Structure and Regulation of the Electricity Networks in Pakistan

Amir Jahan Khan*

Abstract

The main objective of this paper is to present an account of the network part of the electricity industry in Pakistan and analyse the transition of the network operators from part of a vertical-integrated state monopoly to unbundled regulated state monopolies. Empirical evidence documented here shows that dispersion in system losses and revenue losses is high across network operators, although it is not possible to disentangle managerial inefficiency from exogenous technical losses in the distribution systems. Asymmetric information on the part of the regulator and the state ownership of electricity networks is delaying any incentive base tariff regulation regime for the distribution firms. It is important that in the early stage of regulation, standards in cost-based reporting are set and benchmarks are established in order to perform cost-based regulation effectively. As only the availability of reliable information about current and potential future cost can help to rationalize tariffs and generate resources for the long run investment required for the stable electricity supply in the country.

JEL Classification: L12, L51, L94
Keywords: Electricity Networks, Incentive Regulation, State Owned Monopoly, Utility

---

Assistant Professor at Institute of Business Administration (IBA) Karachi. He can be contacted at email address <a.j.khan@warwick.ac.uk>. Author is thankful to Professor Michael Waterson and Dr Robert Akerlof for their comments on the earlier drafts of this paper. Author is also thankful to Syed Safeer Hussain registrar for National Electric Power Regulatory Authority (NEPRA) for his valuable comments on the institutional details documented in this paper.

1 Introduction

This paper is a study of the network part of the electricity industry in Pakistan, particularly in the context of structural and regulatory reforms started in the 1990s. Published reports by the regulator show that the reforms process is not going anywhere even after two decades and the industry is performing poorly (NEPRA[1], 2010). The market is not clearing as load demand is higher than total system supply, particularly during the summer season[2]. There is no electricity due to load shedding for long hours in major parts of the distribution networks during the hot and long summer period. An effort is made here to document the basic facts of industry in an orderly manner and to draw major lessons from the failure of the reforms process and poor functioning of the electricity market. The focus will be on network parts of the electricity supply chain and issues in the regulation of the electricity industry, the restructuring of the natural monopoly components of industry will be discussed in detail.

The electricity industry in Pakistan is quite under researched (GOP, 2013), the main source of industry knowledge is based on government publications. According to available research (NEPRA 2011, Afia M, 2007), the rich information provided in policy documents and regulatory reports has not been analysed in detail. Therefore, documenting basic industry facts and understanding related issues in this paper is a major contribution to the existing literature and will be useful for future policy reforms.

The electricity industry in Pakistan has been functioning as a state monopoly for a long time. The state monopoly includes two vertically integrated electric utilities in

[1] List of abbreviations and acronyms is provided in the appendix Table 3A.
[2] There are no official figures available on load shedding hours. The summer seasons runs from April to October in most parts of the country.

the country; the Water and Power Development Authority (WAPDA) with a customer base of 20.3 million and the Karachi Electric Supply Corporation (KESC) serving 2.1 million customers[3]. In the last two decades, two major changes have occurred in the electricity industry of Pakistan. Firstly, the two state owned utilities went under structural reforms and unbundling in 2002. Second, regulation of the electricity industry started in 1998 and an authority was put in place to regulate electricity prices, allow entry into the industry and set standards for the electricity supply. The reforms were motivated by the intuition that state owned monopolies were less efficient than private enterprise and there was need to either privatize or restructure state entities. The unbundling process included separation of the potentially competitive segment (i.e. power generation) from the network based natural monopoly part of the electricity industry (i.e. transmission, and distribution of power), and division of the natural monopoly part of industry into transmission and distribution networks. The network components of industry are subject to regulation, and distribution utilities also perform as retail electricity suppliers.

The restructuring plan for the state-owned power sector was approved by the government of Pakistan in 1992, however the first substantial change in the industry was the commissioning of independent power producers (IPPs) in 1994. The IPPs started supplying electricity to the system in the late 1990s, and this was followed by privatization of a public power plant in 1996. These early initiatives created political debate and legal disputes between government and IPPs due to the lack of transparency in contractual arrangements and no obvious advantage for the competitive outlook of the generation segment.

[3] In the year 2011, 90 % generation (91,663 GW h) was in WAPDA system while 10 % (10,036GW h) in KESC system (NEPRA 2011).

The regulation of the industry started in 1998 when the National Electric Power Regulatory Authority (NEPRA) was put in place to regulate price, quality, and entry in the industry. NEPRA issued licences to 9 distribution companies (DISCOs) in 2002, including 8 companies in the WAPDA system. A licence was also issued to the National Transmission and Dispatch Company (NTDC)[4] for the transmission business in the WAPDA system. The 8 distribution companies and the NTDC are working as government owned monopolies in the distribution and transmission network of WAPDA, structure of the industry is presented in Figure 1.

The electricity industry in Pakistan is plagued by financial and operational issues which are affecting the economic efficiency and growth of the industry (GOP, 2013). The distribution companies and the transmission company rely on large and recurrent public subsidies[5], 1,290 billion Rupees[6] have been transferred as subsidies to DISCOs from 2007 to 2012 (GOP, 2013). The regulator decides the electricity price for each utility (i.e. a DISCO) after taking into account the consumer mix, transmission losses and operational cost of the DISCOs in accordance with the tariff standards and procedure rules (NEPR 2011). The government decides the final electricity price, which is lower than the price determined by regulators for most utilities. Therefore central government does not pass all of the electricity supply costs to consumers by charging less than the tariffs determined by the regulator[7]. The government introduced price differential subsidies in order to pursue the policy of uniform electricity prices

[4] This paper covers transmission and distribution networks of WAPDA system, KESC is a vertically integrated company operational in the greater Karachi region (with no effective separate cost centres) and issues related to KESC might need a different framework for discussion. However, possible experiment can be done to compare performance of KESC with government owned distribution companies.

[5] The issues related to network part of the industry are discussed here in detail, as the focus is on the distribution and transmission segments of the industry in WAPDA/NTDC system.

[6] about 18 billion US dollars

[7] Government documents show that electricity sale price for all utilities is equal to the lowest determined price for any utility (among all utilities) for a given year (GOP, 2013)

in the country. In this way the performance incentives for firms in power networks can be partially determined by the subsidy allocation mechanism and regulatory tariff structure.

The main objective of this paper is to present an account of the network part of the electricity industry and analyse the transition from state monopoly to a regulated state monopoly. An effort is made to highlight the factors which are potentially slowing growth of the industry and resulting in poor allocation of resources. The documentation of technical, economic, and institutional factors related to transmission and distribution segments is an integral part of understanding market functioning and incentive structure in the electricity industry (Joskow and Schmalensee 1988). The economic efficiency in the electricity industry also depends on the contractual nature and consequent incentives in network economy, and the tariff incentive structure applicable to utilities (DISCOs) and system operator (NTDC). The current tariff structure and evolution to its current state is discussed here, with respect to corresponding implications on incentives for firms in the business of electricity networks.

The electricity networks are an important component of the electricity industry, efficient functioning of transmission and distribution companies and timely capital investment in distribution networks is required for the growth of other segments of the industry. For instance, the power generation segment performance will depend on the reliability and structure of the transmission and distribution networks. The missing interconnection transmission networks or inadequate capacity in the networks affects the operation of existing power plants and has delayed the commissioning of new power generation plants (NEPRA, 2010).

