IMPACT OF ELECTRICITY SHORTFALL ON INDUSTRIAL PRODUCTION OF PAKISTAN

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electric power consumption
load shedding

بسم الله الرحمن الرحيم

APPROVAL SHEET

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DECLARATION

I hereby declare that this thesis, neither as a whole nor as a part thereof, has been copied out from any source. It is further declared that I have carried out this research by myself and have completed this thesis on the basis of my personal efforts under the guidance and help of my supervisors. If any part of this thesis is proven to be copied out or earlier submitted, I shall stand by the consequences. No portion of work presented in this thesis has been submitted in support of any application for any other degree or qualification in International Islamic University or any other university or institute.

Bilal Akhunzada

DEDICATION

To my beloved Mother, Sisters and Teachers,
especially both of my supervisors.

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First of all I am very much thankful to Al-mighty Allah, Who gave me strength and make me able to do such a work which was impossible for me. After that my very respectable supervisors Dr. Hafiz Muhammad Yasin and Dr. Abdul Rashid takes my heartiest gratitude for their extended guidance, support and encouragement at each and every time. Whatever I am and whatever is my work, these are the people to whom I owe deepest of acknowledgments.

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Bilal Akhunzada

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WAPDA	Water and Power Development Authority
KESC	Karachi Electric Supply Company
NTDC	National Transmission and Dispatch Company
PEPCO	Pakistan Electric Power Company
MW	Mega Watt
MWh	Mega Watt per hour
kWh	kilo Watt per hour
KV	kilo Volt
ILO	International Labor Organization
WB	World Bank
IGFD	Intergovernmental Framework Declaration
GSPA	Gas Sale and Purchase Agreement
WDI	World Development Indicators
OGRA	Oil and Gas Regulatory Authority
OGDCL	Oil and Gas Development Company Limited
IPPs	Independent Power Producers
PPL	Pakistan Petroleum Limited
POL	Pakistan Oilfields Limited
CNG	Compressed Natural Gas

Abstract

This study examines the impact of electricity shortfall on production of the manufacturing sector of Pakistan over the period 1972 to 2012. The sample period is divided into two time periods, the first period (from 1972 to 1990), which was supposed that there was no load shedding and the second period (from 1991 to 2012) when load shedding was started and grew to severity due to unavailability of electricity to the manufacturing sector. The demand for electricity was more than that of the supply, so the authorities have to cut the electricity at different times of working hours due to which production of the large scale and small scale manufacturing sector was disturbed. The gap between the actual growth and projected growth was checked by keeping constant the data when there was no or minimal load shedding. The results shows that due to cuts in electricity supply to the manufacturing sector badly affect the production of the various industries of Pakistan. Concluding the study as, if the gap between demand and supply of electricity was not covered up on time then the problem will become severe and uncontrollable. As manufacturing sector of any country plays an important role in economic development and if electricity is not provided, it will stay backward in the development race.

Chapter-1

INTRODUCTION

Energy is considered to be the lifeline of economic development. For a developing economy with high population growth rate, it is important to keep a balance between energy supply and emerging needs of the people. If corrective measures are not effectively anticipated and timely undertaken, significant constraints start emerging to check development activities. With the help of science and technology, modern nations are focusing on sustaining their economic growth and competing in the international market. The rapid growth in technology since the mid of twentieth century has heavily transformed the structure of industry and society.

Energy is being used from the very beginning of human civilization. According to a renowned proverb of science that, *"Energy can neither be created nor destroyed, rather it can be converted from one form to another"*. Energy is used in various avenues, i.e. energy lights our homes and markets, powers our vehicles and runs machines in homes and factories etc. leading to enhancement of our living standards and bringing more facilities in our life. Total commercial energy consumption has grown tremendously over the last two centuries; the per capita energy consumption even in low income countries has more than doubled.

The extraordinary versatility of electricity as a source of energy means it can be put to an almost endless set of applications which include transport, heating, lighting, industrial appliances telecommunications and computation. Electrical energy is used as the source of power for manufacturing as well as for refining and processing minerals. With the advent of low-cost automobiles and the transmission of electricity, the use of energy has been ever growing. Power plants became larger and larger, and now we have massive generators and hydroelectric dams. Power lines are stretched for hundreds of miles between cities, supplying electricity to far flung areas of the whole country. The use of electricity has grown very quickly, roughly doubling for every 10 years. The cost of electricity production declined steadily with the expansion of hydropower and the efficient use of energy has become possible with new equipments.

Electricity is considered as the backbone for an economy's prosperity and it plays a crucial role in socio-economic development. With the passage of time, as rapid development and technological innovation has taken place, the utilization of electricity has also mounted. In simple words, the demand for electricity has increased tremendously over time, while its supply or generation has not developed with comparable speed. This has led to energy crisis, which is getting more severe since the start of 21st century in Pakistan. Shortage of electricity and load shedding has now become the concern of everybody and has become the general topic of hot public debate on every political, economic and social forum.

Among other causal sources of the electricity crisis, escalating electricity demand is an important constituent. Increasing electricity consumption has long been tied directly to economic growth and improvement in human welfare. Whether increasing electricity consumption is a necessary precondition for economic growth or otherwise is not yet clear. Although developed countries are now beginning to delink their electricity consumption from economic growth (through structural changes and improvement in efficiency), there remains a strong direct relationship between electricity consumption and economic growth in developing countries.

If the machinery of the industry would stop running regularly due to electricity shortfall, how could people get employment and how could they enjoy a standard living? People will ultimately seek illegitimate ways for their livelihood if they are idle and jobless. Production as well as employment depends on the availability and proper utilization of every kind of available energy. Electricity, Petroleum resources and Natural Gas provide the best and most efficient forms of energy which are used in the industry.

Modern energy services enhance the standards of living in countless ways. It can directly reduce poverty by raising the country's productivity and expanding the quality and range of its products, thereby employing more people and putting more income into their pockets.

1.1 Current Scenario

At present, about 45 percent of Pakistan's population has no access to electricity[1]. The nation is currently facing power supply shortage of 6000 MW per day[2], the most severe energy crisis that has ever hit the country. The occurrence of prolonged and frequent power outages has a negative impact on industrial production, growth of the economy and the livelihood of citizens in general. While the energy shortage continues to grow, abundant indigenous sustainable energy resources such as wind, solar and biomass remain virtually unexploited. The government attempted to promote the adoption of renewable energy technologies in 2006 by implementing its first renewable energy policy. However, this policy has limited success and faces a number of challenges.

Another important project of natural gas was that Iran-Pakistan (IP) gas-pipeline project, which was started in early nineties. In which the gas is to be supplied from Iran's South Pars gas field and delivered at Pak-Iran border, near Gawadar. The project is being implemented on a segmented approach whereby each country shall be responsible for construction of pipeline in the respective territory[3]. The pipeline will start from the onshore gas processing facility at Assaluyeh in Iran, to cross a distance of 1,150 km up to the Iran-Pakistan border, which will be built and operated by Iran. Iran has already completed a 900-km portion of 56-inch diameter pipeline from Assaluyeh to Iran Shehr. The remaining 250 km up to the Pakistan border is under design, and is

[1] *Pakistan power sector: Report compiled by Consulate General of Switzerland Karachi, 2011.*
[2] Dr. M. Asif, July 13, 2013, The News.
[3] Report compiled by Inter State Gas Systems (Pvt) Ltd.

expected to be completed in two years[4]. The Pakistan section of the pipeline is to be laid close to the Makran costal highway from Iran-Pakistan border up to Pakistan off-take point at Nawabshah covering a distance of over 781 km.

A memorandum under name of Inter-Governmental Framework Declaration (IGFD) on the project was signed by President of Pakistan and Iranian President in May 2009 for support of the project for early implementation by respective governments. Subsequently respective entities entered into the Gas Sale and Purchase Agreement (GSPA) on 5th June 2009, which has become effective on 13th June 2010 after completion of required Conditions Patterns. The socio-economic benefits from this project includes that imported natural gas remains the cheapest and most suitable fuel for power generation. The project will support around 4,000 MW power generation capacities, which will help in covering the current power shortage crisis. The construction of pipeline will also create job opportunities in backward areas of Baluchistan and Sindh. The project will help a great deal in meeting the energy requirements of the country's economy. But the project is still slow and need more attention to achieve the goals.

Another project of electricity importing from Tajikistan is also signed by the heads of the two countries which named as CASA-1000 project[5]. The project, aimed at easing energy shortages in Pakistan and utilizing surplus power in Tajikistan, has the backing of the United States and World Bank, which has approved millions of dollars in financing to execute the program[6]. Similarly, so many projects and opportunities are present but the problem is that of implementation by the higher authorities.

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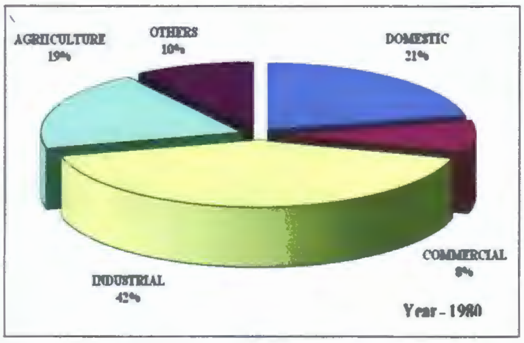
[4] ibid
[5] The Express Tribune, June 24, 2014.
[6] ibid

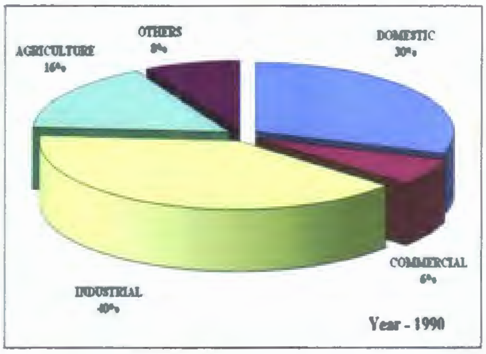
Pakistan has been facing an energy crisis, which has disturbed normal and business life and erased 3 percent off economic growth every year[7]. Aware of the gravity of the situation, the present government has pledged to tackle the shortages but it believes power outages will not end before 2018.These challenges need to be clearly identified and addressed, so as to pave the way forward for a sustainable energy future in Pakistan.

Figure 1.1 Sector wise consumption of electricity from 1980 to 2010.

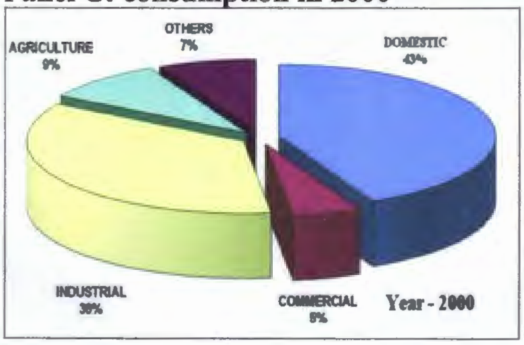
Panel A: consumption in 1980



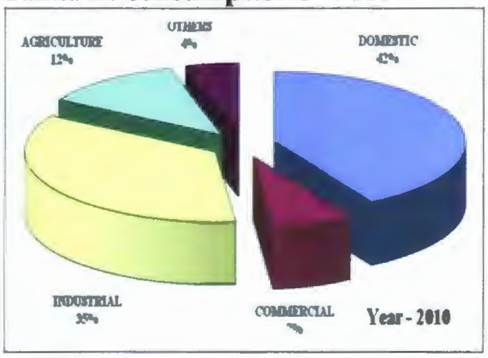
Panel B: consumption in 1990



Panel C: consumption in 2000



Panel D: consumption in 2010



Source: Electricity Marketing Data (34th issue) by Planning Power NTDC.

