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Power Generation Policies, Governance Mechanism and Utilization of Indigenous Resources: A Case of Pakistan

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Abstract

Energy has been playing a vital role in the socio-economic development of the country. Pakistan's energy security holds paramount importance as it is essential for enhancing socio-economic development. Pakistan is currently facing a rising electricity demand and contending with a substantial deficit in natural gas supply. Most of the power generation plants in Pakistan are thermal and generate electricity from oil and gas. Pakistan is not an oil-producing country and natural gas reserves will be died out after 12 years. Under the Power Generation Policy 2015, most of the plants generate electricity from imported coal instead of utilization of national indigenous reserves i.e. local coal. Under the PGP 2015, all the power plants operated under the PPP model known as (BOO). Over the last three decades Government of Pakistan has announced seven energy policies to attract the foreign investors in the power generation sector that have led to acute governance, admirative and implementation problems in the energy sector. This study explores the intricate relationship between energy security, energy crises, demand and supply, and renewable potential in Pakistan. Using qualitative analysis, it addresses the ongoing energy crises and proposes the development of national indigenous resources, presenting a policy framework to achieve power generation goals. The energy status in Pakistan, including supply and demand aspects, is discussed, along with major challenges such as electricity theft and circular debt annually. By considering various approaches, the study identifies key challenges for policy development and implications to create a comprehensive policy framework, incorporating domestic energy resources, policy actors, criteria, and tools. This study highlights Pakistan's significant non-renewable energy potential, advocating for tapping into domestic resources, optimizing energy planning, and policy development to ensure a secure and sustainable energy future for the nation, promoting prosperity and progress.

***Keywords*:** Energy Policy, Policy Administration, Public-Private Partnership (PPP), Independent Power Producers (IPPs) Energy Planning and Infrastructural Development

1. Introduction

The socio-economic development of the country is contingent upon its energy consumption. This critical energy field is interconnected with multiple level of economic development, making it a key factor in determining overall prosperity (Rehman et al., 2017). Due to high energy demands of the modern world, countries heavily rely on both renewable and non-renewable resources to generate energy (Rauf, Wang, Yuan, & Tan, 2015). However, the current energy policy and transmission system is inadequate to meet the escalating energy demands caused by a rapidly growing population and technological advancements (Rauf et al., 2015). According to Pakistan Economic Survey 2016, Pakistan faces similar situation, with the substantial number of energy consumers throughout the year, resulting in sudden shifts in power demand. As compared to other countries in the world, Pakistan is experiencing a severe energy crisis due to wrong contractual agreements with IPPs and ineffective policy implementation. Pakistan is facing significant electricity shortages, affecting a considerable portion of its urban and rural population. Pakistan has been following the faster urbanization trend in South Asia (Z. Fatima, 2022; Gyamfi, Agozie, Bekun, & Köksal, 2023). However, the Country's highly dependence on foreign resources highlights the lack of adequate exploitation of its indigenous energy resources (Kanwal et al., 2022; Raza, Khatri, Haque, et al., 2022b).

Power generation sector in Pakistan legs behind when compared to other Asian countries. Despite having abundance indigenous resources for energy generation, these resources have not been effectively utilization (Qaiser, 2022; Raza, Khatri, Israr, et al., 2022). After 1994, due to private investment in the PPP mode, Pakistan has built significant electricity generation capacity. nevertheless, Pakistan has been continuously struggling to meet the supply and demand gap for the provision of electricity due to the ambiguity in the policy implementation process. According to the 2021 annual report from the National Electric Power Regulatory Authority's (NEPRA), Pakistan has total installed power generation capacity of 39772 MW. This comprises of 63% of energy generated from thermal source (fossil fuels), 25% from hydro plants, and 5.4% from renewable (including wind, solar and biomass) and 6.5% from nuclear. After the implementation of PG the PG Policy 2015 and numerous power generation projects initiated under the CEPEC program, Pakistan managed to overcame its energy shortage crisis in 2017. However, this achievement inaccessible sustainability, as Pakistan faces power shortage issues once again in 2020, failing to meet the supply and demand needs (Qudrat-Ullah, 2022). This persistent problem remains a critical issue that requires attention from the government, decisionmakers and stakeholders.

In contrast the NEPRA policies and increasing tariffs seem to be a major cause of disputes between government agencies and IPPs. NEPRA evaluate the performance of IPPs and impose sanctions. Other issues related to governance and energy theft Nagayama (2010) reveals that in his study there is strong correlation between electricity theft and bad governance. The study indicates that countries with less effective accountability, political instability, lack of participation and corruption tend to experience high level of electricity theft. Moreover, country has significant power generation capacity but has fewer transmission companies and weak power distribution mechanism that indicating issues related bad governance. These issues have hindered the progress of the power generating sectors, whether in the private or public domain. In the current era, with the growing demand for energy to support industrial, agriculture and domestic needs, the inadequacies in the transmission

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sector and the associated uncertainty discourage potential investors to invest in Pakistan. For example, in previous regime, Pakistan was pursuing industrial growth, which led to a significant increase in demand for affordable energy. The Russian government was offering oil at low prices creating golden opportunity for Pakistan to restructure its energy mix in a manner that can be cost- effective. (Zafar & Raja, 2022). However, the lack of government determination and the influence of some supranational institutions poses challenges for energy sector.