The analysis of incentive mechanism for the electricity networks assumes the separation of network segments into clearly defined distribution and transmission networks (Joskow, 2008). Although the unbundling of electric power in WAPDA system occurred in 2002 with the establishment of distribution companies DISCOs and transmission company NTDC, however formal contractual relationships between DISCOs and NTDC are not in place and they were under "de facto" common management until recently (NEPRA, 2011). The role of key public institutions[8] during transition needs to be discussed in order to understand the incentive structure and resulting behaviour of DISCOs and NTDC (see Figure 1 for structure of the Industry). The electricity networks in the main system are government owned regulated monopolies where the authority (i.e. NEPRA) oversees the regulation and determines tariffs for the electricity generation, transmission, and distribution. The knowledge on regulatory effectiveness and incentives creation by tariff structure or regulator lag is quite limited for Pakistan (Afia M, 2007). The documentation of all the institutional details with potential economic consequences for the electricity industry will be useful for the future reforms of the electricity industry in Pakistan.

The following discussion in this paper is divided into four sections, the next section discusses issues related to the structure and management of electricity distribution networks, the natural monopoly role of electricity networks and its implications for economic efficiency are also analysed in this part. The section 3 documents incentive regulation particularly relevant to electricity networks and compares it with current practice in Pakistan. The section 4 expands discussion to the public sector role in the power industry particularly in electricity networks and incentive mechanisms for

[8] One example, Pakistan Electric Power Company (PEPCO), PEPCO's main responsibilities included to oversee WAPDA's unbundling, and to restructure and to corporatize distribution and generation public firms (NEPRA 2010)

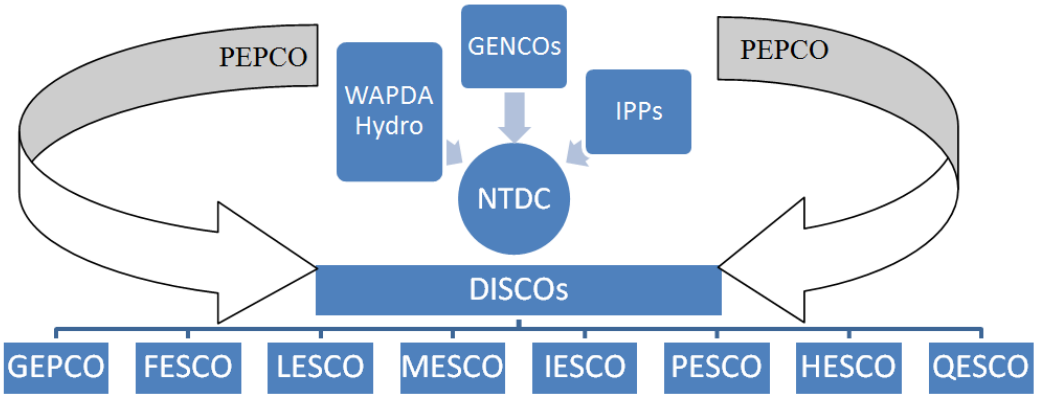
market based reforms. Some policy recommendations based on positive analysis and concluding remarks are documented in the last section. Additional tables and list of abbreviations are given in the appendices.

2 Structure of Electricity Networks

In this section I will discuss the implications of "electricity network" structure on economic efficiency of the electricity systems in the context of theoretical considerations and general practice in the electricity industry. The distribution networks operator also plays the role of retail business in Pakistan, the issues related to the quality of electricity supply are also documented in this section. The structure of electricity networks is intuitively thought to be a regulated natural monopoly like gas or water supply networks, where duplication cost can be avoided by serving a geographical market with a single transmission or distribution company, instead of more than one firm doing the same job (Joskow and Schmalensee 1988). Transmission networks carry high voltage power and connect a generator to other generators and the load centres in the system, while the distribution networks supply electricity on low voltage to consumers and are connected to high voltage transmission networks through boundary grid stations.

In Pakistan, government owned distribution companies DISCOs and system operator NTDC are functioning as distribution and transmission monopolies respectively, while government owned generation companies (GENCOs) are competing with private power producers to supply electricity in the system (Figure 1 below). This structure of industry shown in Figure 1 requires explanation in past institutional context.

Figure 1: The unbundled structure of the vertical integrated state monopoly



Historically, utilities in Pakistan were vertically integrated in their generation, transmission and distribution[9] businesses. Incentives for vertical integration of distribution with generation-transmission arise due to some basic complementarities. The distribution networks are load centres and they provide reliable load forecast to generation and transmission firms for the efficient function of the electricity system. The accurate load forecasts are also necessary for short term planning and long term investments in a generation-transmission system (Joskow and Schmalensee 1983).

The distribution and transmission networks were part of vertically integrated state-monopoly Water and Power Development Authority (WAPDA). As a result of WAPDA's restructuring in 2002, the regulator issued licences to distribution companies DISCOs and transmission company NTDC to work as unbundled natural monopolies. Further, Pakistan Electric Power Company (PEPCO) was formed to manage the unbundling process and to make sure that electricity networks make a successful transition. However, centralization incentive persisted with central government in guise of NTDC/PEPCO as the current system is without any

[9] In Pakistan distribution companies also perform the role of electricity supplier or retailing. In principle, a government or a private firm can run retail business by procuring electricity and paying to intermediary firms in power supply chain. The words distribution companies, DISCOs, and utilities are used interchangeably in this paper for electricity suppliers.

functioning of contractual arrangements between distribution firms and other parts of the industry, until recently distribution companies DISCOs were under the management of NTDC and PEPCO (NEPRA 2010). However distribution companies DISCOs are functioning unbundled and are also performing retail business in monopoly controlled areas.

There is theoretical justification along international practice for the natural monopoly status of distribution networks and the efforts to "unbundle" electric utility in Pakistan were in line with the international experience. The electricity unbundling initiative started in the US in 1980s and a number of countries, including the UK have "unbundled" electricity supply. According to the basic model, the network part of industry became a natural monopoly while power generation firms became part of the competitive market. The intuition for cost saving by one distributor sounds plausible, the unit cost is likely to go down as the number of customers or load increases on a system in a limited geographical location. But there could be limits to economies of scale because grid stations, distribution lines, and interconnectors become overburdened as load increases in a given location. Similarly, diseconomies in equipment maintenance and overheads along other x-inefficiencies can be imagined as distribution network area expands unboundedly[10].

2.1 Distribution Networks

The distribution networks supply electricity from the transmission system to lines below 220 kilo volt, the network infrastructure includes distribution lines and 132 kilo volt and lower capacity grid stations. As shown in Table 1 below, the electricity industry suffers with high system losses (including theft) and high revenue losses. The

[10] As demand for new connections increases or power is supplied to household not already connected to the system.

non-theft system losses can be attributed to the current state of technology and size of the distribution network. The resistance loss increases as the size of a distribution network increases and the system loss can also increase as demand goes up. The regulator reports that *"distribution system in urban centres is over stressed and needs to be upgraded, augmented, and expanded"* (NEPRA 2010). Therefore technical line losses can arise both in large networks (due to resistance) and small congested distribution networks due to resistance and high demand.

On the other hand, system losses caused by theft and revenue losses can arise from managerial inefficiency and corrupt governance. Even technical losses resulting from poor engineering design and system operation can be a result of bad governance and lack of planning. The influence of managerial effort and pure technical losses cannot be disentangled, as disaggregate data for the required analysis is not available, however conjecture can be made where decentralized system loss data is available for a distribution network. Similarly, the potential of theft can be assessed from the number of customers and total households in a given distribution network.

The average area of a government owned distribution system is 98 thousand square kilometres with average density of 67 customers per square kilometre, as shown in Table 1. There is considerable variation in peak load demand and composition of urban towns among networks. There is significant negative correlation (-0.65) between network density and system losses (including theft) or recovery (billing) losses[11]. Technical, structural and managerial diseconomies exist in large distribution companies. For instance, Hyderabad Supply Company HESCO is losing more than one-third electricity from the system and at the top recovering less than 60 per cent of

[11] Except privatized KESC distributing electricity in Karachi, high line losses in KESC are probably caused by theft and lawlessness in a city of 12.9 million.

final electricity sold[12]. The trends in Table 1 persist over time (see Table 2, and Table 3).