The sector-wise distribution of electricity supply over time is reflected in the above charts and graphs from 1980 to 2010. Panel A of figure 1.1 shows the overall electricity consumption by each sector for the year 1980. We can see that in 1980, industrial sector was the largest electricity

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[7] The Express Tribune, June 24, 2014.

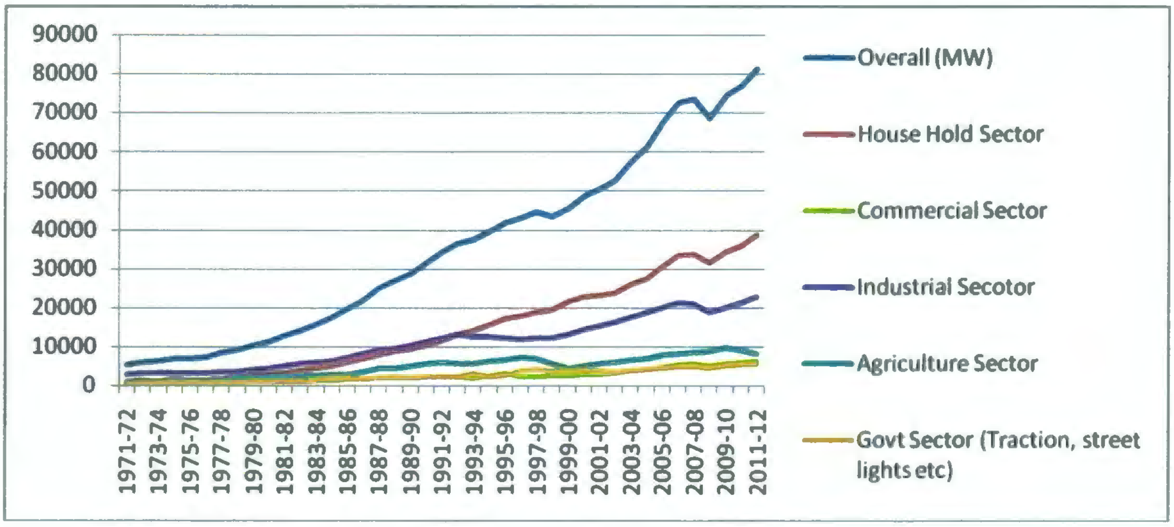
consumption sector which consumed 42 percent of the total electricity supply whereas the domestic sector was the second largest electricity consumer consuming 21 percent of total supply. This was followed by the agriculture sector absorbing 19 percent of total electricity supply and then the government sector and others which consumed 10 percent of the total consumption and then that of commercial sector which consumed 8 percent of the total consumption.

Panel B of figure 1.1 shows the electricity consumption by each sector for the year 1990. Here we can see that the order of consumption of electricity by different sectors is reversed. In 1980, industrial sector was the largest electricity consumer followed by the domestic sector but the consumption of electricity by industrial sector decreased from 42 percent to 40 percent and the consumption of electricity by domestic sector increased from 21 percent to 30 percent in 1990. The consumption of electricity in agriculture sector also decreased from 19 percent to 16 percent as also in the government sector and others which decreased from 10 percent to 8 percent and the consumption of electricity by the commercial sector also decreased from 8 percent to 6 percent.

Panel C of figure 1.1 shows the electricity consumption for the year 2000. In this graph we can see that the consumption of electricity by industrial sector further decreased to 36 percent by the year 2000, as compared to 40 percent and 42 percent in 1980 and 1990 respectively. In contrast electricity consumption of domestic sector increased to 43 percent by the year 2000. Due to this increase in consumption of electricity by the domestic (household) sector, other sectors are adversely affected. The consumption by agriculture, commercial and government sectors have been reduced proportionately.

Similarly, Panel D of figure 1.1 shows the electricity consumption for the year 2010. In this graph we can see that the consumption share of the industrial sector was further reduced to 35 percent by the year 2010, whereas, the share of domestic sector increased to 42 percent. There is a corresponding reduction in the shares of electricity consumption by government sector up to 4 percent and a slight increase in share of agriculture sector (12 percent) and commercial sector (7 percent) by 2010.

Figure 1.2: overall consumption of electricity by different sectors of Pakistan form 1971 to 2012.



Source: Ministry of Petroleum & Natural Resources & Hydrocarbon Development Institute of Pakistan (HDIP)

Figure 1.2 shows the overall electricity supply to different sectors from 1971-72 to 2011-12. This shows that how the supply/consumption of electricity by the household sector outstrips that of industrial sector. This increase in consumption of electricity by household is due to the rural electrification, increase in population, income and changes in living patterns of the people. The supply to or consumption of electricity by the household was much larger than that of all other sectors due to which the industry remained closed for several hours a day and this adversely affected the whole economy.

1.2 Problem Statement

Currently, approximately 60 percent of power generation in Pakistan is derived from fossil fuels (primarily oil and gas) followed by hydroelectricity (35 percent) and nuclear energy (2.84 percent)[8].

Electricity, gas, water and fossil fuel are essential parts of our daily life and their scarcity has severely affected the economy and overall standards of living. Thousands have lost their jobs, business is directed towards depression and our daily life has become miserable. Energy is the main ingredient of life. Without electricity life becomes extremely difficult if not impossible. The production falls heavily as the heavy machinery stops working. This leads to instability in the economy and the growth rate certainly decreases.

Pakistan is going through the worst electricity crisis of its history these days. Electricity shortfall has increased to the level of about 6000 MW[9] and load shedding of 8 to 14 hours daily is the usual practice. The industrial production, commercial activities, the households, agriculture sector and ultimately the whole economy are suffering. Electricity crisis has badly affected the whole Economy. The household sector has been the largest consumer of electricity accounting for 42 percent of total electricity consumption[10]. At present this crisis has literally paralyzed the cities and villages and made life a hell for the citizens. The households, which are connected to the grid station, are going without electricity at an average of 8 to 14 hours of load shedding per day. People protest on the roads and highways of the country due to the discontent caused by the cuts.

Although, households and commercial sectors have alternatives for electricity like generators and UPS but there are no such alternatives available for the industry having heavy machinery. This

[8] NTDC report.
[9] Dr. M. Asif, July 13, 2013, The News.
[10] Economic Survey of Pakistan (2010).

•shortage of electric supply was one of the main themes of discussion on all political forums during the general elections of 2013 and every political party included energy crisis to be resolved on priority basis in their manifesto.

The economy of the country is adversely affected by the electricity crisis via halting major trade, industrial and agriculture activities. The industries consume 35 percent, agriculture 12 percent, household (domestic) consumption is 42 percent, commercial sector 7 percent and government or other sector consumes 4 percent of total supply of electricity[11]. The largest sector of electricity consumption is the domestic sector. The factories have to shut down during the outages, international and domestic orders cannot be fulfilled due to reduced production and sale of electrical appliances has to decrease. Thus the industry has to suffer more than proportionately as compared to other sectors.

1.3 Rationale, Objectives, and Significance of the Study

(a) Rationale

The rational of this study is to evaluate the importance of electricity in the development of economy and to see how the economy suffers if the industry faces cuts in supply of electricity. The foreign demands and or export orders will not be full-filled and the investors will rush abroad. This will be a big loss to the economy if there is loss of power and there is no such policy for resolving this problem.

(b) Objectives

The objective of this study is to examine the impact of shortfall in the supply of electricity on industrial production in Pakistan and finally to evaluate the impact on overall economic growth. In specific terms, the study intends to find answers to the following questions:

[11] ibid.

1) Is there any difference in the output elasticity of electricity in the periods before and after the emergence of load shedding problem?

2) What is the comparative loss in industrial output due to electricity shortage after the problem of load shedding come to the surface?

(c) Significance

The significance of this study is evident. Presently, there is no article available in the literature which directly discusses the impact of electricity shortfall on the production of industry and on the overall growth of Pakistan economy. The study is important because the industrial sector contributes directly to the exchequer in the form of taxes and provides employments to millions of people on the other hand and any shortfall in its output will adversely affect other sectors (like agriculture/ commercial sector in particular) due to its forward and backward linkages.

1.4 Structure of the Study

After this brief introduction, the second chapter provides a brief survey of the energy crisis in Pakistan. The third chapter is devoted to review of the literature. The fourth chapter discusses the model, methodology and data. The fifth chapter occupies the central part of this study where we discuss and analyze the results. The final chapter is reserved for conclusions and policy implications as usual.

Chapter-2

THE ENERGY PROBLEM OF PAKISTAN

2.0 The Importance of Energy

Energy is being used by human beings from the very beginning of the world. Energy is used in various forms in all walks of life. Total commercial consumption of energy has been growing tremendously, since the latter half of 20th century and the per capita energy consumption in this sector has more than doubled in low income countries. About 15 percent of the world's population living in the wealthy industrialized countries consumes over half of the energy used in the rest of the world.[12]

There are five sources of energy existing in the world, i.e. Electricity, Petroleum, Gas, Solar Energy and Traditional sources (including fire wood, coal and charcoal, dung cakes etc.). However, we will focus only on electricity. We generate electricity by burning coal, oil, gas, and even trash. Electrical phenomena have been studied even in the distinct past the advances in the relevant area were not made until the 17th and 18th centuries. Practical applications for electricity however remained few until the late nineteenth century when engineers were able to employ it to industrial and residential usage. The rapid development in electrical engineering has transformed the industry and the society enormously since the beginning of 20th century.

The extraordinary versatility of electricity as a source of energy means that it can be put to an almost limitless set of applications which include transport, heating, lighting, manufacturing communications and computation. Electricity is the backbone of modern industrial society that will persist to remain unless and until a reliable and cost effective substitute is discovered.

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[12] World Development Indicator (WDI).

Electrical energy is used in all sorts of industries, being the source of power for manufacturing, agriculture as well as for refining and processing minerals.

With the advent of low-cost automobiles and the transmission of electricity, the energy use in our society has significantly changed. Power plants grew larger and larger, and now we have massive coal plants and hydroelectric dams. Power lines are stretched over hundreds of miles between cities and supplying electricity to far flung rural areas. Energy use has grown quickly, approximately doubling every 10 years. The cost of energy production declined steadily (particularly hydroelectricity) and the efficient use of energy became possible.

2.1 Energy Resources of Pakistan

In 1950[13], Sui gas field was discovered in the province of Baluchistan, which later on became the biggest natural gas field in Pakistan. In 1955, commercial drilling and exploration of Sui gas fields was started which contributes substantially to Pakistan's fuel requirements and has a daily production of approximately 550 MMSCF[14]. Pakistan Petroleum Limited (PPL) discovered gas reserves at Ouch gas field in 1964 and then the Toot oilfield, located in the Potohar region of Punjab.