From the past three decades, Pakistan's power policies have reflected the government's approach to addressing the energy shortfall through the encouragement of private sector investment by the implementation of the Public-Private Partnership approach. However, PPP approach has also resulted in the accumulation of circular debt, exacerbating the financial crisis and placing an additional burden on both government and general public in the form of higher tariffs. These factors contributing to the circular debt issue leading to financial crisis are PPP adopted policies and models, as well as inappropriate governance mechanism. Furthermore, elaborated that all the previous policies including PG policy 2015, have proven to be ineffective and not truly beneficial for the government. Additionally, these policies exponentially increase administrative problem, poor governance mechanism, contributing to the circular debt and not effectively utilization of national indigenous resources (Aslam, Nazir, & Zia, 2021; Mahmood et al., 2014; Afia Malik, 2015; Raza, Khatri, Haque, et al., 2022a; Raza, Khatri, Haque, et al., 2022b; Raza, Khatri, Israr, et al., 2022).

Conversely, Pakistan is abundantly blessed with wide range of indigenous energy resources including coal, natural gas, biomass, geothermal, and solar energy. By effectively and efficiently harnessing and exploiting these natural reserves, the country has the potential to overcome its energy crises and sustainably meet the future energy demands (Raza, Khatri, Haque, et al., 2022b; Raza, Khatri, Israr, et al., 2022). It is evident that the government of Pakistan not effectively using these natural resources effectively. There is dire need to make proper strategy and plan to effectively utilize these natural resources to meet the energy demand of the county. These strategies and course of actions require urgent attention to ensure a stable and reliable energy supply that that supports the country's development and prosperity. Furthermore, it is essential to acknowledge the importance of exploiting national energy resources and also important to develop long-term energy strategic plans to secure these natural resources like gas. By adopting strategic and sustainable approach, the country can overcome its energy challenges and pave the way for a more secure and self-reliant future (Zafar & Raja, 2022)

Another important component is the national transmission and grid network, which experiences inefficiencies in the smooth transmission of energy process and has leakages in the process. The establishment of well-connected grid network and an improved distribution structure, combined with the encouragement of local involvement in power generation and the promotion of private investment, can make significantly contribute to resolving Pakistan's energy challenges. By developing efficient energy infrastructure, involving local communities in energy generation initiative and attracting private investments, the country can enhance its energy capacity and ensure a more sustainable and reliable energy future (Magnoni & Bassi, 2009; Van Der Schoor & Scholtens, 2015).

Beside confronting all the governance and policy issues, Pakistan remains committed to meeting the sustainable Development Goals (SDGs), with the goal 7 deals with power generation and clean energy. The vision is to achieve clean and secure energy by 2030, ensuring accessibility and affordability for everyone. However, the limited contribution from the private sector has significantly affected this vision and the increasing excessive tariffs are also undermining this vision. After evaluation of policies and projects of power generation under PG policy 2015, it becomes evident that there is a need to develop unified power generation framework that improve the administrative and governance mechanism among the power generation sector organizations.

Based on Pakistan's vision 2025 and national Annual Plan 2020-21, study responds to the policies of power generation sector. Pakistan despite being having numerous indigenous and renewable resources has failed to fulfil energy demand. Therefore, this study focuses to propose a strategic alliance among public and private power generating sectors. The Study deals with evaluation of policies, proposing policy framework and the effective implementation for future power generation options. Based on findings, policy designs and actions would be suggested.

1.1. Research Questions

How can Pakistan develop an effective policy framework to enhance the power generation mechanism and address existing policy challenges in the power sector?

1.2. Objectives

- To analyse the current state of power generation policies and identify key challenges within the power sector in Pakistan.
- To formulate a comprehensive policy frame work that address the identified challenges regarding governance and administrative mechanism.
- To access and recommend practical strategies and implementation method for the proposed policy framework while resolving policy related issues.
- Aim of this study to propose a suitable and effective policy implementation model.