The genuine system losses are not disentangled from theft losses, but three companies QESCO, HESCO, PESCO are susceptible to huge theft losses due to political instability and lawlessness in the region[13]. The high losses also suggest that basic infrastructure is getting overstressed and requires maintenance and replacements, while investment in substations, distribution lines, and human capital will depend on the financial health of the firm which in turn depends on system losses and billing losses.

Table 1: Electricity Prices, Density, and Losses for Distribution Companies, 2010

Distribution Company	*Total Consumers*	*Peak demand (MW)*	*Density (consumer/area)*	*System[1] Losses (%)*	*Billing Losses (%)*	*Power Purchase Price (rupee/kWh)*
IESCO	2,059,207	1457	88.9	9.8	4.1	7.6
LESCO	3,182,292	3916	166.9	13.7	8.2	8.2
GEPCO	2,454,254	1813	142.6	11.0	4.0	8.1
FESCO	2,879,188	2298	65.0	10.9	3.0	8.2
MEPCO	4,057,491	3006	38.5	18.9	4.2	8.7
PESCO	2,947,108	3685	29.0	37.0	14.6	11.4
HESCO	1,511,878	1797	11.2	34.8	40.2	11.0
QESCO	490,805	1316	1.4	20.7	42.3	9.0
KESC	2,051,964	2562	315.7	34.9		

Source: NEPRA, State of Industry Report 2010-11, 1 distribution network losses

[12] The regulation authority appears to be concerned about the inefficiencies in large distribution networks; HESCO was divided into two distribution companies in 2011 (HESCO and SEPCO).
[13] This is validated by published regulator reports and unstructured interviews with officials.

Table 2: Distribution Network, Total System Losses, (%)

Distribution Company	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*
Peshawar	31.8	32.2	32.4	35.2	34.7	35.2	34.9
Islamabad	13.3	12.2	10.3	10.8	9.8	9.7	9.5
Lahore	10.2	11.7	11.2	10.7	11.0	12.0	11.2
Gujranwala	13.1	12.8	12.5	13.3	13.8	13.3	13.5
Faisalabad	11.6	11.5	11.1	10.6	10.8	11.2	10.8
Multan	20.5	18.7	18.5	18.4	18.9	18.2	19.3
Hyderabad	39.2	37.0	35.9	35.1	34.8	28.6	27.7
Sukkur						49.4	49.4
Quetta	20.7	21.4	20.8	20.1	20.7	20.4	20.8
Karachi	37.5	34.2	33.8	38.5	37.3	34.8	32.6

Source: NEPRA, State of Industry Report 2010, 2011, 1 percentage gap between units purchased and sold/billed by the firm

Table 3: Distribution Network, Revenue Losses for Domestic Consumers, (%)

Distribution Company	*2008*	*2009*	*2010*	*2011*	*2012*
Peshawar	23.0	48.3		28.0	48.8
Islamabad	2.0	-3.0	0.4	4.0	-1.1
Lahore	1.0	3.8	3.1	0.8	-1.5
Gujranwala	2.0	3.1	4.1	2.0	3.4
Faisalabad	1.0	1.8	1.7	0.8	0.2
Multan	1.0	2.2	3.6	1.7	1.2
Hyderabad	26.0	42.1	51.1	54.1	36.7
Sukkur[2]					62.8
Quetta	10.0		28.2	31.0	26.5
Karachi	100.0	0.0	0.0	17.1	16.2

Source: NEPRA, State of Industry Report 2010, 2011. 1 percentage gap between amount billed and amount recovered, 2 Sukkur was part of Hyderabad before 2012. The negative numbers shows additional recovery on account of deferred payments for previous years

Despite area-losses correlation, the other factors in poorly performing distribution regions cannot be ignored, these include lack of good governance, law and order, and economic development[14]. High system losses of distribution companies manifest in the power purchase price for consumers, in 2010 price ranged from 7.6 rupees per kilowatt hour to 11.4 rupees per kilowatt hour depending on performance[15]. The reinforcement of billing losses in technically inefficient distribution companies suggests that incentives for improvements in management are low, while new investment is not taking place due to poor financial performance that in turn will restrict the capability of firms to improve system losses, and that becomes a vicious circle.

Tables 2, 3, and 4 show the time trend for system losses, revenue losses and potential consumers without electricity respectively. In theory, housing units without formal electricity connection are not connected to the system, but in practice they might be informally connected to the system without any billing meter[16], particularly in congested areas and remote areas where monitoring of the system is poor or the employees submits to bribes. A major fraction of household consumers are not connected to the system in distribution networks operating in Peshawar (PESCO), Hyderabad (HESCO), Karachi (KESC), and Multan, coincidently the distribution system losses are also high in these firms (Table 2). This supports the hypothesis that households not connected to the system in the congested systems, such as KESC, enjoy electricity stolen from the system. However, it is difficult to attribute system

[14] Particularly deteriorated law and order and weak political administrative structure in Quetta QESCO, Hyderabad HESCO, and Peshawar PESCO regions

[15] The variation in regional average tariffs is not in contradiction with uniform tariff policy as average tariffs are affected by consumer mix and other tariff adjustment by the regulator.

[16] An illegal connection to system without a meter is called "kunda" (the hook on the wire) in local jargon

losses to theft in low density networks, such as HESCO, because the system is losing at low voltage lines while supplying electricity to a dispersed population, for instance a high feeder is supplying electricity on long low voltage lines to a few scattered houses with low demand.

On the other hand, all is not well with medium density low distribution loss networks as high technical inefficiency and system losses prevails in parts of these networks as well. Again this can be a result of poor engineering design, other technical losses, and managerial inefficiency. For instance Gujranwala Electricity Company (GEPCO) is considered to be among the better performing utilities according to regulator reports, however in more than 40 % of GEPCO sub-divisions system losses are higher than 12 %.

Table 4: Domestic Consumers without Electricity, (%)

Distribution Company	*Potential Consumers 2012*	*2006*	*2007*	*2008*	*2009*	*2010*	*2011*	*2012*
Peshawar	2,761,232	45.2	42.7	41.5	41.2	37.4	36.6	36.0
Islamabad	1,882,619			0.0	0.0	0.0	0.0	0.0
Lahore	2,258,940	14.1	11.5	8.6	7.3	4.9	2.6	0.6
Gujranwala	2,808,748	20.6	17.1	14.6	12.5	10.0	7.7	5.7
Faisalabad	2,712,234	30.4	25.7	21.2	18.1	15.8	13.4	11.3
Multan	3,888,629	45.4	40.2	35.8	33.8	31.2	29.5	27.3
Hyderabad	718,422	71.2	70.5	70.3	70.2	70.1	70.1	67.5
Sukkur	552,110							72.8
Quetta	394,843	71.9	71.2	70.6	70.0	69.7	69.6	69.4
Karachi	1,659,766	22.2	21.3	21.6	22.5	21.5	20.6	20.8

Source: NEPRA, State of Industry Report 2010, 2011, estimate suffer substantial downward bias due to lower estimated total potential consumer data in the distribution network, particularly in later years, the last Population Census was conducted in 1998 and the available projections are much lower than actual figures based on partial housing census of 2012.

Overall issues with system losses, engineering design, and managerial practices will affect cost of electricity supply. The system losses result in higher average unit cost of electricity with negative welfare consequences for consumers. The shortage of bulk supply coupled with system losses result in long periods of load shedding and low system reliability. The system reliability in industry is measured by utilities reporting System Average Interruption Index (SAIFI) and System Average Interruption Duration Index (SAIDI). The long durations due to lack of power supply in the system render SAIFI and SAIDI meaningless as it becomes hard to disentangle between the interruptions when there was no power supply and the interruptions when power supply was there, but utility network collapsed due to poor technology. SAIFI and SAIDI are reported in Table5 below.