During Ayub Khan's regime, Pakistan Petroleum Limited (PPL) and Pakistan Oilfields Limited (POL) explored and drilled the first well at Toot which has an approximate capacity of 60 million barrels of oil per annum.[15] The commercial production from Toot oilfield started in 1967. In 1976, Dhodak gas field was discovered in the province of Punjab while in 1981, Union Texas Pakistan Limited (UTPL) discovered an oil field in lower Sindh. In 1983, Dakni gas field, located

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[13] Report compiled by the consulate General of Switzerland, Karachi, 2011.
[14] ORGA.
[15] ibid.

in the south-west of Islamabad, was discovered. In 1984, Tando Adam oil field, located in Hyderabad, was drilled and start production. In 1986, the year witnessed the peak oil production of 2,400 barrels per day from Toot oilfield. Moreover, Chak Naurang field, located 90 km away from Islamabad, was also discovered in the same year. In 1989, Dakni gas field started commercial production. In 1990[16], Qadirpur gas field was discovered in the province of Sindh, which is the third largest gas field in Pakistan. In 1994, Rajjan oil field which is located in Gujjar Khan district of the Punjab, was discovered.

In 1998-1999, the oil fields those owned by UNTPL were producing more oil than the Potohar fields. In 2004, Chanda oil fields, located in the province of Khyber Pakhtunkhwa, started oil production. In 2005, International Sovereign Energy (ISE), a Canadian company signed memorandum of understanding (MOU) with Oil and Gas Development Company Limited (OGDCL). The memorandum entailed further development of Toot oil fields. In 2006, Mela oil fields were discovered in the area of Kohat and in 2009, Nashpa oil fields were discovered in Karak district of Khyber Pakhtunkhwa. In 2010, Sheikhan gas field, which is located in Kohat, was discovered. The drilling process is still continue in different areas of Pakistan and government get success in most of the areas.

There are problems in management and planning. The governments in the past encouraged the use of CNG in vehicles and allowed opening of CNG stations throughout the country without taking into account the demand and supply balance. Likewise, natural gas was provided for household and commercial consumption through length and breadth of the country by investigating (rather buzzing) billions of money in transmission through gas pipeline. The year

[16] OGRA

2011, started with the shutting down of a power plant producing 585 MW of electricity, as one of the pipelines providing fuel was blown up in the district of Jaffarabad.

Pakistan faced one of its most crucial gas crises, with the shortfall rising up to 1.8 billion cubic feet (bcf). The year also witnessed the worst CNG load shedding resulting into heavy losses for the government and problems for the consumers. However, Oil and Gas Regulatory Authority (OGRA) increased the gas tariffs by 14 percent in the beginning of the year which was one of the biggest tariff hikes in the history of Pakistan. Nowadays, same is the situation as shortage of Petroleum resources, Gas resources and Electricity, from which every Pakistani is suffering. However, Pakistan has been endowed with rich and vast energy resources. These resources can play effective role in contributing towards energy security and self-sufficiency of the country.

2.2 The Status of Energy Sector in Pakistan

Before the industrial revolution of the 18^{th} and 19^{th} centuries, human beings had only a moderate need for energy. Man mostly relied on animal power in production and transportation. During the 19th century, the world economy passed through a great change as the industrial revolution, originally started in England, spread to the rest of Europe and other parts of the world. Energy needs were modest. For heat, people relied on the sun and fire wood, straw, and dried dung. For transportation, the muscle of horses, donkeys and camels and the power of the wind in sailing could be utilized. For agricultural production the wastes of the animals could be used as natural fertilizer and life was going simple but difficult.

The dimensions and ramifications of the ongoing energy crisis in Pakistan are numerous and terrible. Citizens in the remote rural areas are facing up to 20 hours of daily load shedding[17],

[17] Dr. M. Asif, July 13, 2013, The News.

a situation they could have never imagined. Official reports acknowledge that over 400,000 industrial workers have lost their jobs and the industries are facing an annual monetary loss of over Rs. 240 bn[18]. This is just a brief overview of the catastrophic socio-economic implications of the issue. It is fact that the issue of load shedding appears to be beyond control in the short run, which is alarming and discouraging. Violent demonstrations have been taking place across the country against this problem since 2006[19].

The current bubble of resistance is a clear indication of the dismal scenarios that can prevail in the future if meaningful measures are not adopted to bring about a reasonable level of relief. It is time for policymakers to cope with reality[20]: they have to realize that their traditional tactic of emphasizing non-issues while ignoring the real problems is no longer effective. If they continue to do this, things may rapidly spiral out-of-control, thereby resulting into deep chaos and causing irreparable damage to the economy on many fronts.

The first and the foremost important step towards addressing the existing energy crisis is the identification of its root causes. The correct solution cannot be formulated unless the factors that created the problem are identified. Any sincere attempt to examine the energy crisis would reveal that it has not emerged overnight. In fact, it was fostered by bankrupt policies followed by various regimes over the last three decades. Amongst the greatest tragedies the energy sector has suffered were the lack of vision and the unwillingness of governments and political leaderships to shoulder their responsibilities.

An examination of the country's energy history shows that with the exception of 1960s and 1970s regimes, none did justice to this important sector. The track record of governments during

[18] Tariq et.al(2009)
[19] ibid
[20] Nazima Ellahi (2011)

this period has been disappointing since they tended to rely on ad hoc arrangements instead of working on long-term, goal-oriented projects. Even in the few cases where farsighted policies were formulated, no attention was given to their implementation. Other major factors contributing to the awakened situation include the pursuance of personal and political interests, financial and administrative irregularities, corruption and nepotism in the energy sector. All the dimensions of the existing energy crisis, such as severe levels of load shedding, unaffordable electricity and gas prices and dependence on foreign energy supplies, are the direct consequences of these malpractices.

Although the country experienced over 100 percent growth in terms of installed capacity over the last two decades[21], it has not been smooth sailing. Hardly any value-engineered projects were developed over this period. Other than the 1450MW Ghazi Barotha project and a couple of nuclear power plants, there is not much to be satisfied about. In addition, the list of blunders in terms of the dumping of essential projects and the launching of unviable and counterproductive projects is very long.

The independent power producers' (IPPs) program of the 1990s, for example, could have been quite beneficial, but ultimately turned out to be counterproductive due to issues such as the lack of transparency, excess-generation capacity, high-tariff structures and unviable power-generation technologies. Interestingly the World Bank, one of the key players in the IPPs Program, has also acknowledged the existence of issues such as the lack of transparency, political influence in the award of contracts and excess generation capacity.

Therefore, although the IPPs brought one of the few periods of electricity prosperity, they ended up with grave economic implications for the country. This sequence of irrational and absurd

[21] WAPDA

decision-making, either by incompetence or by design, gradually put the energy sector in trouble. The country's policymakers must learn from their mistakes before it is too late. As the starting point of any meaningful measure leading to a resolution of Pakistan's energy problems, they have to put an end to malpractices in the system. Weaknesses and inefficiencies have to be checked instead of wasting time and resources in buying unviable solutions.

2.3 The Establishment of WAPDA and afterwards

At the time of independence in 1947, Pakistan inherited 60 MW of power generation capability for a population of 31.5 million[22], yielding 4.5 units per capita consumption. The Government of Pakistan in 1952 took control of the Karachi Electric Supply Company (KESC) engaged in generation, transmission, and distribution of electricity to the industrial, commercial, agricultural, and residential consumers of the metropolitan city of Karachi and its suburbs.

In 1958, Water and Power Development Authority (WAPDA) was established as a semi-autonomous body for the purpose of coordinating and giving a unified direction to the development of schemes in water and power sectors. In 1959, the generation capacity increased to 119 MW[23] and by that time the country started entering in the phase of development, which required a dependable and solid infrastructure, electricity being its most significant part. The task of power development was undertaken by WAPDA for executing a number of hydro and thermal generation projects, a transmission network and a distribution system, which could sustain the load of the rapidly increasing demand for electricity.

[22] NTDC
[23] Hydrocarbon Development Institute of Pakistan

After the first five years of its operation the electricity generation capability rose to 636 MW in 1964-65. At the initiation of WAPDA, the number of electrified villages in the country was 609, which were increased to 1882 villages (688,000 consumers) by the year 1965. The rapid progress witnessed a new life to the social, technical and economic structures of the country.
The task of accelerating the pace of power development picked up speed and by the year 1970, the generating capability rose to 1331 MW with installation of a number of thermal and hydro power plants. In the year 1980s the system capacity touched 3,000 MW which rapidly rose to over 7,000 MW in 1990-91.

However, electricity consumption in Pakistan has been growing at a higher pace due to the increasing urbanization, industrialization, and rural electrification. From 1970 to the early 1990s, the supply of electricity was unable to keep pace with demand that was growing consistently at 9-10 percent per annum. In the early 1990s, the peak demand exceeded supply capability by about 15-25 percent, necessitating load shedding of about 1,500 - 2,000 MW[24]. On the demand side, there was a weak link between the electricity price and demand, which failed to manage the demand. On the supply side, the main reason behind this capacity shortage was the inability of the public budget to meet the high investment requirement of the power sector, despite the allocation of a high share to this sector.

In order to eliminate power shortage/load shedding in the minimum possible time, the Government constituted an Energy Task Force (ETF) in 1993 to devise a consolidated and comprehensive policy for revamping the energy sector. On the recommendations of this body, the Government announced a "Policy Framework and Package of Incentives for Private Sector Power Generation Projects" in 1994, so that the private sector could be incorporated in power

[24] Pakistan Energy Yearbook (2010).

development. The said policy offered a fixed level tariff of USD 5.57/KW[25] to the prospective investors (USD 6.1/KW average for 1-10 years) and a number of other incentives to attract foreign investment in the power sector. The Power Policy 1994 helped in overcoming load shedding in the country to some extent. In the year 2000, the vertical disintegration of WAPDA started as part of the country's new electricity market restructuring and liberalization program. Since then WAPDA has been transformed into fourteen separate units: 4 thermal power generating companies and 9 distributions and transmission companies, and a hydro generating company retaining the old title.

In November 2005, the Government privatized (74.35 percent) the Karachi Electric Supply Company (KESC). At present, KESC and WAPDA operate their own networks but they are interconnected through 220 KV double circuit transmission lines so that they can supply power to each other. On June 30, 2010, the total generation capacity from WAPDA's own hydro and thermal sources plus generation from two nuclear power plants, KESC and Independent Power Producers (IPPs) stood at 20,922 MW[26].

WAPDA suffered from several crucial setbacks, for example dumping of WAPDA's power development Program in 1980s, the throwing out of the State Engineering Corporation's plan to indigenous power plants in the 1990s, barring WAPDA from thermal power generation in the 1990s, the persistent shelving of the Kalabagh dam project, the failure to institute new hydropower projects and growing reliance on thermal power. In Pakistan, electricity is among the most intensively used energy resources. Patterns of energy have changed dramatically since the onset of the Industrial Revolution in terms of both energy quantities and energy quality. In Pakistan, 60 to 70 percent of the population has access to electricity consumption[27]. They are connected to the

[25] Economic Survey of Pakistan.
[26] IPP report.
[27] Economic Survey of Pakistan.

nation's electricity grid, which indicates that as more and more electrification will occur and demand will increase, in other words, demand depends on supply. This necessitates proper planning and demand management.

2.4 The Severity of Energy Crisis

Currently, Pakistan is going through the worst energy crisis of its history. Electricity shortfall has reached to about 6,000 MW[28] and load shedding has increased from 8 to 14 hours daily, industrial growth has declined, the commercial activities, agriculture sector and ultimately the whole economy has suffered.