2. Literature Review

2.1. Power Generation resources and demands in Pakistan

Energy is the essential element in the socio-economic development and backbone for any country. The world has witness of increasing energy demand due to population growth and the innovation of more automated machines, which have made human lives easier and work efficient (Bradu et al., 2022). In the case of Pakistan, due to rising population density and the demand of electricity exponentially increases. According to State Industry report, (2019) Pakistan power generation sector is prominently reliant on fossil fuel resources (crude oil, coal, natural gas, liquified gasoline) instead of renewable energy

resources. Pakistan has a huge potential for renewable energy sources and also experience and capability to generate electricity from nuclear power plants (Asghar, Sulaiman, Mustaffa, Ullah, & Hassan, 2022; Rabbani & Zeeshan, 2022).
From the inception, Pakistan has primarily focused to generate electricity through hydel power plants (Abbas et al., 2022; N. Fatima, Li, Ahmad, Jabeen, & Li, 2021). Regional governments were responsible for the power generation and distribution with 4.5 units per consumer and 31.5 million people were distributed the electricity with capacity of 60 Wh (Baloch, Kaloi, & Memon, 2016). During 1980 era the initiative for the development of nuclear power reactors under the management of Pakistan Atomic Energy Commission sector the capacity of power sector arose to 3 GW. Meanwhile, Pakistan generates electricity from five nuclear plants (Abbasi, 2016; Karim et al., 2018; Rauf et al., 2015; Von Hirschhausen, 2018). By 1990 WAPDA distributed license to private company like Karachi Electric Supply Company (KEC). KEC generation and distribution electricity in Karachi and the capacity of power sector increased to 7GW. The approval of state-owned power sector in 1992 and involvement of independent power producers by year 1994 (K. L. Khatri, Muhammad, Soomro, Tunio, & Ali, 2021; S. A. Khatri et al., 2022; Raza, Aman, et al., 2022; Raza, Khatri, Haque, et al., 2022b).
Currently, 67% of the energy demand in Pakistan is met with non-renewable resources i.e. oil, gas and coal etc., which are increasing at more than 10% every year (I. Khan et al., 2023; Tahir, Saeed, & Ali, 2023). In a recent study it has been seen that the annual average growth rate of energy demand will be 8.35% by 2050 (S. Ali, Yan, Sun, & Irfan, 2023; Conteh et al., 2023). Pakistan is facing an energy crisis due to two main reasons: first, energy policy and energy structure are mainly dependent on IPPs, which are very expensive and always in demand due to electricity shortages. Second, Pakistan's renewable energy sector only participates in 0.3% of overall energy needs, which is negligible. The country's power production sources include natural gas (44%), oil (35.5%), hydropower (11%), coal (7%), nuclear (2%), and renewable energy (0.3%).(Shahid Ali, 2021). Severe energy crises have destructive impacts on the national economy of Pakistan.

2.2. Power generation Policies to attract IPPs

Over the last three decades, Pakistan's power generation policies have witness to attract the private power generation companies by effectively utilizing the national indigenous resources such as coal and gas. The 1994 power policy, introduce new liberal policy that attract private investors in the power generation sector. The government introduce two PPP models BOO and BOOT. BOO for fossil fuels plants and BOOT for hydro plants. Under the PPP approach, the GoP provides facilities, incentives and guarantees to private sectors (Hulio, Jiang, & Chandio, 2022). NEPRA determine tariff for power generation companies using the "Cost- Plus" method. This method assumes that there is a fix cost for providing electricity, which can be known in advance and does not depend on the changing prices in the electricity market due to supply and demand. This approach is wrong because it misunderstands how prices reflects the value of service, which is fixed and unchanging (N. S. Khan, Batool, & Fatima, 2023). Furthermore, IPPs were granted the flexibility to utilize various technologies in the construction of plant and also allow to use imported fuels (Aqeeq, Tahir, Haider, Aqeeq, & Abdullah, 2023). In 1998 power policy was successful in attracting private investors, with Hub power project serving as a notable success story in the history of IPPs. The 1998 policy was a complete contrast of 1994 policy, main focus of government were hydro and coal power projects. Third policy were introduced for IPPs in 2002. This power policy much emphasized on the diversification of energy resources and encouraging the IPPs to introduce thermal plants in Pakistan. This policy introduces a competitive bidding process and aimed to reduce the burden on the government in power generation, transmission and distribution. 2002 policy sought to address the country's growing energy needs by fostering private sector participation and enhancing the efficiency. The short fall of this policy was most of the plants use gas resources that create gas scarcity in the country. In 2013 GoP introduced another power generation policy that is called national power policy 2013. This policy was introduced to reduced supply and demand gap in the country. This policy brings comprehensive policy design that emphasis on addressing transmission, distribution efficiency and enhancing governance mechanism in the energy sector. This policy has not capacity to bring significant changes in the energy sector. 2013 policy not effective as policy makers considered and just after two year GoP introduced an other policy that is called Power Generation Policy 2015 (Zahid Hussain Hulio, 2022). Power generation policy 2015, was introduced in Pakistan due to inadequacy of previous policies in addressing the supply and demand gap (Aized, Shahid, Bhatti, Saleem, & Anandarajah, 2018; Aqeeq et al., 2023; M. Khan, 2020; Mirjat et al., 2017; Raza, Khatri, Israr, et al., 2022; Zameer & Wang, 2018). This policy placed a strong emphasis on IPPs in power projects development and fostering PPP mechanism in the power generation sector. In this policy GoP adopt different modes and model of PPP mechanism that based on Government to Government, Joint venture, and utilization of national indigenous resources instead of rely on expensive imported fossil fuel. Under this policy IPPS introduce mega capacity energy power plants. The GOP also created the Private Power and Infrastructure Board (PPIB) and relevant entities in the provinces, while also offering guarantees to local and foreign investors to attract substantial investment in the energy sector. In 2021, Pakistan introduced another policy that is called "National Electricity Policy 2021".
The National Electricity Policy 2021 was formulated with the primary goal of ensuring affordable, sustainable, and reliable access to electricity for domestic and industrial users. This policy harbor key principles for the power sector, encompassing efficiency, transparency, competition, financial viability, environmental responsibility and indigenization research and development. This comprehensive electricity policy covers all the sub-sectors including transmission, distribution and supply (S. Ali et al., 2023; Aqeeq et al., 2023; Nishtar & Afzal, 2023; Xu et al., 2023). It outlines actions to ensure the efficient operation system, utilizing IT-based automated systems for transparency. The policy emphasizes the adoption of appropriate framework, plans, guidelines and mechanisms to guarantee its effective implementation, with the Ministry of energy and resources entrusted with the responsibility of monitoring and overseeing the implementation of Electricity Policy 2021.
There are four power generation sectors in Pakistan includes PEPCO, WAPDA, PAEC and IPP's and ten power distribution companies and one transmission company. (Khatri et al, 2021).

