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Understanding the Energy Sector Reform in Pakistan and Its Implications

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**UNDERSTANDING THE ENERGY
SECTOR REFORM IN PAKISTAN
AND ITS IMPLICATIONS**

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and Dil B. Rahut

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Abstract

The power sector of Pakistan has undergone numerous reforms, in this context the present study examines the impact of these reforms on efficacy and sustainability. The literature on power sector reforms in developing countries is extensive and diverse, covering various aspects and dimensions of the reform process and its outcomes. However, there is a lack of comprehensive and systematic studies in the case of Pakistan dealing with extensive range of reforms over a long period. This study fills this gap by providing a comprehensive and systematic evaluation of Pakistan's power sector reforms. The findings show that after the reforms, installed generation capacity has increased and the energy mix has shifted to expensive fossil fuels, however, there has been no substantial reduction in transmission and distribution losses. Nominal electricity tariffs increased the least for residential sector creating cross-sector subsidies at the cost of industrial sector. In addition, electricity consumption by residential sector increased substantially, while the commercial, agriculture and industrial sectors shows no significant increase in electricity consumption. The GDP share of the manufacturing and industrial sector declined. The study recommends tariff restructuring to protect poor households and ensuring the industrial sector remains competitive.

Keywords: power sector, reforms, Pakistan, energy poverty, SDG 7

JEL Classification: L94, P11, Q01, L51, Q40

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1. INTRODUCTION

The power sector plays a key role in the socio-economic progress of a nation. However, developing countries encounter problems in delivering reliable, cost-effective, and sustainable electricity services to domestic users and industries. Several nations have undertaken a series of power sector reforms since the 1990s to address these challenges, aligning with the global trend of market-oriented policies. These reforms typically involve the separation of vertically and horizontally integrated state-owned utilities, the involvement of the private sector in power generation and distribution, the establishment of independent regulatory bodies, and the introduction of competition in power markets. The primary goals of these reforms are to enhance the efficiency, quality, and financial viability of the power sector while ensuring improved accessibility and affordability of electricity for disadvantaged and marginalized communities. However, the outcomes and impacts of these reforms differ across countries and contexts, depending on the design, implementation, and evaluation of the reform process.

Pakistan, with its vast population of 240 million as of 2023 (UNFPA 2023) and a GDP of \$376 billion in 2022 (World Bank 2022), grapples with a pressing issue: a persistent power crisis. Frequent power outages, substantial losses in transmission and distribution, limited cost recovery, high subsidies, tariffs, and inadequate service quality characterize this crisis. The detrimental impact of this power crisis reverberates throughout the nation, impeding economic growth, undermining social well-being, and posing threats to environmental sustainability. In an earnest endeavor to surmount this crisis, Pakistan has embarked on a series of power sector reforms since the early 1990s, with valuable assistance and guidance from esteemed international institutions like the World Bank and the International Monetary Fund (IMF).

The literature on power sector reforms in developing countries is extensive and diverse, covering various aspects and dimensions of the reform process and its outcomes. However, there is a lack of comprehensive and systematic studies on the case of Pakistan, which has implemented a wide range of reforms over a long period. Most existing studies on Pakistan's power sector are either descriptive or focused on specific issues or components of the sector, such as generation, distribution, regulation, or pricing. Moreover, many of these studies are outdated or based on limited data and methods. Therefore, there is a need for an updated and holistic analysis of Pakistan's power sector reforms and their impacts on various indicators of the sector's performance and development.

This study aims to fill this gap by providing a comprehensive and systematic evaluation of Pakistan's power sector reforms and their impacts on various outcomes, such as generation capacity, efficiency, quality, reliability, affordability, accessibility, sustainability, and governance. The study uses a mixed-methods approach, combining quantitative and qualitative data and techniques to analyze the reform process and its outcomes. The study also compares Pakistan's experience with that of other developing countries that have implemented similar reforms in their power sectors. The study contributes to the literature on power sector reforms in developing countries by providing an in-depth and up-to-date case study of Pakistan that can offer valuable lessons and insights for other countries facing similar challenges and opportunities in their power sectors.

Therefore, the main research question of this study is how power sector reforms in Pakistan have affected the performance and development of the sector. Thus, the study contributes to the existing literature in four ways. First, it analyzes the process

and components of power sector reforms in Pakistan since the 1990s. Second, this study attempts to evaluate the impacts of power sector reforms on various indicators of power sector performance and development, such as generation capacity, efficiency, quality, reliability, affordability, accessibility, sustainability, and governance. For the academic audience, this study contributes to the literature on power sector reforms in developing countries by providing a comprehensive and systematic case study of Pakistan, which has implemented a wide range of reforms over a long period of time. Third, this research compares Pakistan's experience with that of other developing countries that have implemented similar reforms in their power sectors. For the policy audience, this study provides valuable lessons and insights for improving the power sector performance and development in Pakistan and other developing countries. This study also identifies the challenges and opportunities for further reforms in the power sector, as well as the best practices and pitfalls to avoid. Lastly, the study provides policy recommendations and implications to improve the power sector performance and development in Pakistan.

The rest of this study is organized as follows. Section 2 reviews the literature on power sector reforms in developing countries, focusing on their objectives, components, outcomes, and determinants. Section 3 evaluates the impact of power sector reforms on various indicators of power sector performance and development in Pakistan. Section 4 concludes the study with a summary of the main findings, limitations, and directions for future research.

1.1 Historical Overview of the Energy Policy Reforms

1.1.1 The Pre-Reform Period (1947–1990)

At the time of its independence in 1947, Pakistan's power sector was characterized by its small size and underdevelopment. Recognizing the significance of power sector development for the country's economic and social progress, the government undertook several measures to expand and enhance the sector, including investment in large-scale hydropower projects such as the Mangla Dam (1967) and the Tarbela Dam (1976) to increase generation capacity and reduce dependence on imported oil. The Mangla Dam on Pakistan's Jhelum River, initially designed for 1,000 MW and completed in 1967 at a cost of US\$ 1.5 billion, was expanded to 1,714 MW in 2009 through the Mangla Dam Raising Project, costing Rs. 96.853 billion and funded by the World Bank and Asian Development Bank (Nation, 2016). The Tarbela Dam on the Indus River, initially designed for 3,478 MW and completed in 1976 for US\$ 1.497 billion, was expanded to 4,888 MW in 2018 with World Bank and Water and Power Development Authority (WAPDA) funding, and the ongoing Tarbela Fifth Extension Hydropower Project aims to add 1,410 MW, financed by the World Bank and the Asian Infrastructure Investment Bank (World Bank 2020). By 1980, hydropower was responsible for over 70% of total electricity generation in Pakistan (Khan 2014). With assistance from United States Agency for International Development (USAID) and other donors, the Rural Electrification Program (REP) was launched in 1974, resulting in over 80% of Pakistani villages gaining access to electricity by 1990 (Bacon and Besant-Jones 2001).

1.1.2 The First Wave of Reforms (1990–2000)

During the early 1990s, the power sector in Pakistan faced a severe crisis marked by a growing demand-supply gap, high transmission and distribution losses, low-cost recovery, poor service quality, and mounting debts. The Gulf War in 1991 further exacerbated the situation by increasing oil prices and reducing the country's

foreign exchange earnings. Acknowledging the unsustainability and inefficiency of the existing power sector model, the government embarked on a series of reforms in collaboration with international institutions like the World Bank and the IMF. These reforms included allowing private sector participation in power generation through independent power producers (IPPs). Attractive incentives, including guaranteed power purchase agreements, high tariffs, tax exemptions, and sovereign guarantees, were offered to IPPs.¹ Consequently, over 20 IPPs entered the market, adding approximately 6,000 MW of generation capacity by 2000 (Naqvi 2016; Ullah et al. 2017).

In 1998, the government established three generation companies (GENCOs), one transmission company (NTDC), and eight distribution companies (DISCOs) under the WAPDA framework. This structural change aimed to enhance efficiency, accountability, and transparency by delineating the functions and responsibilities of different entities (Jamil et al. 2022).

Pakistan established an independent regulator for the power sector, the National Electric Power Regulatory Authority (NEPRA), in 1997. NEPRA assumed responsibilities such as issuing licenses, setting tariffs, ensuring quality standards, resolving disputes, and safeguarding consumer interests. The objective was to create a level playing field, ensuring fair competition and regulation within the sector (Qazi et al. 2017). Table 1 shows a summary of structural, institutional, and policy reforms in the power sector in Pakistan.