Energy crisis in Pakistan is one of the severe challenges the country is facing since last two decades. Despite strong economic growth during the 1980's and consequent rising demand for energy, no worthwhile steps have been taken to install new capacity for energy generation. Pakistan needs about 14000-15000 MW electricity per day, and the demand is likely to rise to approximately 20,000 MW per day by 2015[29]. Presently, the country can produce about 11, 500 MW of electricity per day and thus there is a shortfall of about 5000-6000 MW per day. This shortage is badly affecting industry, commerce and daily life of people. Electricity, gas, water, and fuel are essential parts of our daily life and its outage has severely affected the economy and overall living standards of ours. Thousands have lost their jobs, businesses and our daily life has become miserable. During the 1990s, the economic growth rate of Pakistan declined to a level of 4-5 percent per annum as compared 6 percent per annum in the 1980s.[30]

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[28] Dr. M. Asif, June 13, 2013, The News.
[29] ibid
[30] Economic Survey of Pakistan.

Pakistan having about 30 percent standby electricity few years back in 1980-1990, has been facing a severe power crisis over the last ten to fifteen years. The present crisis is considered to be the worst of four such crises that Pakistan has been facing since 1974. Due to a fast growing demand, high system losses, fuel supply limitations, and seasonal reduction in the availability of hydropower, the gap between the demand and supply of electricity is resulting in routine load shedding. Inadequate power generation capacity is just one of the factors affecting power supply. The continuing energy crisis and hiking prices of electricity (due to imbalanced generation mix) are the main factors hampering national economy. The acute power shortages is forcing the industrial sector to have under-production level and threatens badly the export performance besides creating social as well as law and order problems in the country. One of the factors behind the difficult situation is the rising circular debt which affects energy producers, that is increasing over PKR 400 billion[31].

2.5 Impact of electricity crisis on production and employment

Electricity is considered as the backbone for an economy's prosperity and progress. Thus, it plays a crucial role in socio-economic development. With the rapid development and technological innovation, the utilization of energy has also mounted. Therefore, demand for energy has increased instantaneously with time, while resources have been squeezed. Therefore, it requires keen and meaningful research to deal with the ascending energy demand. Energy is used for various purposes at residential, industrial, commercial and agricultural sectors[32]. It is also a fact that price distortion in different sectors and frequent use of electrical appliances boosts the demand of electricity.

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[31] ibid.

[32] Economic survey of Pakistan.

Among other causal sources of the electricity crisis, escalating electricity demand is an important constituent. Increasing energy consumption has long been tied directly to economic growth and improvement in human welfare. However it is not very clear whether increasing energy consumption is a necessary precondition for economic growth or otherwise. Although developed countries are now beginning to decouple their energy consumption from economic growth (through structural changes and increases in energy efficiency), there remains a strong direct relationship between energy consumption and economic development in developing countries.
Same is the case on the petroleum and gas. Petroleum is widely used in the transportation sector and gas is mostly used as raw material in the fertilizers manufacturing industries, besides transportation and household consumption as fuel.

If machinery of the industry would stop working due to failure of electricity supply how could people get employment? Productions as well as employment depend on the proper utilization of every kind of energy. Electricity provides the best and most efficient form of energy which is used in the industries. Proper energy supplies enhance the lives of masses in countless ways. It can directly reduce poverty by raising the country's productivity and extend the quality and range of its products, thereby generate more employment and putting more wages into the pockets of the workers. Energy poverty also refers to the lack of access to modern energy services. These services are defined as household access to electricity and clean cooking facilities. Currently around 1.3 billion people around the world have no access to electricity and gas facilities.[33] Lack of electricity and heavy reliance on traditional biomass are hallmarks of poverty in developing countries. Lack of electricity exacerbates poverty and contributes to its perpetuation, as it precludes most industrial activities and the jobs they create.

[33] WDI.

Chapter-3
LITERATURE REVIEW

3.0 Introduction

Electricity shortfall in Pakistan is one of the severe challenges; the country is facing since last two decades. Despite strong economic growth during 1980s and consequent rise in the demand for electricity, no worthwhile steps have been taken to install new capacity for generation of power. Now, the demand exceeds supply and hence "load-shedding" of electricity is a common phenomenon persisting since 1990s. In the following sections, we discuss some important studies undertaken in the near past to tackle the issue.

3.1 The Issue of Energy Shortfall (General)

1. Shah and Bhatti (2009) analyzed the problem of shortfall in the supply of electrical energy that is presently being faced by Pakistan. They made forecast for next 10-12 years using empirical data and preliminary calculations. A brief review is given about the potential of Pakistan to produce electricity and other energy sources. Importance of utilizing coal resources of Pakistan as well as the potential of water resource for construction of hydro-electric power stations are discussed at length. They also provided a brief review of energy crisis and pin point the main areas to be focused to minimize shortfall of electricity in Pakistan. But they did not address the issue of electricity through which manufacturing sector is affected.

2. Asif (2009) provided an overview of the key dimensions of the crisis, i.e. the growing gap between demand and supply, diminishing indigenous oil and gas reserves, rising energy cost, and security concerns. He also pointed out that hydropower, solar energy, and biomass and wind power as sustainable energy options for the country. The total estimated hydropower potential according to another is more than 42 GW, out of which only 6.5 GW has been tapped so far. In terms of

available solar energy Pakistan is amongst the richest countries in the world, having an annual global irradiance value of 1900–2200 kWh/m2. Despite the fact that the biomass plays an important role in the primary energy mix by contributing 36 percent of the total supplies, it has not been managed to enter into the commercial energy market. Our study is different from this study because we discuss only the short fall of electricity and its impact on industrial production and they focus on other energy sources.

3. Javed et al. (2011) discussed the dilemma of electricity shortfall that is currently faced by Pakistan. They discuss the past as well as the present situation of electricity production and consumption in the country. The electricity generation potential of Pakistan in different sectors is reviewed. They also discuss the importance of utilization of coal resources and water resources for the production of electric power. They present some predictions of electricity made on the basis of empirical data and preliminary observations for the next twenty years. This study is different from our study, as they have made forecasting for next twenty years, while we haven't forecast for future.

4. Siddique (2004) looked at the causality between energy use and economic growth by using time series data from the year 1970 to 2003. She used Vector Auto Regression (VAR), Error Correction Model (ECM), and Autoregressive Distributed Lag Model. The results show that energy expansion is expected to lead to higher growth and its shortage may retard the growth process. The impact of electricity and petroleum products as well as that of electricity only is high and statistically significant. However, the reverse causality is critical for the petroleum products. Although she looked out at the causality between economic growth and energy use, but the time period is different and less than that of our data.

5. Noor-ul-Haq and Hussain (2008) addressed the issue of energy with special focus on electricity, as to how it affects the business of life and economy. They also gave predictions in case the current energy shortfall is not checked it will be doubled in the near future and will be out of control. The government can also overcome the energy crisis by using its indigenous resources such as hydel, coal, waste, wind, solar energy and other renewable resources besides imports. While having nuclear power, there must not be any problem of energy but there is need of policy to make good use of these resources. They have checked the issue of electricity but with some other sources of energy like coal and oil.

6. Wijayatunga and Jayalath (2003) studied the impact of electricity shortfall on the industrial sector of South Asian countries including Sri Lanka, Nepal, Bangladesh, and India. They evaluated the cost to the country's economy in terms of the industrial loss due to supply interruptions and environmental impacts from the standby generation used to supplement the power requirements of the industrial sector. They found that the main economic impact of the power interruptions, both planned and un-planned, is the loss of output in the industrial sector. In the year of power shortages, such as 2001, these losses can be as high as approximately US$ 81 million a year, which is approximately 0.65 percent of the country's GDP. Also, the economic impact due to unplanned outages can be around US$ 45 million (0.3 percent of GDP) in that year. On average, these values for planned and unplanned outages are US$ 0.66 and US$ 1.08 per kWh of energy loss, respectively. They also observed that 92 percent of the sampled industries have standby generation facilities to satisfy either, in full or partially, their own power requirements, which produced approximately 146 GWh of energy in 2001. They suggested that the authorities must take immediate steps to improve energy supply reliability in order to retain consumers and justify the existence of a centralized generation facility.

3.2 Electricity Demand

7. Khan and Ahmad (2009) examined the demand for energy at disaggregate level (gas, electricity and coal) for Pakistan over the period 1972-2007. Their results suggest that electricity and coal consumption respond positively to changes in real income per capita and negatively to changes in domestic price level. The gas consumption responds negatively to real income and price changes in the short run, however, in the long-run real income exerts positive effect on gas consumption, while domestic price remains insignificant. Furthermore, in the short run the average elasticities of price and real income for gas consumption (in absolute terms) are greater than that of electricity and coal consumption. The differences in elasticities of each component of energy have significant policy implications for income and revenue generation. Their study is at disaggregate level while we have focused only on electricity.

8. Khan and Qayyum (2009) examined the patterns of electricity demand in Pakistan over the period 1970–2006 using Autoregressive Distributed Lag (ARDL) technique to co-integration. Long run and short run price and income elasticities are examined for the national level and for the three major consumer's categories— households, industry and agriculture. The overall results suggest that income and price elasticities possess expected signs at aggregate and disaggregate levels in the long run as well as in the short run. The error correction terms possess expected negative signs and are highly significant with reasonable magnitudes. Furthermore, the estimated long run and short-run electricity demand functions remain stable over the sample period. The results thus convey important information to the agents operating in the electricity market regarding the pricing policies and help in planning the future strategy of electricity demand management. Although they have focused on demand of electricity but their data is less than that of our analysis.

9. Tariq et.al (2009) calculated price and income elasticity of electricity demand in Pakistan, via the ARDL approach and using time series data from 1979 to 2006. Their results indicate that electricity demand is price inelastic in both short run and long run. Moreover, income elasticity is almost unitary in the short run as well as in the long run. In addition, household size has a strong positive impact on electricity demand in Pakistan. There is also difference in the time period and procedure of the estimates between our analyses and there's.

10. Chaudhry (2010) analyzed the economy-wide and the firm level demand for electricity in Pakistan. He used panel data from 63 countries from 1998-2008, and calculated that the income elasticity of demand for electricity is approximately 0.69, which implies that a 1percent increase in per capita income will lead to a 0.69 percent increase in the demand for electricity. On the other hand the firm level demand (taken from the World Bank's Enterprise Survey for Pakistan) is approximately -0.57, which implies that a 1 percent increase in electricity prices will lead to a 0.57 percent decrease in electricity demand. Across sectors, the textile sector has the highest price elasticity of demand (-0.81), while it is smallest (-0.31) for firms in the electricity and electronics sector. He also estimates production functions in order to see the impact of electricity shortage on manufacturing output. The results show that elasticity of per capita demand for electricity with respect to per capita income is approximately 0.69 which means that 5 percent increase in per capita income will increase 3.5 percent in the demand for electricity per capita in Pakistan. Our study is different from their study as they have taken many countries and we have just focused on Pakistan.

11. Alter and Haider (2011) analyzed the demand for electricity in Pakistan. They determined the long run and short run dynamics between electricity demand and its determinants by using time

series data from 1970 to 2010 and co-integration technique and vector error correction model. The result of co-integration test shows that the variables integrate in the long run while vector error model shows the convergence of variables towards equilibrium. They concluded that electricity is a necessity good in the short run while it is a luxury good in the long run, the authorities should use the effective price, income, group pricing and peak-load pricing policies for electricity demand management. As they have discussed the long run and short run dynamics and used time series data while our analysis consists of panel data.