Source: Power sector structure (Hulio et al, 2022)

2.3. Regulatory Authority

NEPRA is a regulatory body of the power generation sector in Pakistan. It has responsibility to monitor the performance, issue licenses and determine tariffs to power generation companies. NEPRA also issues licenses to power distribution and transmission companies (Afia Malik, 2022; Masroor et al., 2021). Moreover, NEPRA also has core responsibility to protect the rights of consumers (Iqbal et al., 2019). In 2015, NEPRA established rules and regulation guidelines for net-metering program, enabling DISCOs to procure surplus energy units generated by reneable source from consumers at the rates specified by company offers (Afia Malik, 2022; Zahid et al., 2020). NEPRA has established sules for all distribution and power generation companies. These rules include mandating the construction, opertaionm control, maintenance, production, of their systems in accordance with the consumer service manual, power safety mode and power distribution code. These standards are important to ensuring the safety of power distribution and minimizing the risk of fraudulent activities from the any company (Qazi & Jahanzaib, 2018). In 2020, NEPRA approved the implementation roadmap of Competitive Trading Bilateral Contracts Market (CTBCM) reforms that channelize competition in the power sector (N. S. Khan et al., 2023). Jamil, Ullah, Saleem, Abbas, and Khalid (2022) stated that Pakistan's power market operates and regulate by the NEPRA and it has monopoly to determine the tariffs for all power generation sector as well as for genral public. Government of Pakistan may develop the mechanism that based on the multiple- buyer market principle rather that groom competitive market rather than based on the single-buyer market principle.

2.4. Energy Consumption Overview

Pakistan has experienced a substantial increase in energy demand, primarily due to its growing population, which researched 212.48 million in the year 2021. The significance portion of this population resides in rural areas which is approximately 63.66% (Raza, Khatri, Haque, et al., 2022b). There are five essential energy consumer sectors which are industrial, domestic, commercial, agriculture and pubic services. In 2021 total power consumption demand was 125.392TWh. among these energy consumer sectors domestic sector use most electricity that was 48.05% of the total, while industrial used 24.71%, agriculture used 9.13%, business used 7.68% and remaining public service used 10.43% (Raza, Khatri, Haque, et al., 2022b). The demand for energy is exponentially increase and will increase till 2040. The domestic and agriculture demand will increase at a rate of 6.2%. however industrial sector's energy use will grow at the rate of 8% and the commercial sector's energy use will increase at a rate of 11% (Raza, Khatri, Rafique, et al., 2022)..