Table 5 Distribution System Performances, 2008-09

Distribution Company	*Consumers*	*SAIFI*[1]	*SAIDI*[2]
Islamabad	2,059,207	0.5	22.8
Lahore	3,182,292	100.2	6847.7
Gujranwala	2,454,254	17.3	19.4
Faisalabad	2,879,188	64.9	114731.9
Multan	4,057,491	0.03	2.01
Peshawar	2,947,108	193.97	15787.43
Hyderabad	1,511,878	918.53	83969.3
Quetta	490,805	155.4	12757.3
Karachi	2,051,964	0.1	1074.6

Source: NEPRA, State of Industry Report 2010, 1 SAIFI= (Frequency of Interruption/Total Connected Customer)
2 SAIDI= (Hours of Interruption/Total Connected Customer)

2.2 Transmission Network

The transmission network plays a fundamental role in coordination and achieving system economies, and enables the reliable, stable, and efficient supply of electricity for final use in homes, markets and industries. The importance of the transmission network in electricity industry depends on its critical function and not just operational cost, as the smaller cost component of the transmission network in total cost of electricity can be misleading (Joskow and Schmalensee, 1988). Generation and transmission operations of electricity are simultaneous decisions, transmission lines link power plants to load centres, and installing new generation capacity depends on interconnectors and lines facilities provided by transmission companies. The long run, low cost supply of electricity depends on investment and new technology adoption in transmission, and with a high level of coordination between generation and load centres. Lack of coordination and investment in transmission systems can make generation investments ineffective or can delay the supply of electricity due to dysfunctional interconnectors[17], this institutional context of electricity industry has favoured vertical integration of generation-transmission and distribution. The existence of economies of scale in the use of high voltage lines and transmission links make transmission networks work efficiently as a natural monopoly. While the natural monopoly structure of transmission exists in the electricity industry, however for efficiency reasons high level coordination between transmission and other components of industry is required for an efficient and stable system.

Sunk costs in investments, formal and informal contracts, and system externalities are main features of any transmission network. The investment decisions by transmission operators require high level coordination between load centres and generators, as post

17 For instance, recently a number of new power plants failed to supply electricity because of inadequate capacity of interconnectors and transmission system (NEPRA 2011).

investment reallocation of transmission infrastructure and resources becomes costly. It is not clear that decentralization (unbundling) in industry structure will increase or reduce the electricity supply cost in the system. This aspect is important in Pakistan where policy making authority appears to pursue more decentralization and structural disintegration in the system with independent distribution and transmission networks. The successful unbundling of electric power will require mechanisms for the enforcement of formal contracts and regulatory set up to resolve contingencies uncovered in formal contracts.

National Transmission and Dispatch Company (NTDC) works as a licensed monopoly, sole service provider covering a large area. Although there is no optimal scale for system coordination, some past studies (Joskow and Schmalensee, 1988) mention 10,000 MW of peak demand for efficient scale of transmission network. The area coverage and peak load demand suggests problems in NTDC system, constraints in extra high voltage transmission lines resulted in increased forced outage of the power system (NEPRA 2010). Although the overall transmission losses in recent years are comparable with international standards (World Bank, 2011), see Table 6.

The inexorable electricity demand in Pakistan, particularly the air-conditioning during summer months, has pushed the peak demand to 16,000 MW in the system[18] (NEPRA, 2011). In an electricity system, supply needs to meet demand in real time, the system becomes unstable if demand is higher than supply[19]. On the other hand, the system should be able to hold supply to match rising demand. System operators need

[18] The minister for power affairs recently mentioned in an interview that during hot summer month demand keeps on exceeding supply as system add electricity from more production or new plants. In summer, rolling blackouts are there since 2008 that imply system operator might not even know exact peak demand during summer.

[19] Constraints in transmission or distribution networks can make power system unstable; the load shedding is required to keep the system stable since 2008 load shedding is prevalent in country particularly in summer months.

to check the reliability of transmission systems to sustain peak demand, as policy makers are keen to increase supply to meet unfulfilled demand in the future. It appears that over the years, large gaps between demand and supply of electricity during long summer season has weakened the coordination system between transmission and distribution networks. The load centres (i.e. DISCOs) are unable to determine potential demand in the summer season, as full demand is not met in all parts of the network at any given time. There are even reported incidents stating that when some DISCOs tried to meet load demand, the distribution network was unable to sustain the load.

Table 6: Energy Generation, Units Sold, and Losses in NTDC System, 2002-2010

Year	*Net Generation(GWh)*	*Units Sold Billed (GWh)*	*Transmission Losses (%)*	*Distribution Losses (%)*
2002	59545	45204	7.6	16
2003	62694	47421	7.7	16.2
2004	67697	51492	7.3	16.1
2005	71670	55342	7.4	14.9
2006	80404	62405	7.1	14.8
2007	85987	67480	3.7	17.3
2008	84584	66539	3.4	17.5
2009	82705	65286	3.5	17.1
2010	87072	68878	3.1	17.4

Source: GOP, Electricity Demand Forecast, NTDC

3 Tariff Structure and Incentive Regulation

3.1 Cost of service and incentive regulation: theoretical aspects

According to the regulator, the electricity industry in Pakistan is subject to price, entry and quality of service regulation (NEPRA, 2010), the regulator, NEPRA, determines

tariffs for transmission, distribution, and generation business of electricity. This section examines the theory of incentive regulation in the context of unbundled distribution and transmission electricity networks. The basic idea is to review the issues that arise when the regulator is imperfectly informed and faces asymmetric information about costs and managerial efficiency, and to document the optimal price mechanism in specific scenarios. The prevalent tariff structure in Pakistan is reviewed later to check the conformity with theoretical knowledge and also to see if the electricity industry satisfies basic assumptions for exposure to incentive regulation for unbundled electricity networks (Joskow, 2008).

The knowledge about effectiveness of electricity network regulation in Pakistan is limited, Afia (2007) documented the overview of electricity regulation in Pakistan, and highlighted issues including, the ineffectiveness of the regulator, the lack of autonomy and weak governance of NEPRA, although it is not quite clear what incentives are there for network operators in the current setup to cut cost and enhance efficiency. There are multiple factors affecting the current state of the electricity industry in Pakistan, but regulation framework and related incentives appear to be an important constraint in the growth of the electricity industry[20].

The proper incentives for firms, operating regulated networks, are important for the efficiency of networks and the generation segment, because well performing networks will lead to better decisions and operations by generation firms. The network service cost contributes to final electricity supply cost, better incentives manifested in lower networks cost can improve welfare for society. While documenting the regulatory discussion Kahn, A.E. (1971) noted that "*.....the central institutional question have to*

[20] The comparison of electricity industry between a state monopoly (till 2002), and regulated industry since 2002 requires deeper understanding of issues in both periods, and not feasible with available limited information.

do with the nature and adequacy of the incentives and pressures that influence private management in making the critical economic decisions". Ideally networks should be operated at minimum cost and the regulator should specify the efficient network price. However, the economic incentives in lowering production costs are more important than enforcing the efficient pricing mechanism. This point is well documented in the literature, as the efficiency loss of high cost is of "first order" (impact all infra marginal units) while tariff or price inefficiency loss is second order (Harberger triangle). These earlier notions and the latter theoretical advances provide the foundation for incentive regulation in electricity and other networks.

In a typical situation ex ante, a regulator is not perfectly informed about managerial efforts, technical processes and other factors to lower networks cost, but can get more information through ex post regulatory hearings and mandatory audits. However, the distribution and transmission companies are better informed about the cost of production and managerial practices adopted to improve efficiency. In this situation two extreme tariff regimes can be followed from Laffont and Tirole (1993).