12. Iqbal (1986) studied the substitution of labor, capital and energy in manufacturing sector of Pakistan. He derived the equations of labor, capital, and energy from trans-log cost function which was estimated by Zellner's iterated method for obtaining the elasticities of labor capital and energy and also the substitution elasticities. He concluded that labor, capital and energy are substitutes, while natural gas and electricity are complements. The study is different form our analysis in form of variables and method. They have used Zellner's iterated method for obtaining the elasticities of labor capital and energy while we used simple Cobb-Douglas production function.

13. Halverson and Larsen (2000) empirically estimated the long-run effects of residential electricity demand from changes in the electricity prices in Norway, by using the cross-sectional variation in the stock of electric appliances across the house-holds. They used the discrete-continuous approach to model the long run effects of investments in new appliances. They apply the annual Norwegian survey of consumer expenditure for the period of 1975 to 1994 and estimate the short run and long run own price elasticities using two different approaches. They found that the long run elasticity was slightly higher than the short run elasticity. The rationale was clear.

Since there were no alternative sources of energy (substitutes for electricity) for these appliances, therefore, no significant substitution effects could be noted.

3.3 Causality of Relationships between Electricity and Output

14. Chishti and Mehmood (1991) analyzed the role of energy in the manufacturing sector of Pakistan using the trans-log cost function along with the input demand equations corresponding to energy, capital and labor. They used Zellner's iterative procedure and include time series trends in the cost equation in the view of low Durbin-Watson statistics. Their results justify the inclusion of energy as a separate factor of production. They also estimated the price and Allen Uzwa partial substitution elasticities where price elasticity indicated inelastic demand for inputs and cross price elasticities showed that energy and labor and capital and labor are substitutes. The partial substitution elasticities between capital and energy are negative which shows that higher energy prices will adversely affect investment in capital goods. On the other hand, the positive substitution elasticity between energy and employment implies that higher energy prices would induce more labor absorption. They used different methods to estimate the energy, capital and labor, while we also use the same variables but time period and estimation method is different.

15. Qazi et al. (2012) estimated the relationship between energy consumption and industrial output in Pakistan by utilizing the Johansen method of co-integration. The results confirm the positive effect of disaggregate energy consumption on industrial output. They identified bidirectional causality in the case of oil consumption, whereas unidirectional causality running from electricity consumption to industrial output is also observed. Moreover, unidirectional causality has been noticed from industrial output to coal consumption, although there is no causality between gas consumption and industrial output. It is obvious that conservative energy policies could be harmful

to the industrial production; therefore, the government has to develop innovative energy policies in order to meet the demand for energy. Additionally, the government has to pay serious attention to alternative energy sources such as solar and wind in order to boost the clean industrial growth. We have specified the energy to electricity while they take many other sources of energy.

16. Afzal (2011) estimated the impact of electricity shortfall and increase in the rate of interest on the production of textile industry, which is the largest manufacturing sector in Pakistan contributing more than 60 percent to export earnings. The study adopts the multiple regression analysis using the 11 years data of textile production, electricity usage and interest rates on credit to this sector. The results reveal that textile industry is negatively affected by electricity crises and high interest rates. The industry can be brought to its previous potential level provided the electricity supply is regulated and concession of easy credit is awarded to this sector. He take interest rate on production of textile industry while we have just taken electricity and overall manufacturing sector.

17. Shahbaz and Feridun (2012) tried to identify the long-run equilibrium relationship between electricity consumption and economic growth in Pakistan for the period 1971 to 2008. They use the Autoregressive Distributed Lag (ARDL) bounds testing approach and the Toda and Yamamoto and Wald tests to see the direction of causal relationship between these two variables. Their results suggest that the two variables are in the long-run equilibrium relationship and economic growth leads to electricity consumption but not vice versa. The time period is different in our analysis and also the estimation technique.

18. Altinay and Karagol (2005) investigated the causal relationship between electricity consumption and real GDP in Turkey during the period from 1950 to 2000. They used Zivot and Andrews test and found that both the series were stationary around a structural break and hence they used two different methodologies to test the Granger non-causality; the Dolado-Lutkepohl test using the VARs in levels and standard Granger Causality test using the detrended data. Both tests have yielded a strong evidence for unidirectional causality running from the electricity consumption to the income. This implies that the supply of electricity is vitally important to meet the growing needs for electricity, hence to sustain the economic growth in Turkey. They have taken the electricity consumption of Turkey, while we are studying the consumption of electricity of Pakistan.

3.4 Electricity Consumption and Growth

19. Jamil and Ahmad (2010) analyzed the relationship among electricity consumption, its price, and real GDP at the aggregate and sectoral level in Pakistan, using annual data for the period 1960–2008. They found the presence of unidirectional causality from real economic activity to electricity consumption. In particular, growth in output in commercial, manufacturing and agricultural sectors tend to increase electricity consumption, so far as the residential sector is concerned, growth in private expenditures is the cause of rising electricity consumption. They concluded that electricity production and management needs to be better integrated with overall economic planning exercises. This is essential to avoid electricity shortfalls and unplanned load shedding. They have taken prices as well, while we do not take prices of the electricity and only focus on the electricity demand of the industrial sector.

20. Nazima Ellahi (2011) analyzed the joint role of electricity supply and industrial sector development for economic growth of Pakistan. Theoretically this study is based on endogenous growth model, and empirically it applies Autoregressive Distributed Lag (ARDL) approach to find the short-run and long-run estimates. The results reveal that labor, capital, and electricity supply play an important role in the development of the industrial sector, which in turn is the essential ingredient of economic growth. The shortage of electricity results in dismal performance of industrial sector. The results imply that the industrial sector despite the presence of several policy incentives cannot improve or contribute to economic growth unless the problem of electricity is resolved. The estimation method is different form our analysis and also she focus on the industrial sector development of Pakistan.

21. Shahbaz and Lean (2012) estimated the relationship between electricity consumption and economic growth in Pakistan by controlling for and investigating the effects of two major factors of production, capital and labor. The empirical evidence confirms the co-integration among the variables and indicates that electricity consumption has a positive effect on economic growth. Moreover, bi-directional Granger causality between electricity consumption and economic growth is revealed. Their findings suggest that adoption of electricity conservation policies may unwittingly decline economic growth, which in turn further decrease the demand for electricity. Therefore, the government should explore and develop alternative sources of energy as a strategy rather than just increasing electricity production per se in order to meet the rising demand for electricity in their quest towards sustaining development in the country. They have checked the causality tests while we have just analyzed the impact of electricity shortfall on manufacturing sector.

22. Ghafoor and Eeiss (2001) studied the performance of electric power sector of Pakistan at firm level and sector wise using Cobb-Douglas production function. Economies and diseconomies of scale have also been studied in case of electric power generation. They identified and tried to quantify the extent of inefficiencies. Their study concludes that physical, financial or productivity indicators alone are not able to explain the duality of public infrastructure purposes and the complexity of their multi-dimensional goals, rather a set of relevant physical, financial and productivity indicators can be used in evaluating the performance of the energy sector. They have looked into power sector of Pakistan while we are studying the manufacturing sector of Pakistan.

23. Hye and Riaz (2008) determined the direction of causality between energy consumption (EC) and economic growth (EG) in Pakistan, using annual data from 1971 to 2007. They implement a bounds-testing approach to co-integration and an augmented form of the Granger causality test to identify the direction of relationship between these variables both in the short and long run. Their findings suggest bidirectional causality between EG and EC in the short run; in the long run they found unidirectional causality from EG to EC. EC does not lead to EG in the long run because higher energy prices (oil prices) increase the cost of business, leading to a negative effect on EG. Additionally, when energy prices fluctuate, they create uncertainty that also affects economic growth. Their study recommends direct investment in local energy resources. The gap they left in their study is that of data. Their data is from 1971 to 2007 while our data is from 1972 to 2012.

24. Razzaqi and Sherbaz (2011) investigated the dynamic relationship between energy use and economic growth in the D8 countries. The evidence gathered through application of VAR Granger Causality, Johansen co-integration and VECM proves existence of short-run and long-run correlation between energy use and economic development in all countries. The results supported

either unidirectional or bi-directional causality in the long as well as short run for all the D8 countries except for Indonesia where non-causality was established between the two variables in the short run. They have taken developing eight (D8) countries while we are taking just Pakistan in our analysis.

25. Lee and Chang (2008) analyzed the energy consumption and economic growth in Asian Countries. They applied the most recently developed panel unit root tests, heterogeneous panel co-integration and panel-based error correction models to re-investigate the co-movement and the causal relationship between energy consumption and real GDP within a multivariate framework. It includes capital stock and labor input for 16 Asian countries during the 1971–2002 period. Their empirical results fully support a positive long-run co-integrated relationship between real GDP and energy consumption when the heterogeneous country effect is taken into account. They found that although economic growth and energy consumption lack short-run causality, there is long-run unidirectional causality running from energy consumption to economic growth. This means that reducing energy consumption would not adversely affect GDP in the short-run but would do so in the long-run, as such, these countries should adopt a more vigorous energy policy. Furthermore, they broaden the investigation by dividing the sample countries into two cross-regional groups, namely the APEC and ASEAN groups, which led to even more important results and implications.

26. Akinlo (2009) addressed the issue of electricity consumption and economic growth in Nigeria during the period 1980–2006. The results of his estimation showed that real GDP and electricity consumption are co-integrated and there is only unidirectional Granger causality running from electricity consumption to GDP. Then he applied Hedrick–Prescott (HP) filter to decompose the trend and the fluctuation components of the real GDP and electricity consumption. The estimation results showed that there is co-integration between the trend and the cyclical components of the

two series, which seems to suggest that the Granger causality is possibly related with the business cycle. He further suggested that investing more in the supply of electricity and reducing inefficiency in the use of electricity can further stimulate economic growth in Nigeria.

27. Lorde et al. (2010) used a neo-classical aggregate production model where capital, labor, technology, and energy are treated as separate inputs. They test for the existence and direction of causality between output growth and electrical energy use in Barbados. Their results indicate the presence of a long-run relationship between growth and electricity consumption. In addition, the evidence reveals a bidirectional causal relationship between electrical energy consumption and real GDP in the long run, but only a unidirectional causal relationship from energy to output in the short run. Their forecasts indicated that increasing consumption of electrical energy, particularly by the residential sector. They suggested that plans by the Government to liberalize the sector would encourage efficiency and innovation in production and distribution. Changes in the regulatory environment will also be necessary if such plans materialize. Policymakers will need to pay greater attention to the expected increase in the rate of consumption by the residential sector, as this will help reduce the imports of oil and depletion of scarce foreign exchange resources.

28. Masudduzzaman (2012) investigated the relationship between economic growth, electricity consumption and investment for the economy of Bangladesh through co-integration and causality analysis for the period of 1981 to 2011. He used the Actual Deferral Percentage (ADP) and Perish Pearon (PP) unit root tests and found that all the three variables are co-integrated of order 1. The Johansen co-integration test indicates that all the variables are co-integrated with one co-integrating vector. The Granger F-test results confirmed the existence of unidirectional causality running from electricity consumption to economic growth directly and electricity consumption to investment and investment to economic growth indirectly without feedback in the short run. The

long-run elasticity of economic growth with respect to electricity consumption and investment are higher than their short run elasticities. This implies that over time, higher electricity consumption and investment in Bangladesh will give rise to more economic growth.