Table 1: Summary of Reforms in the Power Sector in Pakistan

Structural	Institutions	Policy
Vertical unbundling (1992)	PPIB (1994)	Power policy 1994
Introduction of IPPs (1994)	NEPRA (1997)	Hydro policy 1995
Single-buyer model (1998)	NTDC (1998)	Power policy 1998
DISCOs (1998)	PCRET (2001)	Power policy 2002
Privatization of KESC (2005)	AEDB (2005)	Power policy 2006
Invitation for whole competition (2005)	CPPA (2015) NEECA (2016)	Renewable energy policy 2006

Note: NTDC = National Transmission and Distribution Corporation, responsible for transmission and distribution of power; AEDB = Alternative Energy Development Board, responsible for alternate and renewable energy development; KESC = Karachi Electric Supply Corporation, a private company providing power in Karachi; NEECA = National Energy Efficiency and Conservation Authority, responsible for the promotion of alternative and renewable energy; PCRET = Pakistan Council of Renewable Energy Technology, responsible for research and development in renewable energy; CPPA = Central Power Purchasing Agency; PPIB = Pakistan Power Infrastructure Board, responsible for investor facilitation in energy sector.

1.1.3 The Second Wave of Reforms (2000–2010)

The power sector in Pakistan encountered another crisis in the late 2000s, characterized by a widening demand-supply gap, high transmission and distribution losses, low-cost recovery, poor service quality, and mounting debts. The global financial crisis in 2008 further worsened the situation by diminishing foreign investment and aid flow to the country. Recognizing the inadequacy and incompleteness of previous reforms, the government initiated a second wave of reforms with the support and guidance of international institutions such as the World Bank and the IMF. These reforms include privatizing certain state-owned entities in the power sector, including

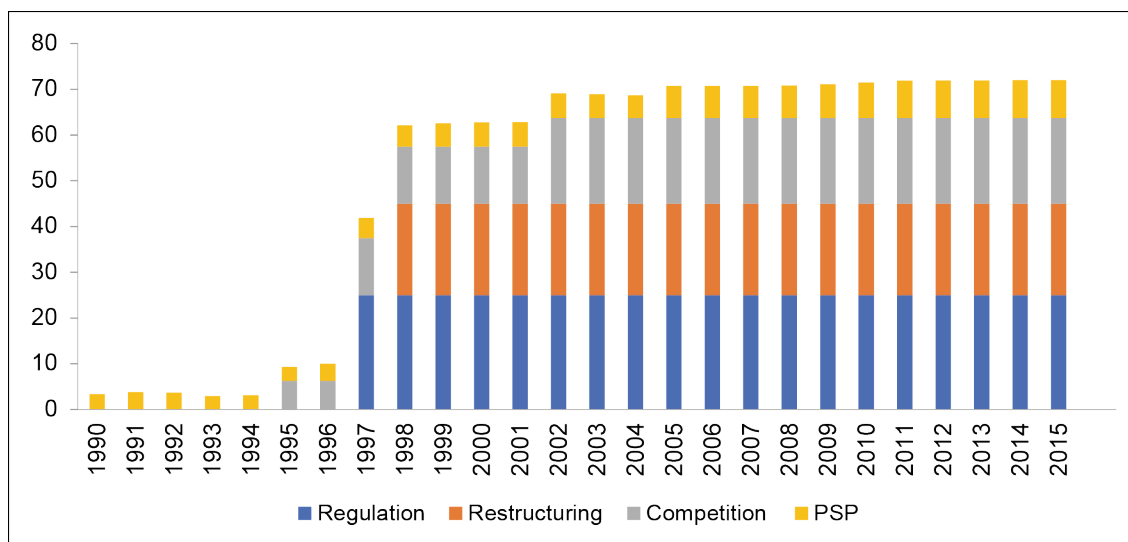
¹ See Table 1 for IPPs' name, capacity and commission dates. Otherwise, see [List of IPP's \(cpa.gov.pk\)](http://cpa.gov.pk). All IPPs use high-speed diesel, furnace oil, and gas for electricity production (Dailytimes, 2023).

KESC, several GENCOs,² and DISCOs. The government sold KESC, Karachi's primary utility, to a private consortium in 2005. Additionally, the privatization process for some GENCOs and DISCOs was initiated in 2007, aiming to attract private investment and enhance sector performance and profitability (Naveed et al. 2022).

In addition, during the first decade of the current century, Pakistan introduced competition in power generation through a single-buyer model. In 2009, the government established the Central Power Purchasing Agency (CPPA), a state-owned entity responsible for purchasing power from generators and selling it to distributors through competitive bidding or contracts. This measure aimed to reduce costs and prices while fostering quality and innovation in the sector (Bacon and Besant-Jones 2001; Khan 2014).

In 2002, the government adopted a multi-year tariff determination mechanism. NEPRA was entrusted with setting tariffs based on cost recovery principles and performance benchmarks. Furthermore, subsidies for various consumer groups, particularly domestic and agricultural consumers, were reduced, while targeted subsidies for low-income consumers were introduced through lifeline tariffs (Naveed and Azhar 2022). An overview of the reforms implemented in Pakistan is depicted in Figure 1. The graphical representation illustrates a noteworthy trend: private sector involvement has exhibited limited growth since 1990. While regulatory measures and restructuring initiatives have been introduced, it is notable that there has been no increase in competition within the sector.

Figure 1: Progress of Reforms in Pakistan



Note: PSP = private sector participation.

Source: Authors' own illustration using data from ESMAP.

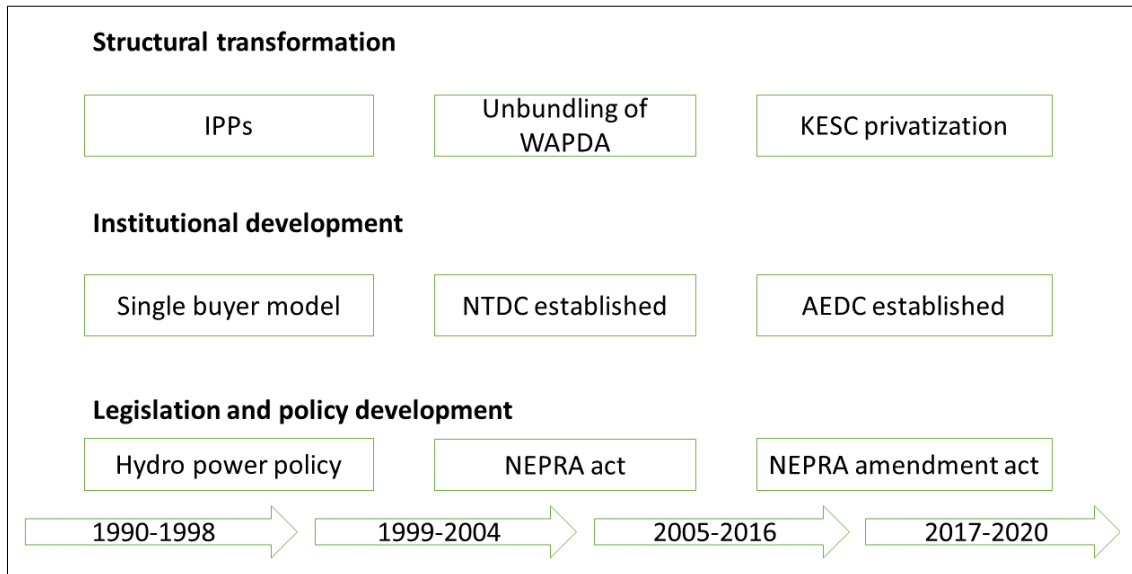
1.1.4 The Current Situation and Future Prospects (2010–present)

The power sector in Pakistan continues to grapple with a significant crisis during the 2010s, characterized by an ongoing demand-supply gap, high transmission and distribution losses, low-cost recovery, poor service quality, and mounting debts. Political instability, security threats, natural disasters, and environmental challenges

² GENCOs are government entities responsible for power generation, operated by WAPDA (Masroor et al., 2021).

exacerbate the situation. Recognizing the unsustainability and inefficiency of the existing power sector model, the government aims to pursue a new vision and strategy for the sector, with guidance from international institutions like the World Bank and the IMF. Figure 2 shows the timeline of reforms implemented in Pakistan’s energy sector.