The first regime is a fixed price regime, where network fees will be charged to consumers by distribution companies going forward. The fixed network charge will evolve by incorporating exogenous price changes in factor inputs; this is referred to as a price cap mechanism (Joskow, 2008). As a price mechanism is responsive to only exogenous price changes, the firm's increased effort to lower cost will result in an equal amount added to the profit of the firm. Therefore the effective price cap mechanism provides greater incentives for the network operator to increase managerial efforts to reduce cost, improve system efficiency, and lower system losses. But given that the regulator wants to make sure that the firm meets budget constraints, uncertainty arises about the level of price cap. Too high a price cap can still generate

incentives to lower cost but may leave large profits for firms, so the mechanism will not be good from "rent extraction" point.

Second regime is standard "cost of service regulation", under this mechanism the network operator will be compensated for all of the production or service costs incurred to run a network. This tariff plan makes sure that firms earn normal profit, so the "rent extraction" issue discussed above can be fixed, but on the other hand there are no incentives for firms to reduce costs as there is no economic rent left by the regulator. Therefore managers will not get a reward for any cost savings in the "cost of service" regulatory plan, or they will overspend in capital expenses in line with Averch-Johnson effects. The fixed price (price cap) regime performs poorly on "rent extraction" while "cost of service" regimes will provide no space for being cost efficient. In an ideal situation a mixture of two regimes can perform better than the adoption of a single regime when the regulator is imperfectly informed about networks (Joskow, 2008), so in effect the price will be contingent on variation in realised cost, while a portion of cost will be fixed ex ante (Schmalensee 1989, Lyon 1996).

As noted by Joskow (2008) the theoretical literature provides partial guidance for incentive regulation in electricity networks, and other circumstance based factors are also incorporated in the practical regulation mechanism adopted by regulatory authorities. In practice, a mix of "price cap" and "cost of service" mechanism is adopted by utilities. An initial price level P_o is set by using cost based or "return to capital employed" yardstick and adjusted with the rate of input price increase (RPI) and productivity factor Z of firms in latter time periods, which gives equation, $P_1 = P_0(1 + \mathrm{RPI} - Z)$ (1).

The tariffs are initially imposed for usually five years and at the end of the period P_o and Z are readjusted after post regulation audit and incorporating the firm's realized costs. In practice, incentive regulation requires an established cost of the service based regulation system. In Pakistan the cost of service or rate base regulation started effectively in 2004, and then on regulator conducts "pricing reviews" to determine tariffs for a period of time, this mechanism is evolving and recent regulatory reports mention methodological process of tariff determination[21]. In the next subsection the tariff or distribution margin determination process for distribution networks is analysed, this will serve two purposes. First, the regulator's information sources for distribution companies costs are highlighted, and the effectiveness of cost reporting protocols are assessed. Second, I check the potential of the regulator's current cost information for credible benchmarking of incentive regulation.

3.2 Cost of service and incentive regulation: practical issues

The analysis of incentive regulation for electricity networks usually assumes that the electricity supply is unbundled with a clearly defined distribution and transmission network, and the industry is regulated by an independent regulator staffed with adequate strength and skills to monitor the industry and implement regulation activities (Joskow, 2008), both of these assumptions are subject to caveats in Pakistan. Although the electricity delivery is unbundled, contractual relationships between network utilities DISCOs and transmission monopoly NTDC are not well established, at least on transparency grounds (NEPRA, 2010). The appointment of the board of directors for DISCOs and interference of NTDC in DISCOs highlights the lack of independence by utilities to run their managerial affairs. The regulator faces constraints to implement the procedures and monitor generation and transmission

[21] NEPRA tariff determination 2012-13

activities, and standard procedures to supply basic industry data have not yet been adopted by distribution networks, from regulator reports it appears that although uniform system of accounts for DISCOs were proposed, such systems have not been operational till late.

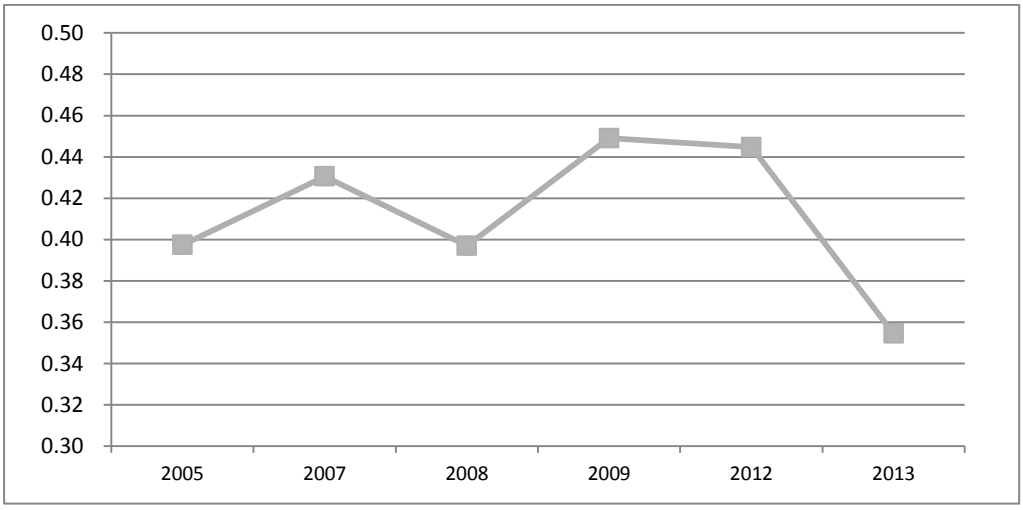
The cost of electricity supply includes generation cost, transmission cost, and distribution margins (DM), these tariff components are fixed by the regulator NEPRA. In 2011 the distribution margin including line losses contributed to approximately 25 % of the average electricity cost, while network fees were less than 2 % of average electricity cost[22]. The tariff structure is based on cost of service or rate of return regulation, the electricity networks recover costs through distribution margin and transmission cost. The cost is collected from consumers by Distribution Companies DISCOs, and then DISCOs transfer power purchase price[23] including transmission fees to the central transmission/dispatch company NTDC[24]. In a single buyer model, NTDC procures electricity from all generators at the prices agreed in Power Purchase Agreements (PPA) and transmits bulk power to DISCOs on high voltage lines. The regulator enforces the tariff mechanism under the principle that network operators (transmission and distribution firms) recover sufficient return on capital to cover all operation costs and reasonable funds for capacity expansion for future needs (NEPRA 2010). The tariff is imposed for a period, and intermediated requests for fuel adjustment charges are entertained by the regulator. The frequency of

[22] Estimates based on public data (NEPRA 2011)
[23] Power Purchase Price PPP is a pass through cost item.
[24] NTDC is given transmission license for a term of thirty years in 2002 by the regulator. *"The Company is entrusted to act as System Operator (SO), Transmission Network Operator (TNO), Central Power Purchase Authority (CPPA) and Contract Registrar and Power Exchange Administrator (CRPEA)"* (NEPRA 2011).

pricing reviews and average cost for a selected distribution company are shown in appendix Table 1A and Figure2.

The regulatory tariff standards listed in the appendix (see Table 2A) and the discussion above imply that the current practice of price regulation in the electricity industry is set in a "cost of service" or rate of return framework. There is no "price cap" mechanism enforced and tariff petitions are settled on a case-to-case basis. The distribution networks are publicly owned monopolies facing no incentives to cut operation costs or line losses as ultimately consumers in shape of electricity price or government through subsidies have to finance the cost of the distribution companies to meet their budget constraints. Earlier, some of the distribution companies proposed multi-year tariffs for five year periods, but the regulator declared an incentive based price cap regime unsuitable for the government owned distribution companies, until the companies are partly divested or privatized (NEPRA 2004). All of the distribution networks in the main system are government owned; therefore the chances of incentive based regulation are minimal until distribution firms are prioritized for privatization.