2.5. Power Generation Sources

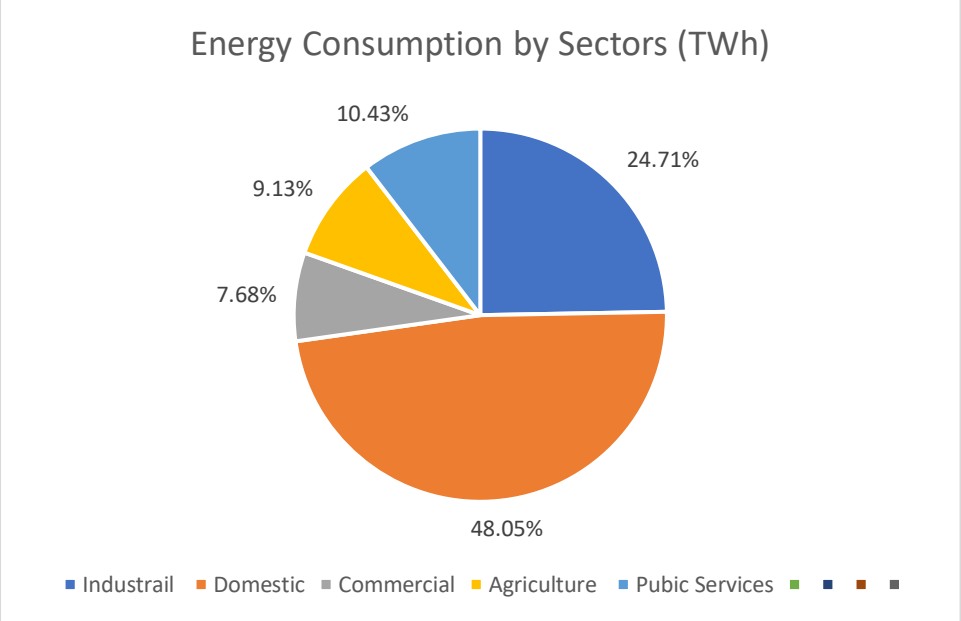
Various energy sources like wind, solar, hydel, and fossil fuels have ever-increasing demand worldwide especially in developing countries. Hence, global energy consumption may rise about 50% by 2050 (Kanwal et al., 2022). According to International Energy Agency, (2019) stated that China and India are forecasted to lead the world energy consumption market. Additionally, millions of dollars are being spent on import of fossil fuels that also resulted in circular debt. Pakistan's electricity demand is gradually increasing, and the country is being challenged with significant natural gas supply-demand deficit. Thar fossil fuel reserves, mostly coal reserves will play a critical role in meeting energy needs for decades.

In Pakistan, hydroelectricity is the only renewable energy source that the nation has been using to generate electricity for several years. Presently, 80% of energy production in Pakistan is provided by crude oil, with hydroelectric power contributing 11%, coal for 6%, LPG for 1%, and nuclear energy for 2%. Percentage share of fuel-wise installed capacity in MW Hydel (10,251), RLNG (9884), RFO (5958), Coal (5,332), Gas (3,536), Nuclear (3,647), Wind (1985), Solar (660), Bagasses (364) (A. Ali et al., 2023).

Since energy production by crude oil is expensive and harmful to the environment. Developing countries such as Pakistan should take serious actions to replace such hazardous forms of energy with sustainable green energy (Naqvi, Uzair, Akhtar, Zaidi, & Kazmi, 2022; Raza, Khatri, Memon, et al., 2022).

The global energy system during the 20th century was predominantly based on coal for power generation due to its low cost and abundance (Miller, 2005). However, Pakistan did not use potentially its coal reserves for energy needs before the CPEC projects (Lin & Raza, 2020). However, it is expected that the share of coal in Pakistan's energy mix will continue to grow in the future in order to meet energy needs from traditional and affordable resources (A. Y. Malik et al., 2020). Under the CPEC, 1320 MW Sahiwal coal power plant, 1320 MW Port Qasim coal power plant, and 1320 MW HUBCO coal power plant are the first-ever coal-fired plants; however, these plants operate on imported coal. In parallel, Engro 2 x 330MW Thar coal power plants have also started functioning since early 2019. These are the first important power plants in Pakistan that use

local Thar coal. It is expected that the share of coal in Pakistan's energy mix will grow to meet energy needs from traditional and affordable resources (Lin & Raza, 2020; A. Y. Malik et al., 2020; Raza, Khatri, Haque, et al., 2022b; Raza, Khatri, Memon, et al., 2022; Syed et al., 2020).



Source: (Raza, Khatri, Haque, et al., 2022b)

Project	Capacity (MW)
Port Qasim Electric Company Coal Fired, 2x660, Sindh	1320
Sahiwal 2x660MW Coal-fired Power Plant, Punjab	1320
Engro thar 4x330MW Coal-fired, Thar, Sindh	1320
HUBCO coal power plant 1X660 MW, Hub Balochistan	660
Rahimyar Khan Coal Power Project, Punjab	1320
SSRL 2×660 MW Mine Mouth Power Plant,Sindh	1320
HUBCO coal power plant 1X660 MW, Hub Balochistan	660
Thar mine mouth oracle, Thar Sindh	1320
Muzaffargarh Coal Power Project, Punjab	1320
Gaddani Power Park Project (2×660MW)	1320
Total Installation Capacity	**11880**

Source: PPIB

2.6. Implementing Agencies in Power Generation

For the sustainable electricity distribution, the Government of Pakistan adopt the Public–Private Partnership model and involved various ministries, public sector organization that make alliance with private sector organizations to take advantage in energy sector (Raza, Khatri, Israr, et al., 2022).