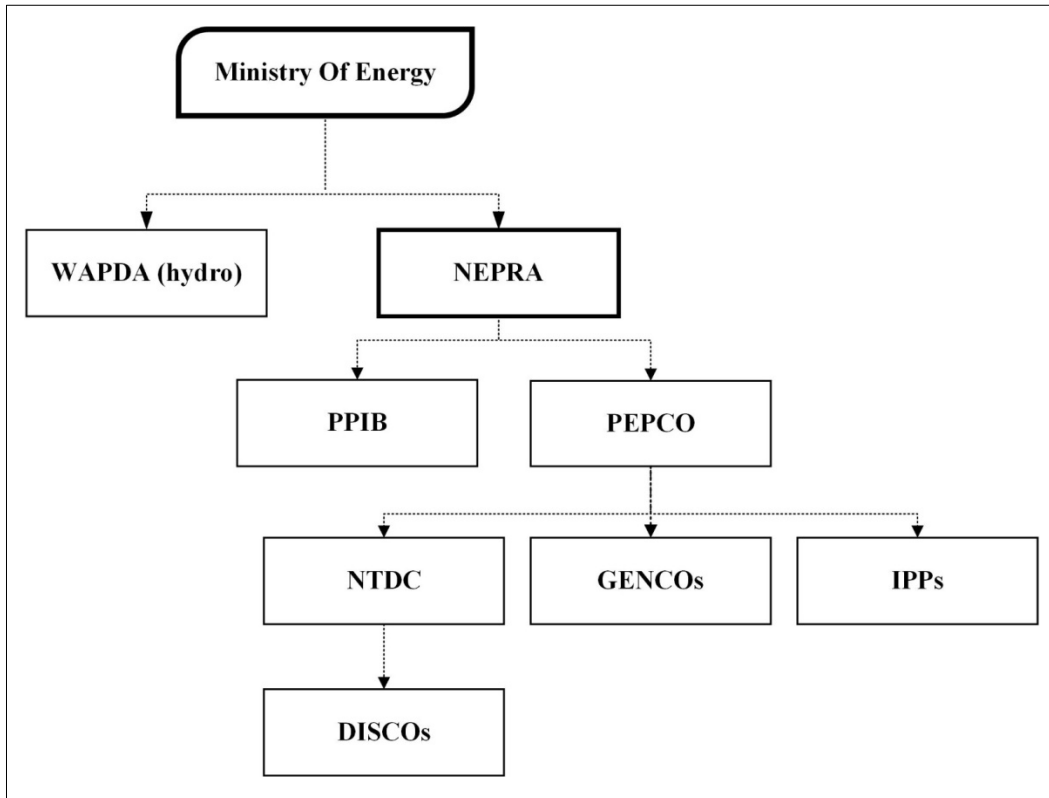
Figure 2: Energy Sector’s Institutional Development Timeline



Source: Authors’ illustration.

The government has introduced various policies and incentives, such as feed-in tariffs, net metering, tax exemptions, and carbon credits, to encourage the development and deployment of renewable and low-carbon energy sources. The objective was to diversify the energy mix, reduce reliance on imported oil and gas, and mitigate greenhouse gas emissions and climate change impacts. Furthermore, the government of Pakistan aimed to enhance regional cooperation and integration in the power sector, exemplified by initiatives like the Central Asia-South Asia Electricity Transmission and Trade Project (CASA-1000) and the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline. The government actively participated in regional agreements and initiatives to promote cross-border trade and the exchange of electricity and gas. The goal was to improve supply security and reliability, reduce costs and prices, and foster regional economic and social development (Rahman et al. 2011; Wolf 2020).

An independent Power Division under the Ministry of Energy in 2017 was established to improve the governance and accountability of power sector entities. The government has implemented various measures to strengthen institutional capacity, transparency, and oversight of power sector entities. These measures include enhancing the autonomy and effectiveness of NEPRA; streamlining the functions and responsibilities of WAPDA, CPPA, GENCOs, NTDC, DISCOs, KESC, and other entities; and implementing performance-based contracts and incentives for managers and employees (Bacon and Besant-Jones 2001; Khan 2014; World Bank 2020). Figure 3 illustrates the overview of the power sector in Pakistan.

Figure 3: Overview of the Power Sector in Pakistan

Source: Authors' illustration.

2. LITERATURE REVIEW

This literature review aims to provide a systematic overview of the existing knowledge on power sector reforms and identify the gaps and limitations that this study seeks to address. The literature review covers both theoretical and empirical studies on power sector reforms in developing countries. The literature review is organized into four thematic sections, namely: (i) the rationale and objectives of power sector reforms; (ii) the components and models of power sector reforms; (iii) the outcomes and impacts of power sector reforms; and (iv) the drivers and challenges of power sector reforms

2.1 The Rationale and Objectives of Power Sector Reforms

The main rationale for power sector reforms in developing countries was the poor performance of state-owned utilities (SOEs) that dominated the sector before the reforms. SOEs were often inefficient, unaccountable, corrupt, and politically influenced (Ullah et al. 2017; Urpelainen and Yang 2019). They suffered from low productivity, high costs, poor quality, frequent outages, low coverage, high losses, low tariffs, high subsidies, and huge debts (Estache et al. 2002). These problems resulted in fiscal pressure on the government budget, economic losses for consumers and producers, social dissatisfaction among citizens, and environmental degradation due to reliance on fossil fuels (Sen and Jamasb et al. 2012; Khan 2014; World Bank 2019).

The main objectives of power sector reforms in developing countries were to improve the efficiency, quality, and financial viability of the sector by introducing market mechanisms, private participation, regulation, and competition (Martins et al. 2020). These objectives were based on the assumptions that (i) market forces would allocate resources more efficiently than state intervention; (ii) private actors would manage utilities more effectively than public bureaucrats; (iii) regulation would protect consumers' interests and ensure fair competition; and (iv) competition would lower costs and prices and increase quality and innovation (Erdogdu 2014; Gore et al. 2019; Sharma et al. 2005).

However, these objectives were driven not only by economic considerations but also by political and ideological factors. Power sector reforms in developing countries were influenced by the global trend of market-oriented policies that emerged in the 1980s and 1990s as part of the Washington Consensus. These policies were promoted by international institutions such as the World Bank and the IMF as conditionalities for providing loans or aid to developing countries. These institutions argued that market-oriented policies would enhance economic growth, reduce poverty, and promote good governance in developing countries (Gratwick and Eberhard 2008; Lee and Usman 2018; Nepal and Jamasb 2012a).

However, these policies were not universally accepted or implemented by developing countries. Power sector reforms in developing countries varied across regions and contexts depending on their level of development, political system, institutional capacity, social preferences, and external influences. Some regions, such as Latin America and Eastern Europe, were more receptive and responsive to market-oriented policies than others, such as Africa and Asia (Erdogdu 2011; Letova et al. 2018; Nakano and Managi 2008; Urpelainen et al. 2018).

2.2 The Components and Models of Power Sector Reforms

The main components of power sector reforms in developing countries are four structural reforms that aim to change the organization and governance of the sector. These reforms are: (1) regulation, which involves creating an independent agency to oversee and regulate the sector; (2) restructuring, which involves unbundling the SOEs into separate entities for generation, transmission, and distribution; (3) private sector participation, which involves allowing private actors to invest in and operate power utilities; and (4) competition, which involves introducing market mechanisms to determine prices and allocate resources in the sector (Ahmed and Bhatti 2019; Nagayama 2010).

However, these reforms are not implemented in a uniform or sequential manner by developing countries. Rather, they are adapted and combined to form different models of power sector reforms that suit different contexts and objectives. The literature identifies three main models of power sector reforms that developing countries have adopted: (1) the single-buyer model, which involves a state-owned entity purchasing power from generators and selling it to distributors; (2) the wholesale market model, which involves a competitive market where generators sell power to distributors through auctions or contracts; and (3) the retail market model, which involves a competitive market where generators sell power directly to consumers or through intermediaries (Qazi and Jahanzaib 2018).

The choice and adoption of these models depend on various factors, such as the size and structure of the power sector, the level of development and demand, the availability and diversity of resources, the political and institutional environment, and external influences. Some regions, such as Latin America and Eastern Europe, have

adopted more advanced and competitive models than others, such as Africa and Asia (Ahmed and Bhatti 2019; Janet Ruiz-Mendoza and Sheinbaum-Pardo 2010; Nagayama 2010; Urpelainen and Yang 2017).

2.3 The Outcomes and Impacts of Power Sector Reforms

This section evaluates how reforms have affected various indicators of power sector performance and development, such as generation capacity, efficiency, quality, reliability, affordability, accessibility, sustainability, and governance (Foster and Rana 2019b). The literature on the outcomes and impacts of power sector reforms in developing countries can be classified into three groups. The first includes implications for power generation (Sen and Jamasb 2012), generation efficiency (Meng et al. 2016), transmission and distribution losses (Nagayama 2010), capacity utilization (Zhang et al. 2008), etc. The second group analyzed the impact of reforms such as liberalization, unbundling, and independent regulators on cross-price subsidies (Erdogdu 2011), price reduction (Nagayama 2009; Swadley and Yücel 2011; Zarnikau and Whitworth 2006), and electricity access (Bensch 2019). The third group analyzed the effect of reforms in the power sector on households; this group analyzed the impact of change in welfare and affordability as a result of market-oriented reforms such as privatization, subsidies, and tariff reforms (Khalid and Salman 2019; Miniaci et al. 2014).

The variation in the outcomes and impacts of power sector reforms in developing countries depends on various factors, such as the design, implementation, and evaluation of the reforms (Nagayama 2009). The design of the reform refers to the choice and combination of the components and models of the reform that suit the specific context and objectives of each country (Li et al. 2017). Implementation of the reforms refers to the process and pace of carrying out the reforms and overcoming the technical, institutional, and political challenges (Kundu and Mishra 2011). Evaluation of the reforms refers to the methods and criteria for measuring and assessing the outcomes and impacts of the reforms (Sen and Jamasb 2012).