29. Adebola (2011) investigated the relationship between electricity consumption and real GDP in Botswana (the world's largest producer of diamonds). He examined capital formation in a trivariate system for the period covering 1980-2008. Zivot and Andrews (1992) unit root test; bound test for co-integration, and Granger causality test are employed. Unidirectional causality is found from electricity consumption to real GDP is in line with study of Altinay and Karagol (2005) among others. The long-run estimate reinforces the Granger causality tests by indicating that electricity consumption is positively associated with GDP. Further findings suggest unidirectional causality from capital formation to real GDP. The implication is that Botswana- being a highly energy dependent country- will have the performance of its capital formation on the economy partly determined by adequate electricity supply.

30. Noor and Siddique (2010) examined the causal link between energy use and economic growth for five South Asian countries over period of 1971-2006. They applied the panel co-integration, Error Correction Model (ECM) and Fully Modified Ordinary Least Square (FMOLS) for short and long run estimates. In short run unidirectional causality from per capita GDP to per capita energy consumption, but not vice versa. In the long run, one percent increase in per capita energy consumption tends to decrease per capita GDP by 0.13 percent. This result is very strong. Thus, short and long-run relationship indicate energy shortage crisis in South Asia due to increased energy use coupled with insufficient energy supply. Moreover, per capita energy consumption is responsive to adjustment back to equilibrium and it takes 59 years approximately. It specifies long run feedback between both variables.

Chapter-4

MODEL, METHODOLOGY, AND DATA

4.1 The Model

This study investigates the implication of electricity shortfall, which directly affects the industrial production of Pakistan besides agricultural, commercial, and household activities. Different techniques have been employed by the researchers to investigate the implications of this issue in different countries as well as in Pakistan. For example, Hye and Riaz (2008) investigated the causality between energy consumption and economic growth for Pakistan using the co-integration bounds-testing approach and an augmented form of the Granger causality test to identify the direction of the relationship between these variables, both in the short and long run.

Similarly, Jamil and Ahmad (2010) found the relationship between electricity consumption, electricity prices and GDP growth in Pakistan using Johansen maximum likelihood approach and Phillips-Pearon tests. Qazi et al (2012) empirically investigated the long run relationship between energy consumption and industrial output in Pakistan by using the Johansen co-integration test. Chaudhry (2010) used Cobb-Douglas production function to evaluate the electricity demand at firm level in Pakistan. Shahbaz and Lean (2012) also used Cobb-Douglas production function with capital and labor as important factors to investigate the dynamics of electricity consumption and economic growth and their causality in Pakistan. Chishti and Mehmood (1991) analyzed the role of energy in the manufacturing sector of Pakistan by using the trans-log cost function along with the input demand equations corresponding to energy, capital and labor.

The present study is focusing on the impact of electricity short fall on industrial production via a generalized Cobb-Douglas production function. It is a matter of common sense that energy is vital for all activities of life, especially for large scale manufacturing. If labor is available up to the required level as well as the necessary capital (machinery, equipment, and the building of the industry) but there is no electricity to run the machines, the production process will remain stand still and all other factors will be obsolete. The usual tradition in economic analysis has been to consider capital and labor as the primary factors of production. The secondary/intermediate factors like raw material and energy requirements are traditionally considered as given. The under-lying assumption has been the perfectly elastic supplies of secondary inputs. However, this assumption does not hold so far as the availability of energy concerned. We employ the production function by considering labor and capital as usual but specifically focusing on electric power explicitly as a determining input for industrial production. It is true that some manufacturing firms are generating their own electric power to some extent, however, majority are using the power provided by the national grid stations. The production function may be expressed in the general format as follows:

$$Y_{it} = f(K_{it}, L_{it}, E_{it}) \tag{4.1}$$

where,

Y_{it} stands for the output of the i^{th} industry (i.e, large scale and small scale)

K_{it} stands for capital stock, machinery and equipment (proxied by investment)

L_{it} stands for labor force employed, (proxied by the cost on wages paid to labor)

E_{it} stands for electric power consumed by the manufacturing sector (in terms of value of electricity consumed)

The production function may assume the specific Cobb-Douglas format:

$$Y_{it} = AK_{it}^{\alpha 1} L_{it}^{\alpha 2} E_{it}^{\alpha 3} \tag{4.2}$$

This may be rewritten in the growth form as:

$$Y_{it}^{g} = \alpha_0 + \alpha_1 K_{it}^{g} + \alpha_2 L_{it}^{g} + \alpha_3 E_{it}^{g} + \varepsilon^{\mu_t} \quad (4.3)$$

where α_s denote the partial elasticities of output with respect to the factors concerned and α_0 is the scale factor encompassing the other implicit factors, "i" stands for the manufacturing industry (small scale and large scale) and "t" stands for time period where μ_t is the error term with usual properties.

By using this equation, we estimate the growth elasticities. It is well known that the growth rate of aggregate output is a weighted sum of the growth rates of individual factors of production. As the regression passes through the mean points, the average growth rates of the variables concerned (the inputs and output) can be easily determined for the entire period. The equation may become as,

$$\overline{Y^g}_{it} = \widehat{\alpha_0} + \widehat{\alpha_1}\, \overline{K^g}_{it} + \widehat{\alpha_2}\, \overline{L^g}_{it} + \widehat{\alpha_3}\, \overline{E^g}_{it} \quad (4.4)$$

whereas;

$\overline{Y^g}_{it}$ shows the mean growth rate of output

$\overline{K^g}_{it}$ shows the mean growth rate of capital

$\overline{L^g}_{it}$ shows the mean growth rate of labor, and

$\overline{E^g}_{it}$ shows the mean growth rate of electricity consumed by the manufacturing sector.

4.1.1 The Benchmark Model

We divide the data in two distinct phases. The period from 1972 to 1990 during which we presume that the problem of electricity shortfall was not there or it was minimal. The second phase comprises the period from 1991 onwards during which the problem came to the surface and grew tense with the passage of time. The shortfall in the availability of electric power and its solution through managed load shedding has inflicted irrecoverable loss to industrial production. In the first phase, we estimate the industrial production in Pakistan and this provides us with the baseline information which will be useful in comparing the industrial output for the subsequent period.

4.1.2 The Actual/Prevailing Position

Next, we check the actual growth of industrial output in the subsequent periods when the problem of load shedding appeared and grew tense from the turning point onward 1991. The equation is estimated once again using the actual data on industrial output and inputs for the period 1991 to 2012, particularly when lesser electric power could be available to the industrial sector. Again, we find the growth elasticities, given by the estimated coefficients.

4.1.3 Comparison of Actual with projected (optimal) output:

The projected growth rate of industrial output during the second phase (1991-2012) is defined for the situation when the electricity (consumption by industrial sector) growth rate of the benchmark (optimal level) is assumed to prevail during the second phase. The actual growth of output is also available for the period 1991 to 2012.

Considering the growth rates of other variables (capital and labor) to remain unchanged (as usual) in the second period but importing the growth rate of electricity during the bench mark period as estimated above in equation (4.4), the projected (counter factual) growth rate of output during this period can be estimated as:

$$\hat{Y}^{p\_g} = \widehat{\alpha_0} + \widehat{\alpha_1}\,\overline{K^g} + \widehat{\alpha_2}\,\overline{L^g} + \widehat{\alpha_3}\overline{E^{r\_g}} \qquad (4.5)$$

Equation 4.5 shows the projected growth of industrial output from 1991 to 2012 where we have fixed the growth of electricity and $\bar{\hat{Y}}$ is the projected growth rate (mean value) of output over time. The loss of output faced by the manufacturing sector due to electricity shortfall will be as under:

$$Y_{loss} = Y_{it}^{r\_g} - Y_{it}^{a\_g} \qquad (4.6)$$

The output loss is equal to projected growth of output minus actual growth of output as;

$Y_{it}^{a\_g}$ is the actual growth (average value) of output during the period 1991 to 2012,

$\overline{\hat{Y}^{p\_g}}$ is the projected growth of output for the period 1991 to 2012.

It is clear from the above analysis as to how much the economy (manufacturing sector) suffered from the evil of electricity shortage.

4.2 Variables and data

In this study we have used industrial output as independent variable and the cost of labor, capital, and electricity as explanatory variables in order to evaluate the impact of electricity shortfall on industrial production in Pakistan. We use panel data from 1972 to 2012 industry wise (large & small scale manufacturing sector). As explained earlier the data set is divided into two spans i.e. 1st period starts from 1971 to 1990 while the second period starts from 1991 to 2012. The data is taken from annual reports of Water and Power Development Authority (WAPDA), National Transmission and Dispatch Company (NTDC), Pakistan Electric Power Company (PEPCO), International labor organization (ILO), World Bank (WB) statistics and various issues of Pakistan Economic Survey, Finance Division, Government of Pakistan. All the variables are expressed in values term at current prices and we brought them to constant prices of common base year of 1999-2000. Finally, we have transformed all values into growth rates.

The Economic Survey includes the following sectors in the definition of industry;

i) Mining and quarrying,

ii) Manufacturing (which is further sub-divided into three sub sectors, i.e. large scale, small scale and slaughtering, but we have merged slaughtering into small scale)

iii) Construction, and

iv) Electricity and gas distribution.

We have excluded mining quarrying, construction and electricity and gas distribution for our analysis on the presumption that electricity usage in these sectors is very low as compared to manufacturing sector. There is also difference in the definition of industry between the bureau of statistics and WAPDA. According to the bureau, an entity where at least 8 workers are permanently engaged is considered as 'industry'[34]. In contrast, 'industry' is defined as an entity where a motor of 3 kWh or above is installed[35]. In this study we used the definition and classification given in the Economic Survey of Pakistan and we just took the Manufacturing Sector which includes large scale and small scale. We use STATA software for our regression analysis.

4.3 Methodology

Since our model comprises the use of panel data, there are so many techniques used for regression analysis like GMM technique, instrumental variable (IV), random effect and fixed effect technique. In the literature there are a lot of examples for using these techniques. Fixed effect (FE) model is used whenever we analyze the impact of variables that vary over time because this model explore the relationship between predictor and outcome variables within an entity (country, person, company, etc.).

Each entity has its own individual characteristics that may or may not influence the predictor variables (for example being a male or female could influence the opinion toward certain issue or the political system of a particular country could have some effect on trade or GDP or the business practices of a company may influence its stock price). This is the rationale behind the

[34] Federal Bureau of Statistics.
[35] Water and Power development authority.

assumption of the correlation between entity's error term and predictor variables. Fixed effect model remove the effect of those time invariant characteristics from the predictor variables so we can assess the predictors' net effect.

Another important assumption of the fixed effect model is that, those time invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. Each entity is different therefore the entity's error term and the constant (which captures individual characteristics) should not be correlated with the others. If the error terms are correlated then fixed effect is not suitable since inferences may not be correct and that relationship (probably using random-effects). Also as fixed effect model controls for all time-invariant differences between the individuals, so the estimated coefficients of the fixed-effects models cannot be biased because of omitted time-invariant characteristics like culture, religion, gender, race, etc. One side effect of the features of fixed-effects models is that they cannot be used to investigate time-invariant causes of the dependent variables. Technically, time invariant characteristics of the individuals are perfectly collinear with the person or entity dummies. Substantively, fixed effect models are designed to study the causes of changes within a person or entity. A time-invariant characteristic cannot cause such a change, because it is constant for each person.