Figure 2: Real distribution cost, GEPCO (rupees per kWh)



Source: NEPRA, Tariff Determination Reports Various Issues, 200-01 constant prices

3.3 Case study of a distribution network

The analysis based on a sample distribution company, Gujranwala Electric Power Company (GEPCO) shows that the regulator determines a firm's distribution margin on the basis of reported costs for operation and maintenance, depreciation, and Return On Rate Base (RORB) (e.g. cost of capital). The frequency of pricing reviews for GEPCO is given in Table 1A. The distribution margin[25] is the economic rent which the firm gets for operating the distribution network. The margin consists of operation and maintenance expenses, depreciation charges, and return on rate base, further adjustments are made for any income earned by the firm. The detail of the distribution margin components is given in Table 7.

Operation and maintenance expenses, including wage and salaries, are the largest component of a distribution network's cost (about 90 %) excluding transfer prices for generation and transmission companies. Distribution networks are public owned companies and jobs are sanctioned for various pay scales historically with employees entitled to post retirement benefits. The regulator allows costs for salaries and wages based on past audited figures with the adjustment of annual pay increases of public employees and the impact of hiring on vacant positions, with very little allowance for new staff hiring, particularly with non-technical contract employees[26]. But pricing reviews reveal information asymmetry with the regulator, for instance, in 2012 the regulator allowed Rs3,563 million for wages and salary, while audited account puts

[25] Although revenue requirements of a distribution network includes power purchase price including transmission network user fee but that requirement is part of transfer fees so not directly related to incentive items for a distribution company.

[26] GEPCO is a 100 % Public Sector Company since unbundling the employees are hired on contractual basis and regularised to permanent posts after sometime.

the figure at Rs5,040 million. Apparently, the company spends money through public exchequer and put in prior year adjustments in the next year "pricing review". This shows a lack of consistent accounts data availability for current expenses of workers' wages and post-retirement benefits. The regulator matches the GEPCO request for new staff hiring with the justification for "prudent utility practices", while neither of the firms supply matching information on any potential "efficient utility practices" gained by new hiring, nor does the regulator specify any yardstick for new appointments. This is quite similar to the situation when new investment requirements by the firm are matched with potential system improvement gains to justify new investment. The lack of information coordination between the regulator and the distribution company underlines the gap in current cost-based regulation regime. This information gap needs to be filled in order to set the platform for incentive based regulation and continual human capital investment in the distribution firm.

Since regulation started in 2004, it is important that in this early stage, standards in cost-based reporting are set and benchmarks are established in order to perform cost-based regulation effectively. To some extent goals were set at the same time as the "rate base" was set in 2004, and updated accordingly in pricing reviews (Table 8). However, the basic accounting information is coming from the distribution company through internal audit reports. The regulator requests for the required information from firms, but have not commissioned any study to determine the standards for various cost components, as seen in Table 7 and Table 8.

Table 7: Distribution Margin GEPCO, Selected Years (million rupees)

	2006-7	2007-8	2008-9	2011-12	2012-13
Operation and Maintenance	3,298	3,254	3,739	6,318	5,454
Depreciation	510	556	829	971	1,098
Other Income	-970	-970	-1,116	-1,505	-1,960
Return on Assets	893	799	1,522	1,313	1,583
Income Tax		195			
Net Distribution Margin	3,732	3,833	4,979	7,097	6,175

Source: NEPRA, Tariff Determination Reports Various Issues, data is missing for some years

Table 8: Rate Base GEPCO, Selected Years (million rupees)

	2011-12*	2012-13**
Opening Fixed Assets in Operation	27,681	31,379
Assets Transferred During the Year	3,698	2,914
Gross Fixed Assets in Operation	31,379	34,239
Less: Accumulated Depreciation	9,387	10,485
Net Average Fixed Assets in Operation(Rate Base)	21,992	23,754
Plus: Capital Work In Progress (closing)	2,811	4,371
Total Fixed Assets	24,803	28,125
Less: Deferred Credit	11,516	13,324
Total Regulatory Base	13,287	14,801

Source: NEPRA, Tariff Determination Reports Various Issues, data is missing for some years,* actual, ** projected

According to regulation rules, sufficient tariffs should be allowed to generate a reasonable investment in technology to maintain the system and improve the reliability of the electricity supply (NEPRA 2012-13). In practice the regulator cares for the effect of a firm's capital investment on rate base, so that chances of overinvestment can be reduced. However there is no mechanism available to ascertain

a reasonable amount of investment in infrastructure that will ensure a reliable electricity supply. In regulatory pricing reviews, GEPCO have not provided evidence of any perceived benefits of proposed investment to the regulator, but the regulator allowed investment on the basis of past trends. This shows a gap of information in the regulatory system which can result in overinvestment or under investment in infrastructure for distribution companies. Since a reliable electricity supply depends on continued investment in infrastructure, the regulator should develop a detailed knowledge base for the investment needs of distribution firms after taking into account future demand growth and system reliability.

4 Public Sector Ownership, Subsidy, and Reforms Incentive

The network part of the electricity supply including distribution companies DISCOs and the transmission company NTDC are publicly owned monopolies[27], this is in fashion with industry practice in most countries where the natural monopoly part of a power supply chain is treated as a regulated monopoly[28]. The power sector reform started in the 1990s to unbundle electricity and thereby establish distribution networks as independent organizations with their own command and management structure. However corporatization of DISCOs has not been worked out fully and no formal contractual relationship exists among transmission, distribution and generation (government owned) segments of the industry (NEPRA 2010). A new government-owned establishment, Pakistan Electric Power Company (PEPCO), was formed in 1998,, to corporatize generation, distribution and transmission units of the vertically integrated state monopoly WAPDA, and make these entities administratively and financially independent.

[27] There are also some generation plants owned by public generation companies GENCOs.
[28] Although electricity networks can potentially save resources as regulated natural monopolies, but they are not necessarily government owned in practice.

Published reports by the regulator suggest that PEPCO continues to interfere in matters of government-owned generation and distribution firms, posing problems for independent and optimal decision making and resource allocation of these firms. The distribution networks claim that noncompliance of efficiency and quality regulation targets results because of centralized management of routine decision making through PEPCO (NEPRA 2011). This gives an impression that the power industry has not completed the transition from state monopoly to unbundled electric supply. On the one hand, the efficiency gains from vertical integration and central planning have decreased, while on the other hand, scant benefits have emerged from unbundling. The actual situation regarding overall management practices in industry might be even worse, as in the past all of the firms were part of a vertically integrated monopoly with coherent managerial hierarchy, while in the post-reforms period there is an increase in an interventionist role of other ministries and cosmetic departments[29].

In the following discussion, two questions are raised. Firstly, what is the role of public institutions in allocating resources among distribution firms and how efficient are these transfer mechanisms? Secondly, what is the motivation for changing ownership from public to private enterprise in the electricity industry and is there any evidence within the industry to support this?

The government of Pakistan has adopted a uniform electricity price policy across the distribution networks in the country, although prices vary across different customer categories within each distribution network. The regulator determines the price of electricity for a distribution network after taking into account revenue requirements of the firm including distribution margin, while the government only allows a uniform

[29] A complete study of history of reforms requires detailed information and goes beyond the scope here.

end user price according to the lowest determined price for each customer category among all distribution firms (Government of Pakistan GOP, 2013). The government does not allow the full passing on of the electricity supply cost to customers, the gap between the cost of electricity and government set tariff results in a subsidy referred to as tariff differential subsidy (TDS), Table 8 highlights this gap for few periods. The failure of the government to settle tariff differential subsidy, regularly results in the accumulation of Circular Debt[30] in the electricity industry. The other major contribution in this resource gap emerges from the inability of distribution firms to collect revenue (either in the shape of no recovery of bills or high system losses, see Table 1).