The literature also shows that the outcomes and impacts of power sector reforms in developing countries vary across regions and contexts. Some regions, such as Latin America and Eastern Europe, have achieved better outcomes and impacts than others, such as Africa and Asia (Machado et al. 2016). This variation reflects differences in the level of development, political system, institutional capacity, social preferences, and external influences that affect the design, implementation, and evaluation of power sector reforms in each region (Sen and Jamasb 2012).

2.4 Drivers and Challenges of Power Sector Reforms

In the 1990s, the idea of reforms in the power sector came with a wider Washington Consensus. Mainly, the idea was based on growing dissatisfaction with state-owned utilities (Bacon and Besant-Jones 2001). In response to Washington Consensus policies, developing countries started reforms to restructure utilities, their privatization, and the creation of regulators to achieve competition in the power sector (World Bank 2019). The reform package's perception was that government-monopolized utilities are less efficient than privately managed utilities (Khan 2014).

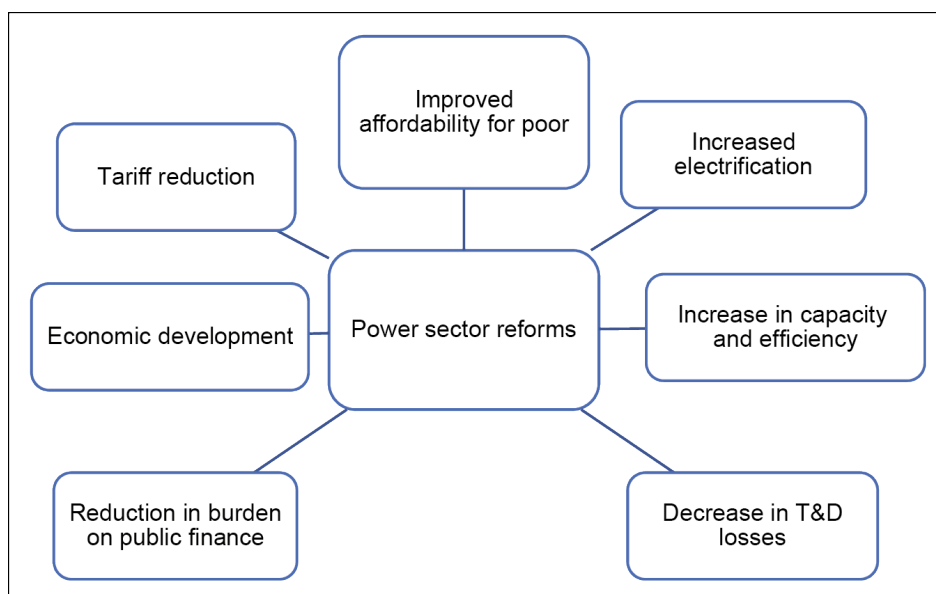
The literature on the determinants and challenges of power sector reforms in developing countries is rich and diverse, covering various aspects and dimensions of the reform process (Ullah 2013). The earlier literature on the determinants of reforms can be categorized into three distinct groups. The first deals with the political economy of power sector reforms, meaning the role and influence of various actors

and interests in shaping the reform agenda and outcomes (Amin and Djankov 2014; Singh and Brock 2015). The actors include politicians, bureaucrats, regulators, utilities, consumers, civil society, donors, and investors (Kathuria 2021), while the interests include economic, social, environmental, ideological, and institutional factors (Ullah 2015). The literature shows that power sector reforms are often subject to political interference, resistance, capture, and reversal by different actors and interests that may have conflicting or divergent objectives and incentives (Nepal and Jamasb 2012).

The second group concentrates on the institutional capacity that influenced power sector reforms (Qazi et al. 2017). This refers to the ability and readiness of various institutions and organizations to design, implement, and evaluate power sector reforms. The institutions include ministries, agencies, utilities, regulators, courts, and markets (Khan 2014), while the organizations include formal and informal rules, norms, values, and practices that govern the behavior and interaction of different actors in the sector (Estache et al. 2002). The literature shows that power sector reforms often face institutional constraints, gaps, weaknesses, and failures that may affect the quality and effectiveness of the reform process and outcomes (Nepal and Jamasb 2012).

Thirdly, external factors play a crucial role in shaping power sector reforms (Sharma et al. 2004). These factors encompass global trends, regional dynamics, technological advancements, environmental changes, and the role of international institutions (Bhattacharyya 2007). Additional factors include market pressures, competition, cooperation, learning, and diffusion of best practices and lessons learned from other countries and regions (Ahmed and Bhatti 2019; Den Hertog 2010; Foster and Rana 2019a). Drawing upon the insights gleaned from the extensive literature review, Figure 4 elucidates the anticipated outcomes stemming from the instituted reforms. These expectations include a spectrum of objectives within the power sector reforms, encompassing reductions in tariff rates and transmission and distribution (T&D) losses, easing the fiscal burden on public finances, enhanced affordability and accessibility, enhanced capacity and operational efficiency, and a positive stimulus for economic development.

Figure 4: Expectations from Reforms in the Power Sector



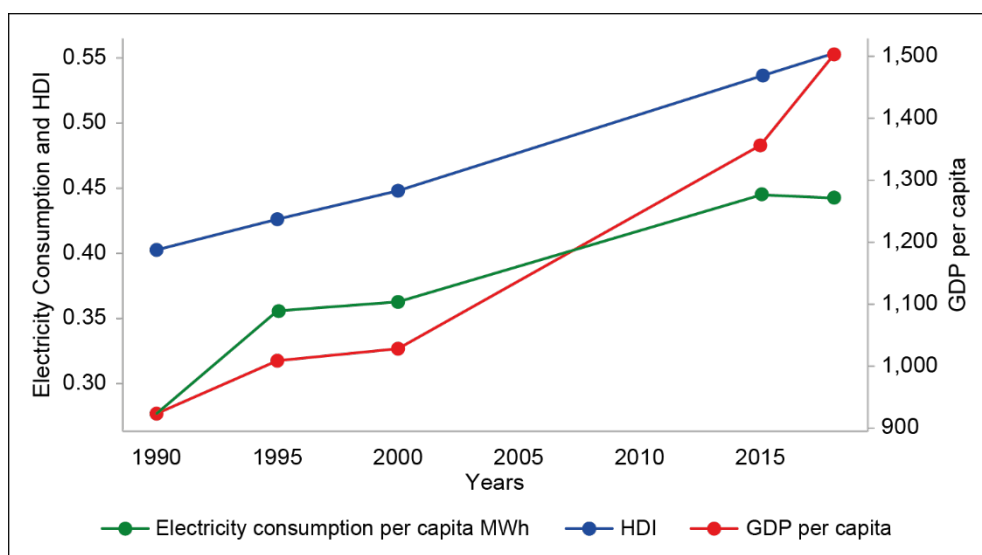
Source: Authors' own illustration.

3. RESULTS AND DISCUSSION

In this study, an attempt has been made to study how far reforms in Pakistan’s power sector were successful in improving the electricity sector’s desired outcomes. To this end, we employed descriptive analysis of data from various sources, including annual NEPRA, NTDC, and WAPDA reports and online data sources such as International Energy Agency (IEA), the World Bank, and the Pakistan Bureau of Statistics. Since no continuous data are available for reforms, we relied on non-regression methods such as descriptive statistics and graphical analysis.

Since the study undertook a descriptive analysis of data compiled from various national and international publications, this section presents an evaluation of the reforms with the help of tabulations and charts. Figure 5 shows the relationship between economic growth, measured through GDP per capita in real terms and the human development index (HDI) and electricity consumption per capita in Pakistan during 1990–2018. We observe a fascinating trend: as GDP per capita rises, so does electricity consumption per capita. This positive correlation indicates that as Pakistan experiences economic growth, its citizens consume more electricity, reflecting improved living standards and increased industrial and commercial activities. Several key moments stand out throughout the period, highlighting the consequences of power sector reforms. For instance, when the government implemented measures to enhance the efficiency of electricity generation and distribution, we observe a notable boost in both GDP per capita and electricity consumption per capita. Conversely, periods of stagnation or decline in the graph may point to challenges faced by the power sector, such as insufficient infrastructure investments or ineffective policies. An increase in electricity consumption could be indicative of greater economic activity and advancements in various sectors, leading to higher GDP. The rise in GDP per capita and electricity consumption also suggests that living standards and access to basic facilities such as electricity have vastly improved, resulting in a rising HDI score. Since electricity is used in time-saving home appliances, education, health, and social activities, it is likely that with the rise of electricity consumption per capita during three decades of reforms in the power sector, the HDI is both directly and indirectly improved.