Random effects assume that the entity's error term is not correlated with the predictors which allows for time invariant variables to play a role as an explanatory variables. In random effects must specify those individual characteristics that may or may not influence the predictor variables. The problem with this is that some variables may not be available therefore leading to omitted variable bias in the model. Random effect model allows to generalize the inferences beyond the sample used in the model. In a random effects model, the unobserved variables are assumed to be uncorrelated with all the observed variables. Random effect model may still be desirable under some circumstances for example it can be estimated via Generalized Least Squares (GLS).

The fixed effects and random effects models both have potential advantages as well as disadvantages to consider when selecting an approach. The random effects model will introduce bias in estimates in rare circumstances but can greatly constrain the variance of those estimates leading to estimates that are closer, on average, to the true value in any particular sample. Different researchers may have different preferences for using of bias and variance in this regard. So on the above comparison of both the models we used random effect model as compare to fixed effect model because it seems most suitable and preferable as compare to other techniques regarding our data and for this purpose we used STATA software for our regression analysis. The rest of evaluation is mathematical which is discussed in the next chapter.

Chapter-5

ESTIMATION AND RESULT DISCUSSION

5.1 Regression Analysis

As discussed in the previous chapter, we have divided the data span into two periods, keeping in view the historical trends in power supply.

1. The base line period from 1972 to 1990 during which the problem of load shedding in Pakistan was minimal and which can serve as the benchmark for subsequent analysis.
2. The period from 1991 to 2012 during which the problem of load shedding came to the surface and grew to severity, thereby adversely affecting industrial output.

5.1.1 Regression analysis for the first period (1972-1990)

In the first step, we estimate the model for the base period (1972-1990), concentrating on the growth rates and elasticities. The model fitted for the first phase is used for further forecasting during the second phase when shortage of electricity became problematic. The data on power supply for the second phase (period 1991 to 2012) is utilized to evaluate the difference between optimal demand and factual power supply. Using this information, the shortfall in productivity is projected and compared with the factual position. Finally the impact of this gap in demand and supply of electricity on overall economic growth is worked out.

Total number of observations for the first period (i.e. from 1972 to 1990) involves two groups over cross section, i.e. large scale and small scale manufacturing sectors.

The following model is estimated, as discussed in the previous chapter and reproduced as;

$$Y_{it}^{g} = \alpha_0 + \alpha_1 K_{it}^{g} + \alpha_2 L_{it}^{g} + \alpha_3 E_{it}^{g} + \mu_{it} \qquad (4.3)$$

Y_{it}^{g}, K_{it}^{g}, L_{it}^{g}, and E_{it}^{g} are the growth rates of output, capital, labor and electricity respectively, whereas α_0, α_1, α_2 and α_3 are the partial elasticities for the baseline information on the factor of production for the period 1972 to 1990. The results are as shown below;

Table 5.1: Estimates of output growth for the 1st period (i.e. 1972 to 1990)

Variables	Coefficient	Standard Error	P-value
Electricity Growth (E^g)	0.726	0.288	0.012
Labor Growth (L^g)	1.359	0.058	0.000
Capital Growth (K^g)	1.076	0.408	0.007
Constant	-0.004	0.029	0.943
R^2	0.513		

Table 5.1 shows that the coefficient of growth in electricity is significant at 5 percent level, while coefficient of growth in labor is significant at 1 percent level and that of growth in gross fixed capital formation is also significant at 5 percent level. Since we are working through Cobb-Douglas specification, the coefficients show partial elasticities. The value of R^2 is 0.513 which means that 51 percent of the total variations in the dependent variables are explained. Of course, there are many other socio-political and economic factors that would have affected the growth of industrial output.

5.2 Required growth of electricity

Now we have to find out the estimated or required level of electricity growth to achieve the same level of growth in the second period (i.e. 1991 to 2012) by calculating equation (5.1) as;

$$\hat{Y}_{it}^{g} = \hat{\alpha}_0 + \hat{\alpha}_1 K_{it}^{g} + \hat{\alpha}_2 L_{it}^{g} + \hat{\alpha}_3 E_{it}^{g} + \mu_{it}$$

For finding the value of required growth of electricity in the second period (i.e. 1991 to 2012), we have,

$$\hat{E}_{it}^{r\_g} = \frac{1}{\hat{\alpha}_3}\bar{Y}_{it}^{g} - \frac{\hat{\alpha}_0}{\hat{\alpha}_3} - \frac{\hat{\alpha}_1}{\hat{\alpha}_3}K_{it}^{g} - \frac{\hat{\alpha}_2}{\hat{\alpha}_3}L_{it}^{g} \qquad (5.2)$$

Equation (5.2) shows the required growth of electricity for the second period (i.e. 1991 to 2012) necessary to maintain the growth rate of industrial output as it was for the first period. The values of K_{it}^{g} and L_{it}^{g} are the actual values of the second phase (period from 1991 to 2012), and the values of the parameters we have,

$\hat{\alpha}_0$ = - 0.004, $\hat{\alpha}_1$ = 1.076, $\hat{\alpha}_2$ = 1.359, $\hat{\alpha}_3$ = 0.726, $\bar{Y}_{it}^{g}$= 0.0688

By putting all the above values in equation (5.2), we will have,

$$E_{it}^{r\_g} = \frac{0.068}{0.726} - \frac{0.004}{0.726} + \frac{1.076}{0.726} K_{it}^{g} - \frac{1.359}{0.726} L_{it}^{g} \quad (5.3)$$

Equation (5.3) shows the required level of electricity growth supposed to be in the second period (i.e. 1991 to 2012). This is shown in the following table.

Table 5.2: Actual and required mean values of electricity for the second period

	Variables	Mean value	Standard Deviation
Large Scale	**Actual growth of Electricity (E^{g})**	0.018	0.002
	Required growth of Electricity (E^{r_g})	0.058	0.004
Small Scale	**Actual growth of Electricity (E^{g})**	0.008	0.000
	Required growth of Electricity (E^{r_g})	0.057	0.006

Table 5.2 shows the actual and required growth rate of electricity for the second period (i.e.1991 to 2012).

The graphs of the above regression analysis are as under,

Figure 5.1: Trend in actual and estimated growth of electricity (Large Scale)

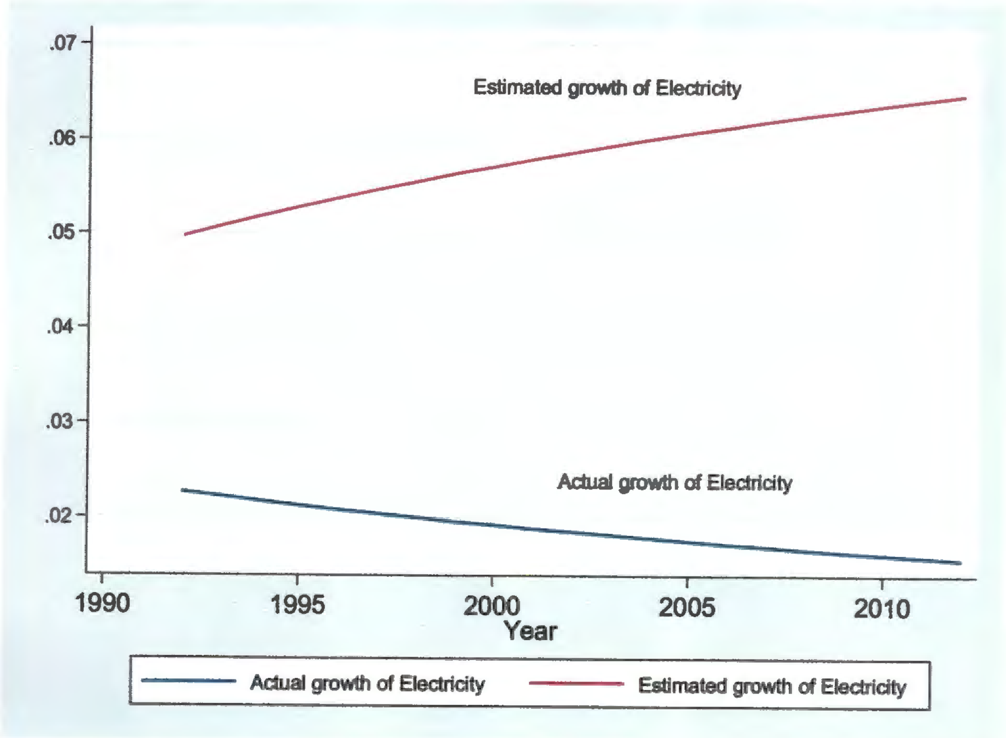

Figure 5.2: Trend in actual and estimated growth of electricity (Small Scale)

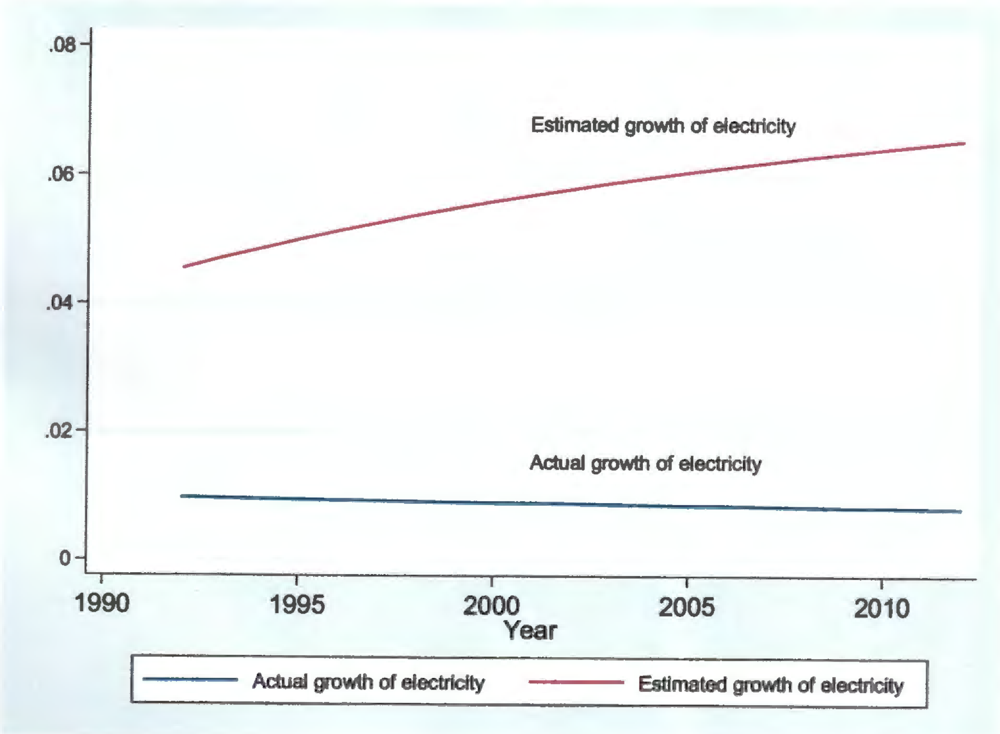

Figure 5.1 shows the required electricity and the actual position of electricity for the large scale manufacturing sector for the second period from 1991 to 2012, this shows a clear picture of the gap between the required electricity and the actual growth of electricity for the period from 1991 to 2012 for the large scale manufacturing sector. On X-axis we take time period and on Y-axis we take the growth rate of the electricity both the actual and the estimated. Due to this gap the output decreased and cause negative impact on the industrial production of Pakistan. As large scale manufacturing sector have no alternatives to run their big machinery as compared to the small scale as they have alternatives like power generators and up to some extent urgent power supply (UPS).