Table 9: Average Cost of Electricity Supply and Price charged in Rupees

Period	*Cost Per[1] KWh*	*Price Per[2] KWh*	*Gap Per KWh*
24 February 2007	5.14	4.25	0.89
01 March 2008	5.6	4.78	0.82
05 September 2008	8.42	5.58	2.84
25 February 2009	8.42	5.63	2.79
01 October 2009	8.42	5.96	2.46
01 January 2010	10.09	6.67	3.39

Source: NEPRA, State of Industry Report 2011, 1 Cost based Tariff determined by regulator 2 Consumer-end Tariff determined by Pakistani Government

The tariff differential subsidy is transferred by the central government to the central power purchasing company NTDC, and the NTDC allocates the subsidy among

[30] Circular Debt is common terminology in Electricity Industry of Pakistan, the debt is caused by accumulation of deficit which results when payments flow in supply chain of power is affected. The distribution companies not pay to the transmission company (power purchasing agency) that not pays power generators who not pay to oil/gas supply companies for fuel.

distribution firms. During 2007 to 2012 Rs1.29 trillion worth of price subsidies for distribution networks was transferred to the central transmission company. There is no transparent information available for the transfer of these payments (GOP 2013). Assuming transfers are made according to the actual difference between regulator price (cost of electricity supply) and the consumer end price (government allowed), the resulting subsidy allocation mechanism lacks any incentive for an efficient distribution firm. On the contrary, subsidy payment compensates for inefficiency caused by a distribution firm.

For instance, Peshawar Electric Supply Corporation (PESCO) experiences the highest operation cost including line losses, but it charges the end consumer the price of the lowest cost supply firm according to the government policy. As a result, PESCO recovers substantial business cost through tariff differential subsidy, while an efficient supply firm collects most resources through consumers. Since fulfilling budget balance constraints and subsidy internalization, the mechanism is not transparent and the exact welfare consequences for each firm are not clear. However, in the current regulation and subsidy transfer system there are virtually no incentives for unbundled electricity networks to increase efficiency and reduce system losses.

4.1 Privatization Reforms

The basic idea of the 1990s strategic reforms for state monopoly was to make unbundled firms in the electricity industry administratively and financially viable and then sell these firms to the private sector. However, current financial chaos partially caused by the political pricing regulation regime (uniform end user electricity price), lack of financial transparency in unbundled firms, and Circular Debt, probably provides few incentives to private buyers to purchase the electricity network

business[31]. For instance, for some time now, there have been publicly owned distribution firms with high line and revenue losses potentially available for privatization,[32], but so far, have not been privatized despite government efforts.

In theory, if electricity is considered as a basic infrastructure facility and the government wants to continue the supply of electricity to consumers at an "affordable" price, then the government can transmit and distribute electricity in-house or procure through a private supplier. The private owner has an incentive to lower costs while facing a given output price, but the private supplier might lower product quality. The reason behind the lower private supplier quality is an un-contractible component of a contract that is quality (Hart et al, 1997). In the case of the electricity supply specifying quality of product is relatively easier than another public good such as schooling or hospital as electricity is a homogenous product. The private distribution firms can be monitored by a quality regulation regime with specific parameters including average interruption indices. The x-efficiency gains and asset ownership incentives also go in favour of the private supplier, as private firms can offer a more flexible contract to employees depending on their human capital and experience.

However, it is not clear what the economic gains of privatizing a state monopoly (say a distribution network) will be, if the current regulation with asymmetric information along government's subsidy policy continues. Keeping the regulatory regime unchanged will result in an inefficient private monopoly instead of an inefficient public monopoly. The opinion on privatizing state owned firms is divided among

[31] PEPCO formed in 1998 to monitor unbundling and corporatization for two years, the slow pace of reforms can be judged from the fact that PEPCO dissolution occurred in 2012

[32] Some of electricity firms including PESCO, QESCO, HESCO, and FESCO are listed on privatization priority list, not clear about the timing of the inclusion or any future selling date. Privatization Commission Pakistan http://www.privatisation.gov.pk/power/power.htm (Accessed 13 September 2012)

policy makers and politicians (World Bank, 1997), overstaffing, non-performance based worker salaries, and lack of transparent procurement are associated with public owned electricity networks (GOP, 2013). However, in the absence of a fully informed regulator and without an incentive based regulation regime there is a chance that private firms will not function very differently than public firms.

The pace of privatization and market based reforms in the electricity industry is slow, so far one distribution firm, Karachi Electricity Supply Corporation (KESC), has been sold to private firms. KESC was privatised in 2005; the comparison between KESC and other distribution companies can give some idea for potential gains by privatizations on some selected indicators. As the government implements a same tariff policy in the whole country, so KESC also receives a public subsidy to cover the difference between cost of electricity supply and average tariff charged to costumers. However KESC's policy is to cut power for longer hours in the locations where revenue recovery is low and theft or system loss is higher. Although KESC earned profit for the first time in 2012, the system losses are still high, Table 2. There is a modest reduction in KESC losses, again it is not clear if that shows improvement in infrastructure or the effectiveness of a better load shedding management plan. In comparison, no incentives are available to government owned distribution companies (DISCOs) to lower cost and improve quality of the electricity supply. The government recently reconstituted boards of directors for DISCOs and increased the number of private board members in these public companies, but still the utilities are far from privatization.

5 Concluding Remarks

The cost of supplying electricity and the price charged to consumers are two basic parameters that can be employed to evaluate the performance of power sector reforms

and the future of the industry. The production incentives generated by current ownership structure and the regulatory regime, along with other residual factors, are affecting price and cost of the electricity supply. The price charged for electricity produced is not covering the cost of production giving incentives for consumers to overuse electricity. The inefficiencies in distribution networks including high line losses and low recovery are imposing high costs for the electricity supply.

The technical losses in the system cannot be disentangled from non-technical losses (including theft), continuous investment in physical capital and system maintenance required to improve the reliability of the electricity supply and reduce technical losses. The experience of privatization of one utility does not support that non-technical losses can be reduced in short run with a change of management or ownership structure. The multiproduct nature of the electricity supply requires a reliable demand forecast, as the cost of the electricity supply in high-demand summer hours will be different from the low-demand winter season. The cost of the high-demand season supplies has to incorporate future investment in infrastructure in order to ensure reliability. In current practice, the regulator and the firms lack sufficient knowledge about the required investment and potential costs of a multiproduct electricity supply.

In current practice, investment rules of utilities that would affect system loss reduction efforts and timely investment for reliable supply of electricity are not being implemented. The distribution firms lack information for the investment gap or at least they cannot justify the required investment with the regulator, while the regulator has not set any tangible yardstick for better utility practices. This information asymmetry between the regulator and utilities is slowing down the growth of the electricity industry and is not reflecting the actual cost of a reliable

electricity supply which might be substantially higher than determined by the regulator. The revenue losses and system losses create a real challenge to generate the investments required for revamping the basic network infrastructure, let alone moving to new technologies such as real-time monitoring and smart meters.

Further research should focus on the economic model of electricity supply in Pakistan to address the fundamental question, is electricity a public good, a private good or a marketable public good? The historical experience in Pakistani context puts electricity closer to being a marketable good supplied by the government. In the current situation, privatization will make electricity a privately provided public good as has happened in the case of Karachi Electricity Corporation (KESC), as KESC have supplied heavily subsidised electricity in private ownership since 2005. The politically motivated village electrification plan follows in line with the "cheap affordable electricity" model where the supply of electricity to a scattered housing unit could result in substantial system loss. The future industry reforms should be undertaken in light of further research and clarity on the business model for the electricity supply.

References

Afia, M. (2007). Effectiveness of Regulatory Structure in the Power Sector of Pakistan, Pakistan Institute of Development Economics, Working Paper 25.

Government of Pakistan (2010). Economic Survey 2009-10, Pakistan Ministry of Finance, Islamabad.

Government of Pakistan (2013). The Causes and Impacts of Power Sector Circular Debt in Pakistan, Study Commissioned by Planning Commission of Pakistan, Islamabad.

Hart, O., Shleifer, A., and Vishny, R. W. (1997). The proper scope of government: theory and an application to prisons. *The Quarterly Journal of Economics*, 112(4), 1127-1161.