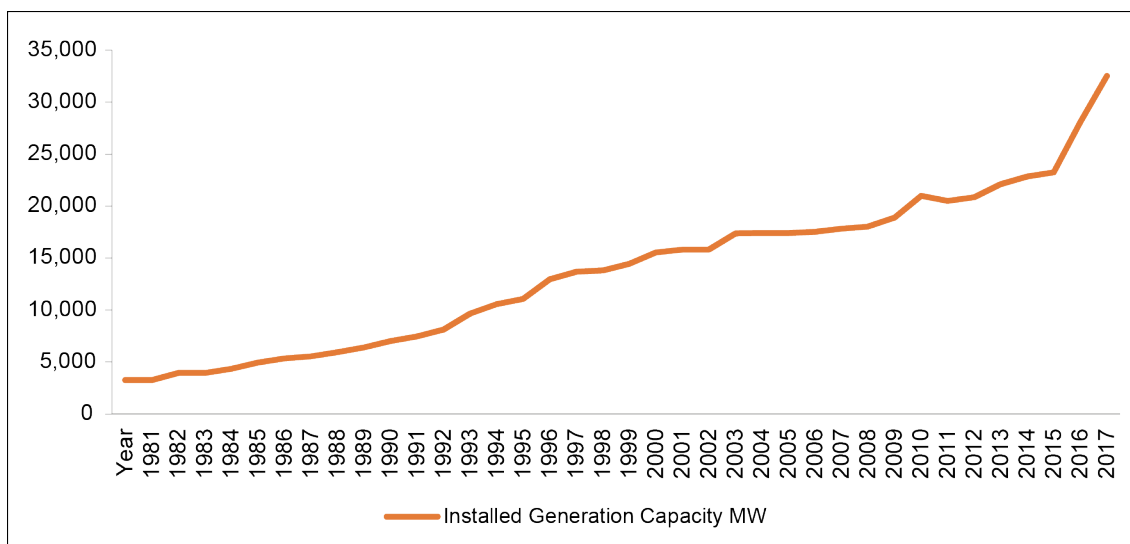
Figure 5: Relationship Between GDP and Electricity Consumption



Source: Authors’ own illustration.

To evaluate the success of the reform process in Pakistan, we analyze the change in installed generation capacity from 1980 to 2016, as shown in Figure 6. There was an increase in the growth rate of installed generation capacity after the reform period started in 1992. With various reforms from 1993 to 1998, an acceleration in installed generation capacity can be observed. There was a sharp rise in installed generation capacity after the year 2015.

Figure 6: Installed Generation Capacity of Electricity in Pakistan

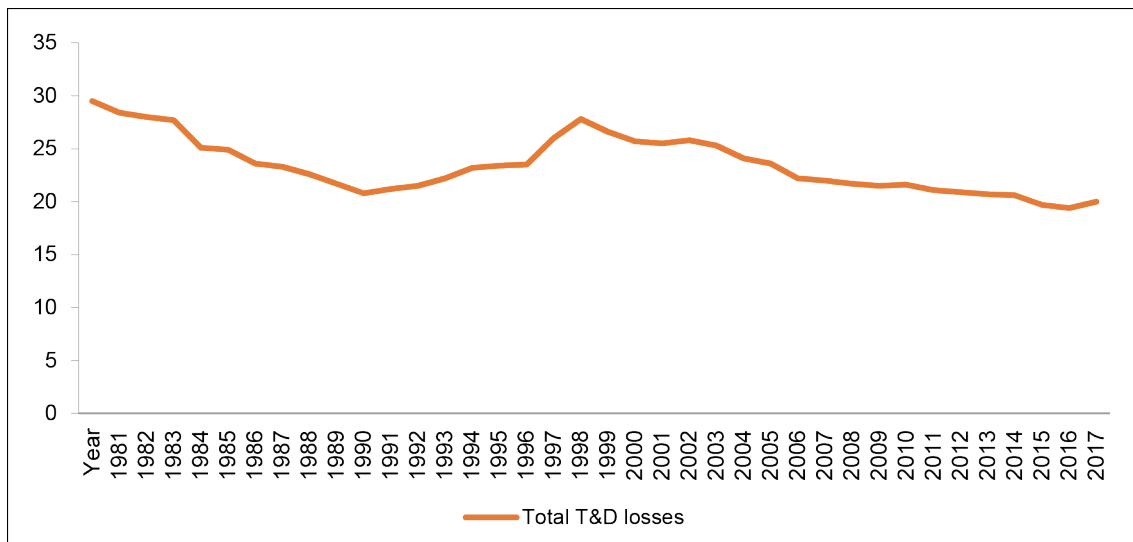


Source: Authors' own illustration.

One of the most highly used indicators in the literature evaluating reforms in developed and developing countries is T&D losses. Unfortunately, T&D losses in Pakistan are still very high, even after several years of reform implementation, as shown in Figure 7. Even after two decades of reforms implemented in the power sector in Pakistan, transmission and distribution losses in the power sector are high. The power sector in Pakistan has seen huge losses in T&D, which burden the utility's efficiency and efficacy. T&D refers to the electric power lost during the process of transmitting and distributing electricity from the sources of supply to the points of consumption (WDI 2023). This includes unpaid electricity, theft, uncharged electricity, and technical line losses. Another technical reason for these losses is the distance between the power generation site and the end-users. With the long distance between distribution networks and the generation plants, technical and unavoidable losses increase manifold. However, in the case of Pakistan, electricity theft, unmetered connections, and non-payments by both commercial and residential customers are a reason behind the high T&D losses. Reforms are expected to bring down the T&D losses as their main promise is based on efficiency and de-politicization of the power sector.

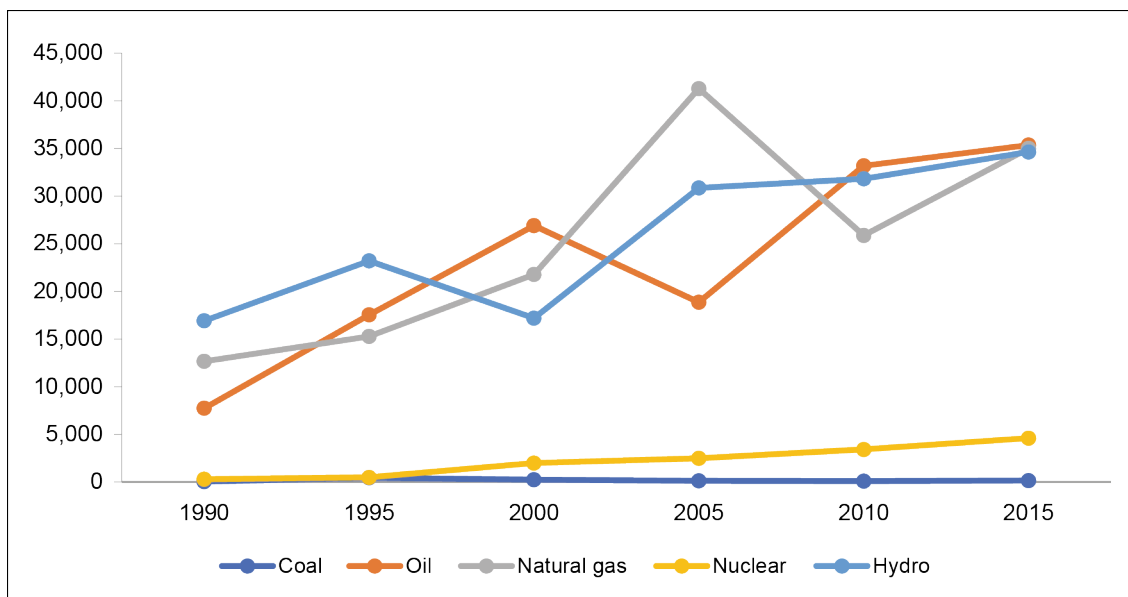
Figure 8 shows that hydropower generation increased by 104.5% during 1990–2015. There was no significant increase in coal-fired power projects during this period; however, the share of oil-based electricity has increased in the last two decades due to private power producers mainly using oil for power production. Pakistan is a nuclear power and produces electricity from nuclear sources. The generation capacity of nuclear-based power has also slowly increased.

Figure 7: Transmission and Distribution Losses



Source: Authors' own illustration.

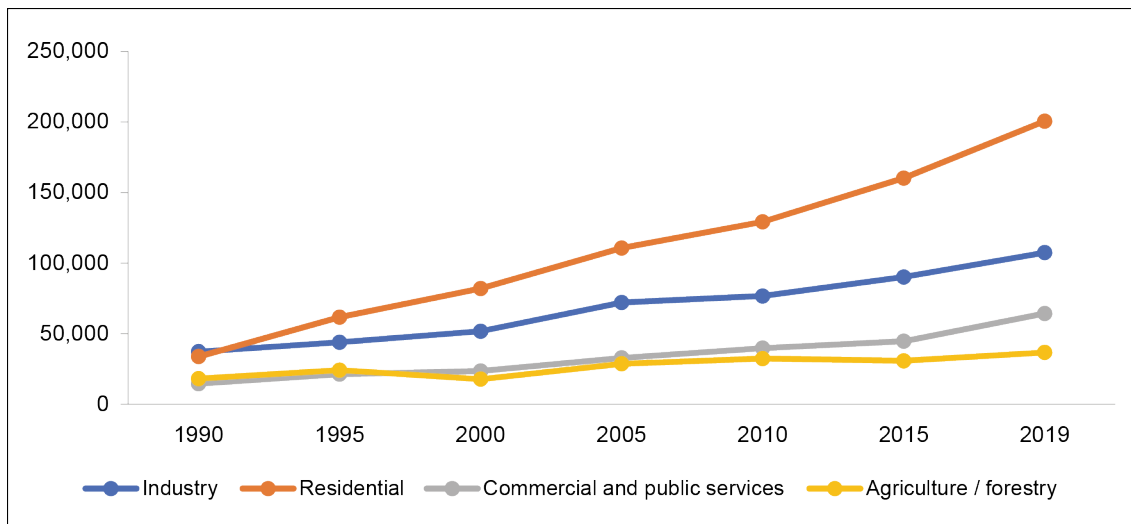
Figure 8: Electricity Generation by Source in Gwh



Source: Authors' own illustration.

