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Research paper

An integrated sectoral framework for the development of sustainable power sector in Pakistan

Usama Qazi *, Mirza Jahanzaib

Industrial Engineering Department, University of Engineering and Technology, Taxila, Pakistan

HIGHLIGHTS

- Up-to-date Review of Electricity Reforms in Pakistan.
- Performance Review of Power Sector.
- Review based integrated framework for sustainable power sector in Pakistan.

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ABSTRACT

To achieve sustainable power sector in Pakistan, several reforms were introduced in last two decades. These reforms included structural transformations, institutional developments and policy advancements. Despite these reform efforts, the performance of overall power sector remained unsatisfactory and ended up in severe crisis. Currently, power sector is confronted with extended blackouts, high tariffs and deteriorated quality of service. To identify the causes of crisis, this article first reviewed the power sector reforms. Secondly, it reviewed the performance of electricity generation, transmission and distribution sectors comprehensively by employing several technical and administrative sectoral variables. Results revealed that biased and undue policy provisions, affected the performance of electricity generation sector. Whereas, poorly planned institutional transformations resulted in deficient performance of distribution sector. In transmission sector the appropriate institutional developments resulted in satisfactory performance of transmission sector. It has been further explored that, for the development of sustainable power sector, electricity generation and distribution sector need serious attention whereas transmission sector only require continuity in its performance enhancement. An integrated sectoral framework is also proposed which provide comprehensive performance enhancement plans for each sector. The proposed framework provides a roadmap for the development of sustainable power sector in Pakistan.

1. Introduction

For the development of sustainable power sector in Pakistan, several electricity reforms were initiated in late 90's. The primary objective of these reforms was to develop a sustainable power sector in terms of efficiency and social wellbeing that offer affordable and reliable access of electricity. These reforms included structural transformations, institutional developments and policy advancements. Under structural transformation, a state-owned entity was vertically unbundled which resulted in transition of market models i.e. shifting of monopoly model to single buyer model (Qazi et al., 2017). Whereas, institutional developments resulted in establishment of administrative institutions like market operator and regulator. Apart from these institutions, several functional departments were also established to support the development of sustainable power sector in the country. To fulfill the legal obligations for structural transformations and institutional developments, six energy policies were also enacted by different political governments in last two decades. Despite these extended efforts along with 8th largest private sector investment (Jamasb and Littlechild, 2004), power sector remained under severe stress. Currently, country is facing supply demand deficit of approximately 5000 MW with extended blackouts of 8–12 h, increasing tariffs, extended line losses, burden of circular debt and deteriorated quality of service (Kessides, 2013; Valasai et al., 2017). All these issues affected the overall performance of power sector and disrupted the economic growth as well (Komal and Abbas, 2015; Qazi et al., 2018).

* Corresponding author.
E-mail addresses: waleed.kazi@uettaxila.edu.pk (U. Qazi), jahan.zaib@uettaxila.edu.pk (M. Jahanzaib).

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The existing power situation triggered the need to identify the real causes of power sector crisis in policy and technical concerns. Although, several studies have analyzed the power sector crisis in context of generation and distribution sectors (Alvi et al., 2018; Mirjat et al., 2017; Perwez et al., 2015; Zakaria and Noureen, 2016; Zhou et al., 2017) but separately. Similarly, some studies have also identified the shortcomings of reforms that resulted in power crisis (Mirjat et al., 2017; Qazi et al., 2017; Ullah et al., 2017; Zameer and Wang, 2018).

In this context this research aims to identify the causes of existing power sector crisis by reviewing the power sector reforms and the performance of electricity generation, transmission and distribution sections separately using several sectoral variables for the period of past few years. The review of reforms and performance of power sector entities identified the key issues that resulted in crisis and eventually hurdled in development of sustainable power sector. Based on review of reforms and performance of power sector entities, an integrated sectoral framework is proposed which included performance enhancement plan for each sector i.e. electricity generation, distribution and transmission. The proposed framework is also accompanied with governmental and organizational support plan essential for the execution of sectoral enhancement plan. The integrated sectoral framework not only proposed the solution of existing power crisis, but also provide a structured roadmap essential for the development of sustainable power sector in Pakistan. The study is first of its kind presenting the comprehensive review of power sector reform, policies and performance of electricity generation, transmission and distribution sector. This research also fills the gap by comprehensive assessment of the power sector in both technical (sectoral performance review) and policy (power reforms) concerns. Similarly, the resulting proposed framework contributes as a way forward for all the stakeholders including policy makers, electricity generators and distributors for the development of sustainable power sector in Pakistan. This research will also serve as a base for future studies relating to power sector of Pakistan.

