share of oil and gas in the supply structure is to

be reduced to only 11.8 percent with the total gross installed capacity less than 14000 MW.

1) Increased Alternative Renewable Energy Share in the Supply Mix. A diversified approach is needed to be adopted with increase in the share of solar, wind, biomass, and nuclear resources of energy. Wind Projects planned in already identified wind corridors of Sind and Balochistan be completed.
2) Enhanced Use of Nuclear Energy. A self-sustaining Nuclear Power Vision 2050 for producing 40,000 MW is to be earnestly perused.
3) Solar Sector in Energy Production through Net Metering. The potential of solar energy is high in Pakistan. Utility companies should be tasked to propagate 'net metering' for domestic consumers, to generates low-cost electricity during daytime, when power demand maximizes.

h) Development of Inter Provincial – Federal Harmony on Energy Issues

The grievances of provinces on water share, hydroelectric profit, share of energy and other energy related issues should be addressed. Myths related to disputed large reservoirs be exploded and political rifts and issues should be delinked from such important energy projects by building confidence and bringing provinces together through just distribution of resources and awareness campaigns.

i) Strong and Continued Political Will

Strong and continued political will for structural reforms is needed to secure the future energy needs. Political consensus on the issues of energy tariffs, T&D losses and recovery of energy costs should be developed with a view to curb financial deficits in energy supply chain.

j) Promotion of Biogas in Ruler Areas for Domestic Use

Pakistan is the 13th largest country in cattle production and can produce biogas for off grid uses in villages and small towns to reduce the dependence on gas for domestic use.

k) Waste to Energy Projects

The solid waste in 9 major urban centres is around 7.12 million tons per annum which is increasing by 2.5 % per year. This capacity can be utilised to produce power generation of around 13,900 GWh per annum.

l) Use of Modern Technologies

Recently, Pakistan faced a countrywide blackout due to sudden decrease in frequency in transmission system.[32] Pakistan still operates outdated power grids and transmission systems. There is a need to utilise the latest technologies in the energy sector i.e., automation, efficient management, fault eradication, artificial intelligence, smart computers, latest research and development tools to avoid undesired power cuts and T&D losses.

Conclusion

To meet the growing demand of Pakistan's energy, country needs a multi-pronged approach and all-encompassing energy eco-system, comprising of a strategic energy culture, a national energy narrative, a national social energy outlook, and energy supportive education to develop human capital system and a system of incentivizing the energy sector. Energy security can be achieved through political will, robustness and resilience. Pakistan needs to have the right methodology and structure to go about the energy security. Also needs to have the right energy mix and reduced dependence on fossil fuels. There is a dire need to exploit indigenous resources whether they are hydel, renewable, nuclear or coal to bring energy sufficiency and reduce the cost of imported energy. The over utilisation of expensive imported resources has already deteriorated the energy situation and has seriously impacted our economy. The diversification of the energy mix and utilisation of indigenous resources is key option with Pakistan to ensure its energy security. At the same time, environmental concerns should be kept at the forefront in dealing with the energy crisis and options for greener and sustainable energy should get the priority to ensure a cleaner environment for the local population.

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