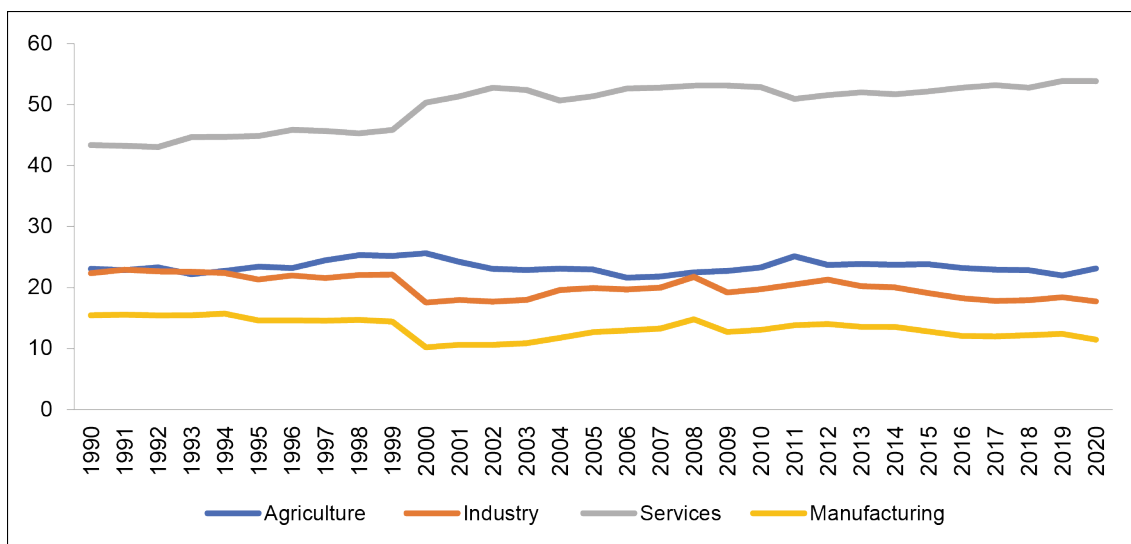
Figure 9 shows the trend in value addition by various sectors of the economy of Pakistan. The contribution of different sectors to GDP is worth noting, as shown in Figure 10, in relation to the electricity consumption by various sectors. The services sector is Pakistan's highest GDP-contributing sector; however, it ranks after the industrial sector in electricity consumption. Similarly, the agriculture sector's share in GDP has remained around 10%–15%; however, its share in total electricity consumption is the lowest among all sectors. The importance of the services sector in GDP and the low share of the agriculture sector in GDP calls for further in-depth analysis of their contribution to labor and other economic sectors to formulate policies related to sector-wise subsidy distribution from the public sector budget.

Figure 9: Electricity Consumption by Sector



Source: Authors' own illustration.

Figure 10: Percentage Share in GDP by Sector

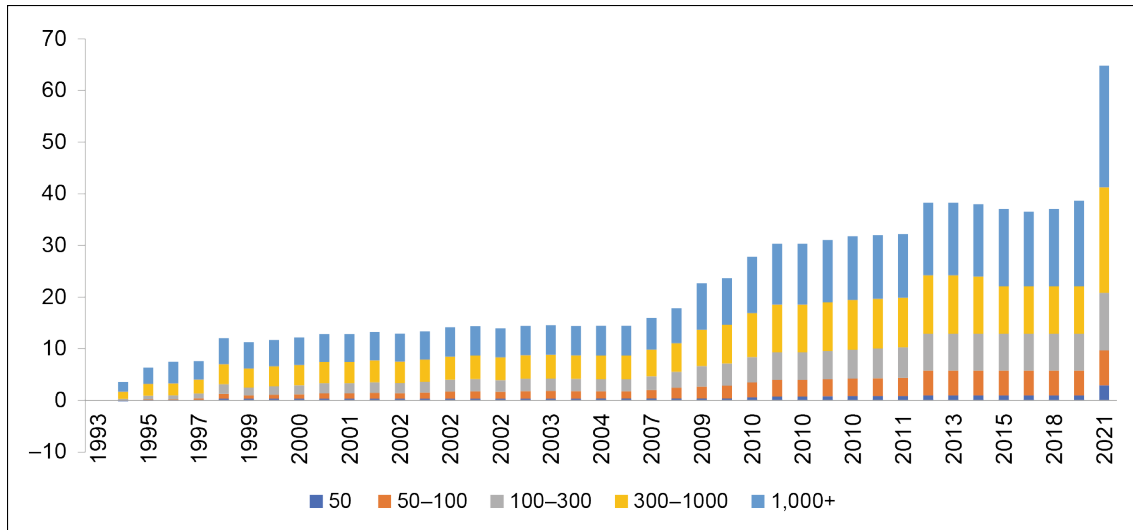


Source: Authors' own illustration.

3.1 Affordability Among Poor and Non-poor Households

Figure 11 shows that over time, the percentage tariff increase for various consumption slabs increased; however, the percentage increase is higher among high consumption groups compared to lower ones. The literature review shows that deregulation in the power sector reduces power tariffs (Necochea-Porrás et al. 2021). However, the literature argues that a reduction in the electricity prices in response to reforms is possible in the long run but not in the short run (Nagayama 2010).

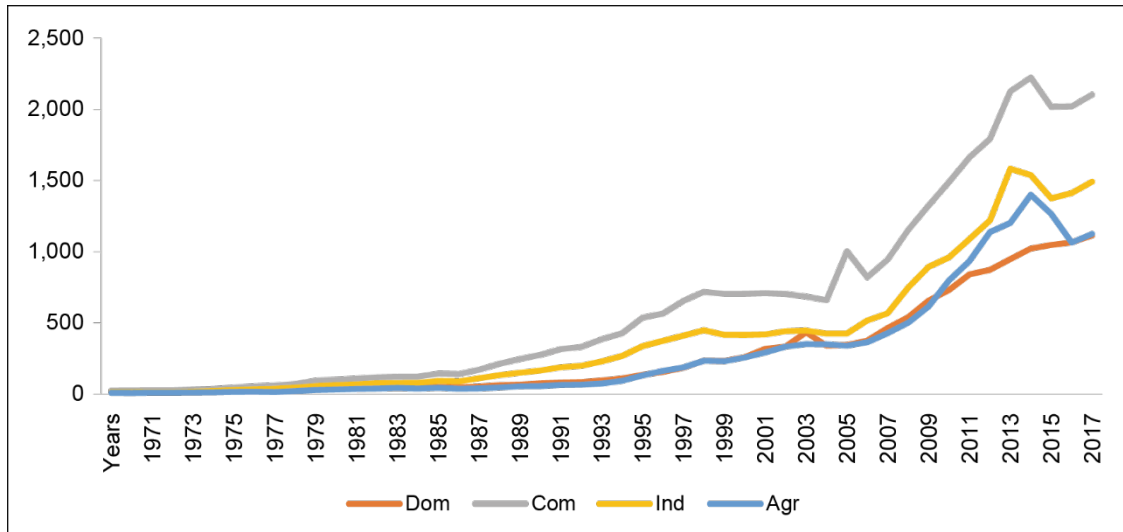
Figure 11: Percentage Increase in Tariff for Various Consumer Slabs



Source: Authors' calculation using data from NEPRA.

In addition, Figure 12 shows the increase in electricity tariff for commercial sector is higher than residential sector. The disparity in tariff rates across customer types may be indicative of cross-sector subsidies, where revenues generated from one type of sector are used to subsidize the prices of another sector.