The key institutions and organizations developed operational framework comprise the Ministry of Power Divion and resources, which includes the Petroleum Division, Power Division, facilitator and Regulatory bodies. Power division is the responsible for the power generation, transmission and distribution across the Pakistan. The petroleum divison regulate the operation of petroleum entities like PSO, PPL and OGDCL. Ministry of water and resources regulate and control Hydro projects through WAPDA. Number of regulatory bodies such as OGRA, PNRA and NEPRA play a crucial role to evaluate the performance of power generation plants. NEPRA determine the tariff and PPIB perform its duties as a facilitator. NTDC is a power transmit company and DISCOs has ten power distribution companies. DISCOs companies are MEPCO, HESCO, FESCO, QESCO, PESCO, SEPCE, GEPCO, LESCO, TESCO and K.E. CPPA-G is a single energy buyer agency in Pakistan. CPPA-G also purchase energy from IPPs.

acronyms.

1. PSO = Pakistan State Oil
2. OGDCL = Oil & Gas Development Authority
3. PNRA = Pakistan Nuclear Regulatory Body
4. WAPDA = Water & Power Development Authority
5. SPGCL = Southern Power Generation Company Ltd
6. NPGCL = Northern Power Generation Company Ltd
7. IPP's = Independent Power Producers
8. KANUPP = Karachi Nuclear Power Plant
9. HESCO = Hyderabad Electric Supply Company
10. MEPCO = Multan Electric Supply Company
11. FESCO = Faisalabad Electric Supply Company
12. IESCO = Islamabad Electric Supply Company
13. QESCO = Quetta Electric Supply Company
14. PESCO = Peshawar Electric Supply Company
15. PPL = Pakistan Petroleum Limited
16. OGRA = Oil and Gas Regulatory Body
17. NEPRA = Pakistan Electric Power Regulatory Body
18. GENCO's = Power Generation Companies
19. CPGCL = Central Power Generation Company Ltd
20. PPIB = Private Power Infrastructure Board
21. PAEC = Pakistan Atomic Energy Commission
22. CASNUPP = Chashma Nuclear Power Plant
23. SEPCO = Sukkur Electric Supply Company
24. GEPCO = Gujranwala Electric Supply Company
25. LESCO = Lahore Electric Supply Company
26. TESCO = Tribal Electric Supply Company
27. K.E = Karachi Electric
28. NTDC = National Transmission & Dispatch Company

Source: (Raza, Khatri, Memon, et al., 2022)

3. Energy Security Challenges in Pakistan

3.1. Economical condition of Pakistan

The economy of Pakistan has been struggling from the inception phase. Due to economic instability country highly rely on IPPs. Power generation sector including IPPs and GENCO generate energy from imported fuels, like oil and imported coal. In 1990s, Pakistan welcome number of private investors in the energy sector and they produce electricity on high price and government of Pakistan could not able to pay back to IPPs. For example: power generation companies owe money to fuel supplier, who, in turn, owe money to refiners, creating circular debt cycle among these entities, as a result, this process leads to a shortage of fuel supply to power generation companies, and government not efficiently recover the bill from the consumers. Yaqoob et al. (2021) stated that in the financial year 2019, Pakistan imported oil from the international market worth 34.2 trillion rupees for energy. As a result, the overall output of Pakistan's economy decrease by 24,89 rupees due to 1-kilowatt-hour reduction in electricity supply.

S. S. Ali and Badar (2010) stated that circular depth issue in Pakistan has been the prominent and persistent problem in the energy sector, causing crises in the country for years. Faizi (2013) stated that number of factors have played a role in the development of circular debt. First the inefficient distribution system is a significant factor, determined by low revenue collection and substantial line loses with in the DISCOs. Secondly, tariff policy of NEPRA lack rigours management, failing to adequately cover the expenses associated with power generation. Lastly, the irregular payment of electricity subsidies is a consequence of fiscal constrain (Yaqoob et al., 2021). However, Government of Pakistan has insufficient funding to overcome the energy crises and the lack of funding is unable provide bases for large power projects and distribution network (Hulio et al, 2022).

3.2. Social Condition

Social condition of the country directly effects on the socio-economic development. Social factors have impact on the energy consumption. Due to corruption and leakages in energy distribution organizations and electricity theft at gross root level increase the gaps between supply and demand. smit divided electricity transmission and distribution lose into two border areas technical and non-technical lost (Bhatti et al., 2015).