The remainder of this paper is organized as follows: Section 2 presents an overview of power sector of Pakistan Section 3 provides an overview of major reforms initiated over the past 20 years and summary of various energy policies introduced under different political governments. Section 4 reviews performance of electricity generation, transmission and distribution sector. Section 5 discusses the summary of sectoral review. Section 6 explains the integrated sectoral framework and Section 7 provides conclusion.

2. Power sector of Pakistan: An overview

Power sector of Pakistan comprises of 78 electricity generation firms. These firms vary in installed capacities and operating fuel. These electricity generation firms can be segregated in two administrative structures i.e. public (WAPDA and GENCOs) and private (IPPs). The installed capacity of WAPDA, GENCO and IPP is 6902 MW, 6438 MW and 9638 MW respectively. The total installed capacity of power sector is 22,978 MW in which the share of WAPDA, GENCOs and IPPS is 30.04%, 28.02% and 41.94%. The details of existing power sector are given in Table 1.

Table 1 shows that total share of thermal fuels in installed capacity is 63.4% with natural gas (43.9%), furnace Oil (18.7%), coal (0.7%) and HSD (0.1%). Similarly, hydro, nuclear and wind resources contribute 31%, 2.8% and 1.3% respectively. In electricity distribution sector, there are ten public sector DISCOs which serve six consumer categories in their respective regions. The total number of consumer are 24,517 Million. The average loss of distribution system is computed as 19.17. In electricity transmission sector, the total length of the network is 53,005 km with 1111 grid stations and transformation capacity of 92,871 MVA.

3. Review of power sector reforms in Pakistan

In context of global power sector reforms (Nepal and Jamasb, 2015), Pakistan initiated its power sector reform program in late 90's (Qudrat-Ullah, 2015). The reform program consisted of several sub activities which can be segmented into structural transformations, institutional developments and policy advancements. These reform activities were undertaken in parallel manner in different phases, over the period of last twenty years. Fig. 1 shows the time line of sub activities of reforms.

3.1. Structural transformations

In last two decades, power sector of Pakistan has undergone through several structural transformations. The first significant structural transformation took place in 1992 when state-owned natural monopoly namely Water and Power Development Authority (WAPDA), was vertically unbundled. Unbundling of WAPDA resulted in remodeled electricity generation and distribution sector (Qudrat-Ullah and Davidsen, 2001). Fig. 2, presents the pre- and post-unbundling structure of power sector.

Fig. 2 shows that before unbundling, all operations (electricity generation, transmission and distribution) of power sector were solely managed by WAPDA. Whereas, after unbundling, WAPDA was administratively split into separate electricity generation, transmission and distribution sectors. In generation sector, WAP DA was split to WAPDA (hydro) and Generation Companies (GENCOs). WAPDA hydro was given the responsibility to manage the hydro based power plants. Whereas GENCOs were made responsible for thermal power plants. Both WAPDA (hydro) and GENCOs were given the status of public sector. Under this transformation, Independent Power Plats (IPPs) were offered to start their operations in the country in 1994. Initially IPPs could utilize thermal fuels for electricity generation. With the passage of time, IPPs were motivated to utilize renewable energy resources as well. Administrative outcome of vertical unbundling and introduction of IPPs, was development of single buyer market in Pakistan. The second structural transformation occurred in 1998 when distribution sector was split to ten (initially 8) separate electricity Distribution Companies (DISCOs) (Jamil, 2013). These DISCOs still operate under government control but with independent regional jurisdiction and organizational autonomy. The third structural transformation was privatization of State owned enterprises (SOEs) which was initiated in 2005. Under this transformation Karachi Electric (KE) was privatized and was allowed to serve entire area of Karachi independently with its own electricity generation, transmission and distribution network. Another important structural transformation was planned in 2015 i.e. the development of wholesale competitive market. In this regard, private sector was permitted to lay down their own transmission lines. Similarly, net metering was also introduced as preliminary arrangements for the development of wholesale electricity market (Shahzad et al., 2016)

3.2. Institutional developments

Institutional developments involved establishment of various administrative and technical institutions. The aim of establishing these institutions was to provide administrative support to different phases of structural transformations after unbundling and introduction of IPPs. Administrative institutions included Pakistan Power Infrastructure Board (PPIB), National Electric Power Regulatory Authority (NEPRA), National Transmission and Dispatch Company (NTDC) and Central Power Purchasing Agency (CPPA-G). Whereas technical institutions include Pakistan Council of Renewable Energy Technology (PCRET), Alternative Energy Development