Figure 12: Electricity Tariff in Paisa/KWh

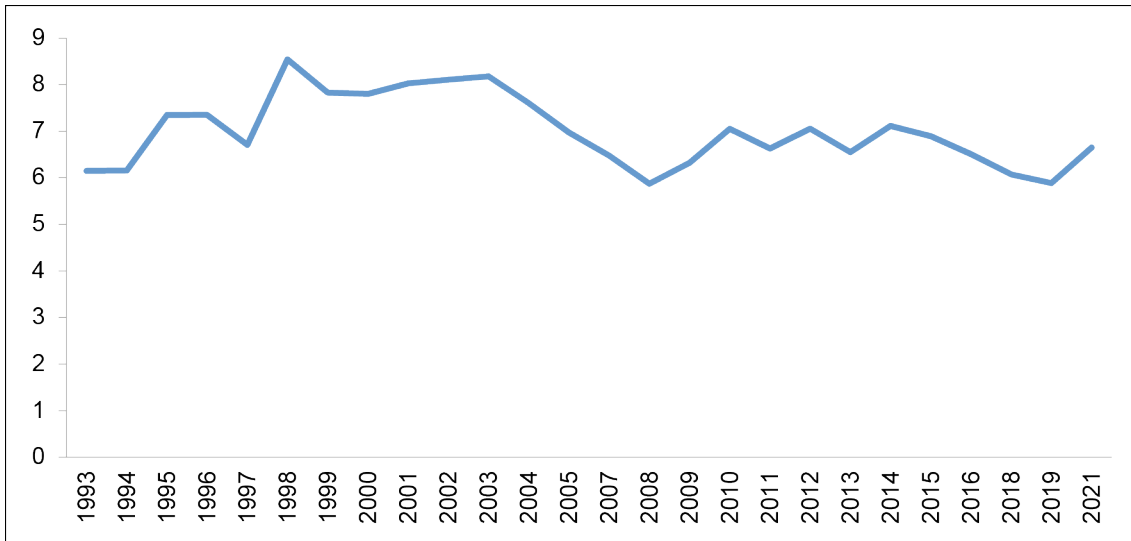


Source: Authors' calculation using data from NEPRA.

Figure 13 shows the trend for normalized electricity tariffs. With the help of the consumer price index, we normalize the average tariff charged to residential customers. Data on tariffs are collected from various annual reports by NEPRA. During the reform implementation period, tariffs showed a sharp increase from PKR 6 to PKR 8.5; however, in the long run, the per-unit price of electricity in average and real terms was reduced to PKR 6. However, from this analysis, one thing is clear: the promise

of reforms to bring tariffs down, particularly for residential customers, has not been fulfilled in Pakistan.

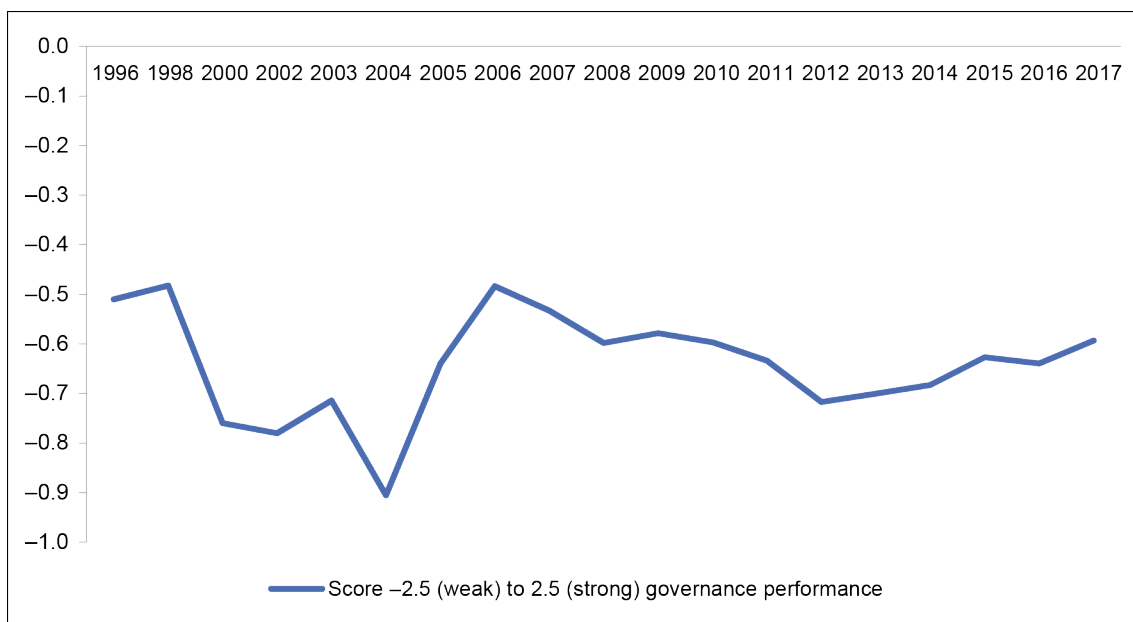
Figure 13: Average Normalized Tariff for Residential Customers



Source: Authors' calculation using data from NEPRA.

Figure 14 shows the trend in the regulator quality of the power sector in Pakistan. The data source is ESMAP, obtained through reports available on its website. The graphs show that after 2006, the regulatory quality of institutions related to the power sector, transmission, distribution, and generation improved. However, there has been no further improvement in the regulatory quality of power sector-related institutions since 2006. It is worth mentioning here that the regulatory body of Pakistan is NEPRA, which is mainly responsible for the regulation of generation, transmission, and distribution.

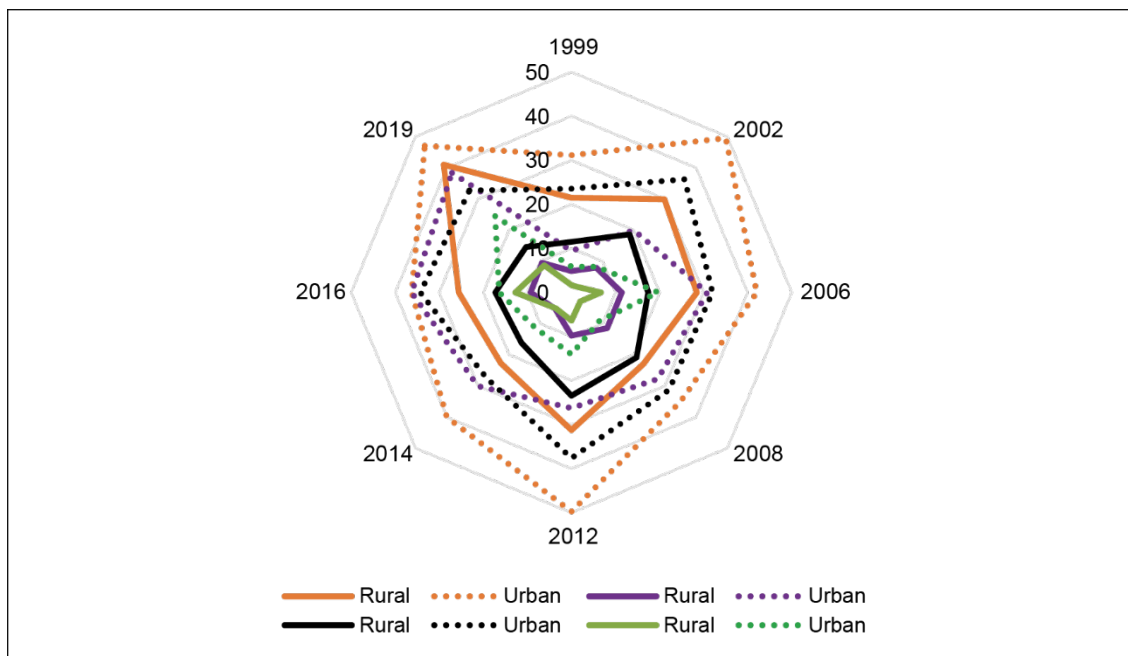
Figure 14: Trend in Regulator Quality of Pakistan



Source: Authors' calculation using data from NEPRA.

Figure 15 shows the percentage of households facing an affordability problem in households in various regions (urban and rural and province-wise) during the last two decades. It shows strong heterogeneity in the affordability problem faced by households across Pakistan. The graph also shows that some regions improved but some worsened over time. This signifies the importance of evaluating reforms from a regional perspective. Local and regional policies for electricity access and consumption should focus on such an affordability analysis to guide future reforms in the power sector.

Figure 15: Percentage of Households Facing an Electricity Affordability Problem



Source: Authors' estimation using HIES surveys 1998–2019.

Table 2 shows the time trend of various reform measures and the electricity sector output indicators. The top 12 rows show various output indicators related to the electricity sector, while the last three rows show qualitative and quantitative indicators of reforms and their scores.

We start our discussion with output indicators in the electricity sector. Access to electricity is the first indicator of output or success in the electricity sector. For detailed analysis, we use disaggregated data for urban and rural areas. Table 2 shows that the electricity access rate in urban areas was about 93 in 1998. It is interesting to note that 1998 was the year when two major reforms, unbundling and the power sector regulator, were introduced in Pakistan. Therefore, we see a sharp rise in urban electrification, reaching nearly 100% in 2018. From 1998 to 2002, major reforms were implemented in Pakistan, including vertical unbundling of the utility.