Non-technical loss results from electricity theft, leading to illegal energy supply and consumption. In Pakistan both employees of power consumer agencies and consumers involved in the electricity theft. On the technical side, Pakistan's distribution companies and grid stations are significantly inadequate energy supply across country. There are several factors in technical side includes voltage fluctuation, lack of grid expansion, line losses and infrastructure deficiency.

3.3. Political Condition

Political economy highly depends on the trade agreements. Energy projects under the CPEC agreements bring efficiency in the energy sector of Pakistan. Most of energy projects under the CPEC based on different form of agreements like Joint venture, G2G bases and PPP models. And these projects are implemented in all provinces of Pakistan. According to the Eighteen Amendment to the Constitution of Pakistan provincial governments in the country are responsible for the establishment and management of the energy requirements within their provinces (Shah, Shah, & Shah, 2021).

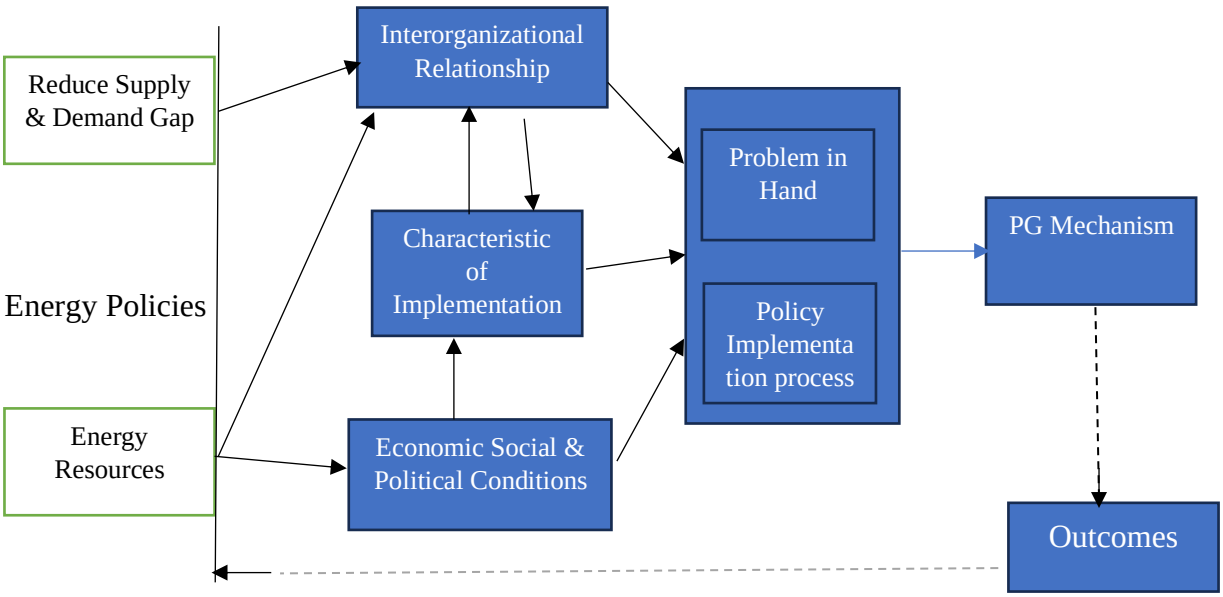
4. Methodology

The research methodology employed in this study adopts a qualitative approach, with a primary focus on examining power generation policies through a theoretical-model approach. The policy implementation model in use consists of the Van Horn & Ostrom models. Data was gathered from number of sources, including articles, books, supranational institution reports, annually performance reports, PG policies and public sector reports.

This study is useful in recognizing the hurdles, active governmental policies in energy transmission sector and possible developments required. The first section provides the background of energy sector developments and related policies organized by the government of Pakistan. The second section describes indigenous resources reserves of the country. Its percentage availability in the different energy resources, the percentage usage of already exploited resources and remaining reserves according to the national and international survey reports. Third section includes the role of government of Pakistan

in overcoming the energy crises, the overview of till now initiated projects and ensuring better energy transmission and security based on data obtained from various articles and sources. Fourth section consisted of current challenges faced by the power sector of Pakistan either economical, social, technical or political according to the survey reports of various organizations discussed by the different Authors. Followed by list of future recommendation and conclusion based on analysis of mentioned data to overcome energy security challenges.