Joskow, P. L., and Richard S. (1983). Markets for Power: An Analysis of Electricity Utility Deregulation", MIT Press: Cambridge.

Joskow, P. L. (2013). Incentive regulation in theory and practice: electricity distribution and transmission networks. In Economic Regulation and Its Reform: What Have We Learned? University of Chicago Press.

Joskow, P. L. (2008). Incentive regulation and its application to electricity networks. *Review of Network Economics*, 7(4).

Joskow, P. L. (1997). Restructuring, competition and regulatory reform in the US electricity sector. *The Journal of Economic Perspectives*, 11(3), 119-138.

Kahn, A. E. (1970, 1971). The Economics of Regulation: Principles and Institutions, Volume 1 (1970) Volume 2 (1971), Wiley: New York.

Laffont, J. J., and Tirole, J. (1993). A Theory of Incentives in Procurement and Regulation, MIT Press: Cambridge.

Lyon, T. P. (1996). A model of sliding-scale regulation. *Journal of Regulatory Economics*, 9(3), 227-247.

National Electric Power Regulatory Authority (NEPRA), Determination of the Authority in the matter of Petition filed by Gujranwala Electric Power Company Ltd. for Determination of its Consumer end Tariff Pertaining to the FY 2012-13.

National Electric Power Regulatory Authority (NEPRA), Determination of the Authority in the matter of Petition filed by GEPCO for determination of its Consumer end Tariff Pertaining to the FY 2011-12.

National Electric Power Regulatory Authority (NEPRA) (2011), State of Industry Report.

National Electric Power Regulatory Authority (NEPRA) (2010), State of Industry Report.

National Electric Power Regulatory Authority (NEPRA) (2004), Determination of Tariff in respect of GEPCO, NEPRA/TRF-23/GEPCO-2003.

Schmalensee, R. (1989). Good regulatory regimes. *Rand Journal of Economics*, 20(3), 417-436.

World Bank (2011). World Development Indicators, World Bank, Washington DC.

Appendix

Table 1A: Tariff Determination, Gujranwala Electric Power Company (GEPCO)

27-03-2013	Determination of the Authority in the matter of Petition filed by Gujranwala Electric Power Company Ltd. for Determination of its Consumer end Tariff Pertaining to the FY 2012 — 13
24-02-2012	Decision of the Authority in the Matter of Reconsideration Request filed by Ministry of Water & Power against Authority's Determination for GEPCO for the FY 2011-12
13-12-2011	Determination of the Authority in the matter of Petition filed by GEPCO for determination of its Consumer end Tariff Pertaining to the FY 2011-12
27-04-2011	Determination of the Authority in the matter of Petition filed by GEPCO for Determination of its Consumer end Tariff pertaining to the 2nd, 3rd and 4th Quarters (October - June 2011) of the FY 2010-11
09-12-2010	Decision of the Authority with respect to Motion for Leave for Review filed under Rule 16(6) of NEPRA (Tariff Standards and Procedure) Rules, 1998 by GEPCO against the Authority's Determination
08-09-2010	Determination of the Authority in the Matter of Petition filed by GEPCO for Determination of Consumer-End Tariff for 4th Quarter (April - June 2010) of FY 2009-10
19-04-2010	Determination of the Authority in matter of Petition filed by GEPCO for Determination of Consumer-end Tariff for 2nd Quarter (October-December) of Fy 2009-10
09-12- 2009	1st Quarterly Determination Based on the FY 2009-10 Determined under NEPRA (Tariff Standards and Procedure) Rules, 1998 for GEPCO
14-09-2009	Determination of the Authority in the Matter of Petition by GEPCO for Determination of Consumer-end Tariff for the Year 2008-2009 under NEPRA (Tariff Standards and Procedure) Rules, 1998.
15-01-2009	Modified Decision of the Authority on Federal Government's Request for the Reconsideration of Gujranwala Electric Power Company Ltd (GEPCO) Decision dated 1st January, 2009 [Case No. NEPRA/TRF-102/GEPCO-2008 (3)]

09-09-2008	Determination of Tariff in respect of Petition filed by (GEPCO) [(Case No. NEPRA/TRF-102/GEPCO-2008 (3)]
30-05-2008	Decision of the Authority on Federal Government's Request for the Reconsideration of GEPCO decision dated January 10, 2008 (Case No. NEPRA/TRF-36/GEPCO-2005)
01-02-2008	Biannual Adjustment in the Consumer-end Tariff on Account of Charge in Power Purchase Price
10-01-2008	NEPRA/TRF-36/GEPCO-2005 (Revised)
28-06-2004	NEPRA/TRF-23/GEPCO-2003

Notes: In between more than 35 “fuel price reviews” were conducted by NEPRA to adjust fuel prices in electricity supply prices.

Table 2A: Regulation Standards for Tariff

1. Tariffs should allow licensees the recovery of any and all costs prudently incurred to meet the demonstrated needs of their customers, provided that assessments of licensees' prudence may not be required where tariffs are set on other than cost-of-service basis, such as formula-based tariffs that are designed to be in place for more than one year
2. Tariffs should generally be calculated by including a depreciation charge and a rate of return on the capital investment of each licensee commensurate to the earned by other investments of comparable risk
3. Tariffs should allow licensees a rate of return which promotes continued reasonable investment in equipment and facilities for improved and efficient service
4. Tariffs should include a mechanism to allow licensees a benefit from, and penalties for failure to achieve the efficiencies in the cost of providing the service and the quality of service
5. Tariffs should reflect marginal cost principles to the extent feasible, keeping in view the financial stability of the sector
6. The Authority shall have a preference for competition rather than regulation and shall adopt policies and establish tariffs towards that end
7. The tariff regime should clearly identify interclass and inter-region subsides and shall provide such subsides transparently if found essential, with a view to minimizing if not eliminating them keeping in view the need for an adequate transition period
8. Tariffs may be set below the level of cost of providing the service to consumers consuming electric power below the consumption levels determined for the purpose from time to time by the Authority, as long as such tariffs are financially sustainable
9. Tariffs should, to the extent feasible, reflect the full cost of service to consumer groups with similar service requirements
10. Tariff should take into account Government subsidies or the need for adjustment to finance rural electrification in accordance with the policies of the Government
11. The application of the tariffs should allow reasonable transition periods for the adjustments of tariffs to meet the standards and other requirements pursuant to the Act including the performance standards, industry standards and the uniform codes of conduct
12. Tariffs should seek to provide stability and predict ability for customers; and
13. Tariffs should be comprehensible, free of misinterpretation and shall state explicitly each component there of

Source: NEPRA (2010)

Table 3A: Abbreviations and Acronyms

CPPA	Central Power Purchase Company
DM	Distribution Margins
DISCOs	Distribution Companies
FESCO	Faisalabad Electric Supply Company
GEPCO	Gujranwala Electric Power Company
GENCOs	Generation Companies
GEPCO	Gujranwala Electric Power Company
GOP	Government of Pakistan
GWh	Giga-watt Hours
HESCO	Hyderabad Electric Supply Company
IESCO	Islamabad Electric Supply Company
IPP	Independent Power Producers
KESC	Karachi Electricity Supply Company
KWh	Kilo-watt hours
MEPCO	Multan Electric Supply Company
MMCF	Million Cubic Feet
MW	Mega Watt
NEPRA	National Electric Power Regulatory Authority
NTDC	National Transmission and Dispatch Company
PEPCO	Pakistan Eclectic Company
PESCO	Peshawar Electric Supply Company
PPA	Power Purchase Agreement
QESCO	Quetta Electric Supply Company
SAIFI	System Average Interruption Index
SAIDI	System Average Interruption Duration Index
SEPCO	Sukkur Electric Supply Company
SO	System Operator
WAPDA	Water and Power Development Authority