Table 2: Major Power Sector Indicators and Reforms Timeline

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Access to electricity – urban									25	92					96
Access to electricity – rural									23	62					69
Affordability – urban							12.2					40			
Affordability – rural							5.4					33			
Private sector participation	3.4	3.8	3.7	3.0	3.1	3.1	3.8	4.4	4.6	5.1	5.3	5.3	5.3	5.2	4.9
Average domestic tariff	0.7	0.8	0.8	0.8	1.0	1.1	1.4	1.6	1.9	2.3	2.3	2.6	3.2	3.3	4.3
Average tariff to all sectors	1.3	1.4	1.6	1.7	2.0	2.2	2.91	3.1	3.6	4.1	4.0	4.1	4.3	4.5	4.8
Subsidy (allocated)												20	25	49	50
Circular debt billion PKR															
Generation capacity MW	6,409	7,023	7,463	8,122	9,651	10,563	11,063	12,956	13,683	13,800	14,444	15,534	15,819	15,819	17,367
T&D losses	20.7	19.9	22.2	22.8	22.8	22.8	23.4	24.6	30.4	26.7	24.3	26.1	26.5	25.2	24.6
Electricity consumption KW per capita	277	297	334	335	345	345	359	363	344	356	37.2	378	385	410	429
Regulatory quality (perception)							-0.51		-0.48		-0.76		-0.78	-0.71	-0.91
Regulatory reforms			First reform approved		IPPs allowed	Competition started		Regulation started (INEPRA)	Restructuring (unbundling)+ PEPCO + NTDC						Restructuring and deregulation of WAPDA
Reforms score by ESMAP	3	4	4	3	3	9	10	42	62	63	63	63	69	69	69
Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	
Access to electricity – urban	96	97	98	98	98	98	98	96	98	98	99	98		98	
Access to electricity – rural	78	80	81	86	87		88	88	90	89	90	85		87	
Affordability – urban	38		33			38	42		35		35				
Affordability – rural	28		23			24	28		20		25			34	
Private sector participation	7.0	7.0	7.0	7.1	7.4	7.8	8.2	8.2	8.2	8.3	8.3				
Average domestic tariff	3.4	3.5	3.8	4.6	5.4	6.6	7.3	8.4	8.7	9.5	10.2	10.5	10.7	11.1	
Average tariff to all sectors	4.4	5.3	5.2	6.0	7.4	8.7	10.0	11.3	12.6	14.7	15.5	14.3	13.9	14.6	
Subsidy (allocated)	50	50	100	150	109	178	346	464	264	156	185	117	102	81	
Circular debt billion PKR		84	111	161	145	23.5	365	537	450	450	600	600	620	1,100	
Generation capacity MW	17,395	17,395	17,526	17,827	18,022	18,892	20,986	20,499	20,850	22,104	22,849	23,247	28,072	32,525	
T&D losses	24.0	22.3	19.6	21.2	19.9	16.2	16.9	17.0	16.3	17.1					
Electricity consumption KW per capita	463	487	481	443	459	465	455	450	482	471					
Regulatory quality (perception)	-0.64	-0.48	-0.53	-0.60	-0.58	-0.60	-0.63	-0.72	-0.70	-0.68	-0.63	-0.64			
Regulatory reforms	K-Electric privatized	Exemption from income tax							Competitive bidding + reduction of subsidies						
Reforms score by ESMAP	71	71	71	71	71	72	72	72	72	72	72	72	72	72	

However, rural electrification did not rise despite various reforms implemented in Pakistan's power sector. Similarly, the electricity affordability problem remained a financial burden on rural households. Since a reduction in power tariffs is a major expectation from the reform process, one can anticipate that electricity affordability has improved after two decades. However, the opposite is the case, particularly for rural households whose ability to afford electricity has reduced in the last two decades. Since the reforms were introduced in the early 1990s, private sector participation has increased from 3.4% to 8.2%, while the average electricity tariff rose sharply in this period. The average cost per unit for electricity for the residential customer has risen from PKR 0.7 to PKR 11.14. Similarly, the average unit price of electricity in all residential, commercial, and industrial sectors has increased from PKR 1.3 to PKR 14.5. In addition, the subsidy allocated to the power sector nearly tripled during 2002–2018. As a policy, a reduction in subsidies was set as an aim by the government in 2013. However, subsidies, which international aid organization demand from Pakistan to remove, is a lifeline for poor residential customers who are the primary beneficiaries of such subsidies. Moreover, circular debt has crippled Pakistan's power sector causing frequent power outages, and is a threat to the future sustainability of the power sector in the country. On the positive side, generation capacity increased from 6,409 to 32,552 MW from 1990 to 2018. In addition, T&D losses have improved (reduced) from 20% to 16%. Electricity consumption has increased from 277 to 485 KW per capita. Similarly, the perceived regulatory quality has improved from –0.48 to –0.70.

4. CONCLUSION

Electricity affordability is still a challenge to governments in developing countries. Reforms in the power sector aimed to improve affordability by reducing electricity supply tariffs. Earlier literature analyzed the claim of reforms to improve affordability from macro data sets. The present study attempted to investigate data from various reports and online sources, revealing new insights into power sector reforms and future strategies to ensure sustainable development in Pakistan.

The results based on descriptive analysis show that electricity consumption per capita and GDP growth were observed in Pakistan from 1990 to 2018. Also, a sharp rise in installed generation capacity was observed after the introduction of various reforms in Pakistan's power sector. However, there is no significant improvement in the country's T&D losses in the power sector. Indeed, the average 20% T&D losses when the reforms were introduced in the country are still at the same level. On the other hand, energy generation in the country has seen a sharp addition of power generation from hydro, oil, and natural gas.

Despite implementation of various reforms in the power sector, the industrial sector has not shown a significant increase in electricity consumption. Without a significant rise in electricity consumption in the industry sector, the country cannot move toward improving its citizens' living standards and raising the per capita income. The residential sector is the only sector showing a significant rise in electricity consumption. This increase indicates that residential customers are the primary beneficiaries of the various power reforms. They might receive a cross-sector subsidy, consuming cheap electricity at the expense of industrial customers. Our findings also revealed that the manufacturing and industry sectors' share in GDP declined during the reform implementation period. This raises further concerns about the success of reforms and questions about how these reforms were implemented. The only sector that showed an increased share in GDP was the services sector, which includes commercial banks.

Historical data analysis on tariff rises showed that industrial and commercial customers faced more price increases than domestic/residential customers. The energy generation mix that changed because of various policies adopted in Pakistan made electricity very expensive, particularly for the commercial sector. The share of hydropower reduced from 42% to 25% during 1994–2020 (Jamil et al. 2022). As the share of hydropower reduces in the country's power generation mix, expensive power is produced from fossil fuels. The rise of fossil fuel-based electricity also adds a fiscal burden and weakens local currency by depreciation/devaluation.

This study mainly focused on residential customers to see their welfare benefits as a result of the reform process and to guide policymakers in the future framework of reforms in the power sector. The results showed that when regulatory quality is low (1998–2007), the average normalized tariff was high compared to years when regulatory quality was better.

Our results are engaging because they present empirical evidence of the affordability problem among the poorest households. Electricity is less affordable to the poorest income group in our sample, which shows that the government needs to restructure the tariff, keeping the lowest income group in view. Furthermore, the study found that higher electricity consumption is associated with improvement in the HDI besides the direct welfare benefits of electricity price reduction.

Based on the results and findings of the present study, some policy guidelines are suggested. Private sector participation should be encouraged in the power sector in Pakistan. The financial and operational capacity building of distribution companies should be improved. On the one hand, strong regulations should be introduced to improve managerial failures and operational mismanagement in the power sector. On the other hand, to implement the reforms, the regulatory body should be given more independence to enforce compliance with regulations. It is essential to retire, or at least reduce the consumption of, coal-based energy to achieve the carbon neutrality target in Pakistan. The transition toward solar and wind-based renewable energy is a viable solution to reduce dependence on imported fuel-based electricity and achieve the country's environmental goals.

As suggested elsewhere (Kessides et al. 2009), it is important to distinguish between various kinds of affordability problem, such as distinguishing between households that are living in areas that have no access to electricity, households that voluntarily choose not to get access due to other sources of power such as solar, and households that cannot afford connection charges. However, due to data limitations, this study did not consider and distinguish between the various kinds of household.

The impact of tariff reforms on affordability depends on the change in tariff relative to the change in household income (Fankhauser and Tepic 2007); therefore, a more sensitive affordability analysis is required. Our data limitation in respect of home appliances, debt, regional inflation, etc. might make this study vulnerable to less robust results. Due to data limitations, the study could not highlight the impact of reforms on public finance.

Future studies may consider including measures for obsolete technologies that some poor households are using, causing overconsumption of electricity. Such households must be distinguished from others that are using energy-conserving home appliances. Furthermore, future research may consider the presence of certain innovations that give rise to more electricity consumption. Future research may consider the fuel-cost equivalence scale as proposed by Hills (2012). Future research may also consider the impact of reforms on electricity output per employee, job creation, and/or subsidies provided to the power sector.

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