5. Framework



Ostrom and Van Meter Model

6. Discussion

The energy transmission and security evaluation has been performed by national and agencies around the world. The studies show, the potential need for energy security and formal power supply planning as well as Pakistan's potential to use indigenous resources. With regards to the evaluation done by the sources the government of Pakistan or the policy implementors have recognized the cause of energy crises following financial burden and high energy loss. As well as the need for the exploitation of indigenous resources. However further advantages can be gained through ensuring energy mix in the production process, less reliant on foreign resources and fuel while providing prominent energy security and scattered supply network, introduction of transparency in public and private sector, efficient collection of tariffs by the government organizations to acquire financial balance, creation of employment opportunity for people with introduction of local power plants and Formation of stable country through public awareness campaign. In the material provided by the study, different resources are recognized throughout various regions of Pakistan by the statistical data provided in the form of figures and numerical calculations, there distribution by the type of fuel and geographical locations.

In documentation, there are various power production and transmission projects planned by the government of Pakistan but the obstacle of funding still remains as a prominent issue and tax arrangements are still to be made. Such attitude of government causes huge mistrust between investors causing no further private involvement and they already working investors show less interest in future rolls.

The power policies provided by the government of Pakistan has yet proved to be in-effective and unable to reach the set goals within provided timeframe due to negligence or lack of interest shown by political leader ship either in the form of contradictions in decisions or deviance from already made policies. The policies formed to overcome the energy crises still proved to be non-worthy as the problem still exist. Due to frequent change in the government there is no such continuity found in energy scheming. The political un-stability creates a stubborn governmental behaviour as one doesn't want to follow the footstep of previous i.e working on projects planned by the previous ruling party. On the other hand not all resources could be utilized to it potential in various provinces like the case of Kala bagh dam, certain representatives and locals had severe contradictions with the creation of dam. However, some of the projects obtained high demands and positive response form the public due to their low cost reliability factor I.e solar. Hence the government has also actively contributed in this sector by operating plants densely in Punjab. Some other factors as energy theft, technical limitations and circular depth has also contributed to in-efficient energy transmission. By the study it is recognized that there are certain factors that play role as obstacles in energy development process. By reviewing the past policies of the GOP we can conclude the emphasize was on private investment in the energy sector but Some of major drawbacks are formal power planning, timely execution of goals, limitations of transmission and distribution networks and transparency in public institutions regarding fair role of its agents. Another setback for energy sector is availability of more than one departments working for transmission, distribution, generation and energy safety as lack of communication within these organizations and mutual policy making decisions. Such issues can be eradicated though interdepartmental communication and transparency within the organizations, running awareness campaigns, thorough energy transmission plan and public contribution.

7. Conclusion and Recommendation

Energy plays an essential role in Pakistan's socio-economic development. Keeping in view the current literature and the ongoing energy crisis scenario, it becomes evident that the persistent issue of an energy crisis is not unique to Pakistan; it is, in fact, a national wide concern that directly impact the country's socio-economic development. This study provide valuable understanding of mechanism of energy sector instructions and interconnectivity of the organizations. It is worth noting that the energy crisis is not only dilemma of developing country like Pakistan; ever many developed countries also facing energy crisis issues.

Pakistan confronts a distinct challenge in the energy sector. The country has all kind of resources for electricity generation like fossil fuels, hydroelectric plants, nuclear plants solar, and wind energy. Pakistan has capacity to produce electricity doubled as compared to its demand. However, the presence of number policies, an ineffective policy implementation process and bad governance mechanisms have hindered the power generation ability to meet country energy requirement.

Pakistan's energy sector is at a critical issue, with a growing demand for electricity and significant deficit in natural gas supply that create threats to thermal plants that were developed under the power generation policy 2002. The overreliance on non-renewable energy resources, compounded by governance and administrative barrios, challenges and poses a considerable obstacle. To address these issues the development of local coal energy plants and the implementation of a comprehensive policy and framework are essential.

The research provides detail information and analysis of the energy sector, including distribution networks, current and past policies, availability of natural resources, governance issue and highlight urgency of the situation that warn the policymakers to develop course of action to tackle down these issues. Restructuring the energy sector by utilizing the local coal resources and improving accessibility, inter-organizational connectivity and community involvement is imperative for a secure and sustainable energy future. The findings of this study have the potential to pave the way for a better future in Pakistan's energy sector.

7.1. Recommendation

- To address Pakistan's energy challenges effectively, it is essential to investigate on a multi-faceted approach. First, there is a dire need to raise awareness for all including government, decision-makers and general public about the economic burden of Pakistan reliance on imported fuel and the benefit of indigenous energy resources. There is also need give awareness about energy security issues.
- Second, the establishment of a technology innovation platform and energy development wing that can facilitate the energy policies besed on the indigenous resources, support private investments and conducting crucial research on resource availability.
- Third, there is a essential need for improved governance system and upgrading of the energy generation system to enhance the efficiency, along with the development of a comprehensive solution to address transmission capacity and losses.
- At last, government should develop a framework to reduce its dependency on IPPs and consider eliminating capacity charges and subsidies

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