Similarly, Figure 5.2 shows the gap between actual growth of electricity and required growth of electricity for the period from 1991-2012 for the small scale manufacturing sector. On X-axis we take time period and on Y-axis we take the required and the actual supply of electricity.

Although the small scale manufacturing sector did not suffer as much because they have alternatives for electricity to manage it and they can run their machinery with other sources but the problem is that it is costly than that electricity which is provided by the government.

5.3 Projected vs actual growth of output (comparative analysis)

After we find the required growth of electricity, we next find the projected growth of output in the second period (i.e. 1991 to 2012) with the required growth of electricity by supposing the parameters estimated in the first period remains the same over the next period when the electricity shortfall became problematic and only electricity will be put as the required and not the actual value in the second period because of load shedding. This is shown in the following table.

Table 5.3: Estimates of output growth for overall period (i.e. 1972 to 2012)

Variables	Coefficient	Standard Error	P-value
Electricity Growth (E^g)	0.814	0.094	0.000
Labor Growth (L^g)	1.118	0.009	0.000
Capital Growth (K^g)	1.264	0.238	0.000
Constant	-0.016	0.012	0.181
R^2	0.764		

Table 5.2 shows the estimated values of output growth for the overall period (i.e. period from 1972 to 2012). The P-values of coefficients for growth in electricity, labor, and capital is 0.000, in each case, which means that all explanatory variables are significant at 1 percent level. Likewise the coefficients of all the explanatory variables are positive as in the previous case. There are slight changes in the values of elasticities. However electricity still remains a necessity for the growth of output, while capital formation is relatively a luxury. The economic rationale is clear; investment in the manufacturing sector should be a luxury in the presence of electricity shortfall. The growth elasticity of output with respect to labor (employment) has somewhat gone down, since many industrial units were likely to shut down due to electricity shortfall.

The value of R^2 is 0.76 which means that 76 percent of the variables are explained by the equation. This is much important situation as compared to the benchmark period. The projected growth of output is replicated as under,

$$\hat{Y}_{it}^{p\_g} = \hat{\alpha}_0 + \hat{\alpha}_1 K_{it}^g + \hat{\alpha}_2 L_{it}^g + \hat{\alpha}_3 E_{it}^{r\_g} \tag{5.4}$$

Equation (5.4) shows the projected growth of output for the second period (i.e. 1991 to 2012) where the value of growth of capital (K_{it}^g) and growth of labor (L_{it}^g) remains the same or they are actual values of the second period (i.e.1991 to 2012) while the value of electricity is taken from equation (5.3) which is the estimated value of the first period (i.e. 1972 to 1990). As we have the values of the parameters as,

$\widehat{\alpha}_0$ = - 0.016, $\widehat{\alpha}_1$ = 1.264, $\widehat{\alpha}_2$ = 1.118, $\widehat{\alpha}_3$ = 0.814,

Thus, by putting the values to equation (5.4) we will get,

$$\hat{Y}_{it}^{p\_g} = -0.004 + 1.076\, K_{it}^{g} + 1.359\, L_{it}^{g} + 0.726\, E_{it}^{r\_g} \quad (5.5)$$

Equation (5.5) shows the projected growth of output for the second period (i.e. 1991 to 2012) with required period of electricity. The values of parameters of capital (K_{it}^{g}) and labor (L_{it}^{g}) are the actual values while the value of electricity ($E_{it}^{r\_g}$) is taken as the expected or the required growth rate for the second period (i.e. 1991 to 2012). This is shown in the following table.

Table 5.4: Actual and projected value of output for the second period (i.e. 1991 to 2012)

	Variables	Mean value	Standard Deviation
Large Scale	**Actual growth of Output (Y^g)**	0.037	0.004
	Projected growth of Output (Y^{p_g})	0.084	0.000
	Output Loss	0.047	0.004
Small Scale	**Actual growth of Output (Y^g)**	0.021	0.004
	Projected growth of Output (Y^{p_g})	0.055	0.000
	Output Loss	0.034	0.004

Table 5.4 shows the actual and required mean values of output for large and small scale manufacturing sector and clearly mentioning the overall output loss in the second period (i.e. 1991 to 2012) which occur due to shortfall of electricity both in the large scale and small scale manufacturing sector.

Graphical representation of the above regression analysis can be seen as under.

Figure 5.3: Trend in actual and projected growth of output (Large Scale)

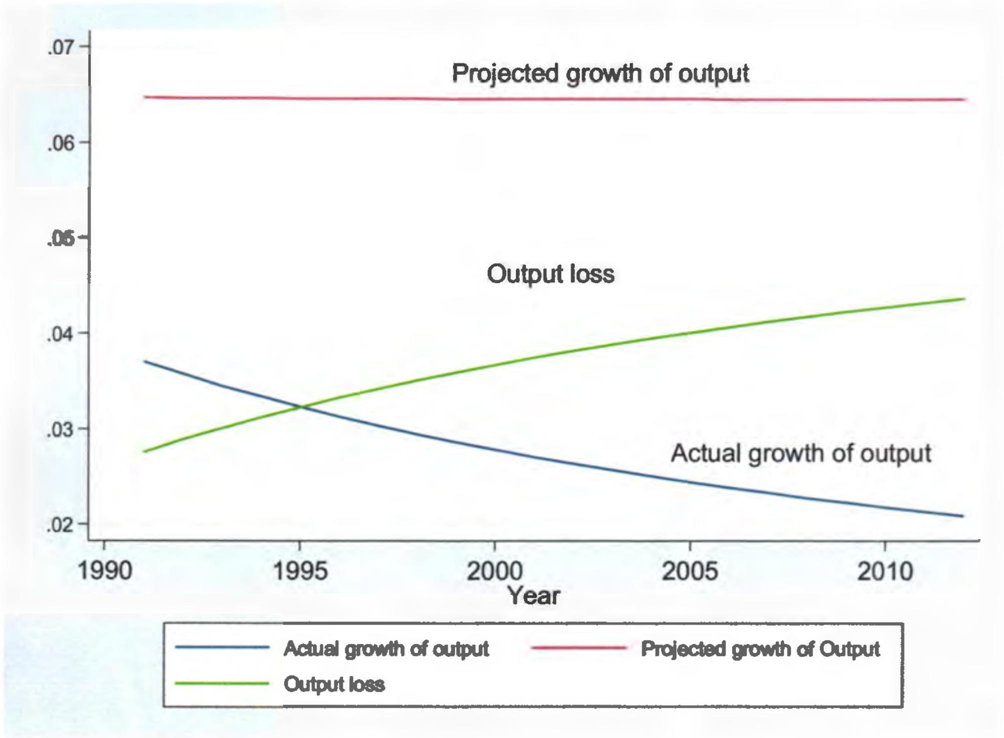

Figure 5.4: Trend in actual and projected growth of output (Small Scale)

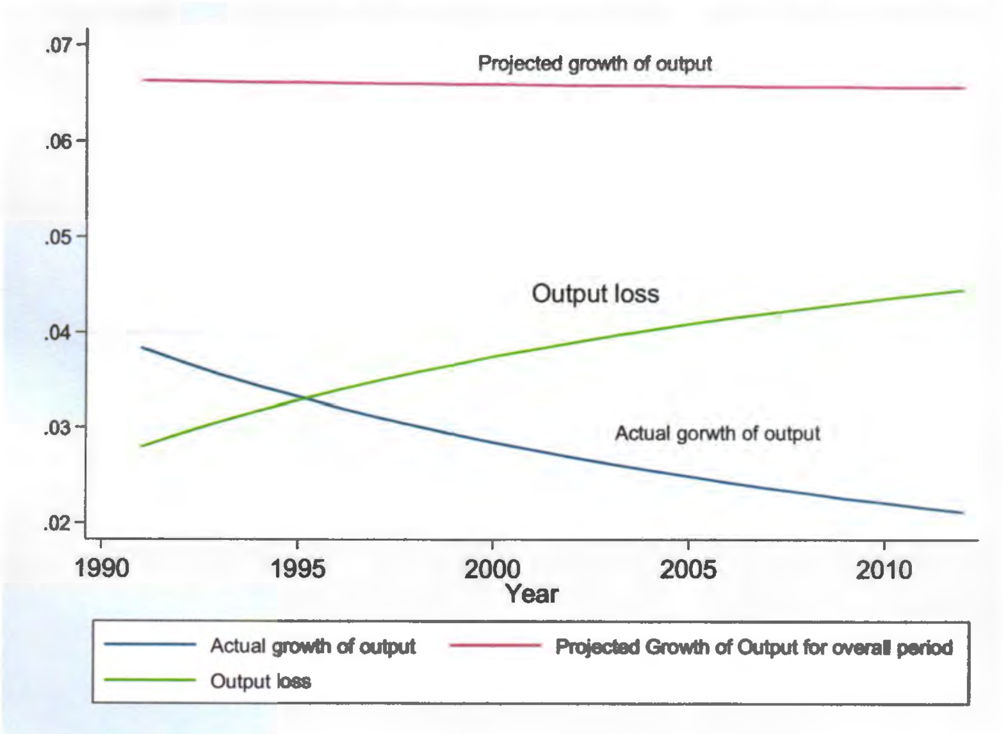

Figure 5.3 shows the gap between actual and projected output with output loss over time period (i.e. 1991 to 2012) for large scale manufacturing sector. It clearly shows us that there is a big difference in the required output and the actual output over the time period from 1972 to 2012 due to the shortfall of the electricity.

Similarly, Figure 5.4 shows the gap between actual and required output with output loss over the time period from 1991 to 2012 for small scale manufacturing sector. It also clearly shows that there is a difference in the projected growth output and the actual growth of output over the time period from 1972 to 2012 due to load shedding.

5.4 Quantifying the output loss

Next we find the output loss by subtracting the actual growth of output from estimated growth of output both for large scale manufacturing sector and small scale manufacturing sector over the time period from 1972 to 2012, as we have,

$$Y_{loss} = Y_{it}^{r\_g} - Y_{it}^{a\_g} \tag{5.6}$$

Equation (5.6) shows the loss of output due to cut of power to both sectors that of large scale and small scale manufacturing sector. Where $Y_{it}^{r\_g}$ is the required growth rate of output and $Y_{it}^{a\_g}$ is the actual growth rate of output for the time period from 1991 to 2012. Which can be seen in the below graph.

Figure 5.3 shows the estimated output loss of large scale manufacturing sector over time. On X-axis we have time period from 1991 to 2012 and on Y-axis we have output loss in the large scale manufacturing sector during this period. The graph clearly shows that over period of time there is increase in the output loss which means that production of large scale manufacturing sector is badly affected by the interruption of electricity supply.

Figure 5.4: Estimated output loss over time for large scale manufacturing sector

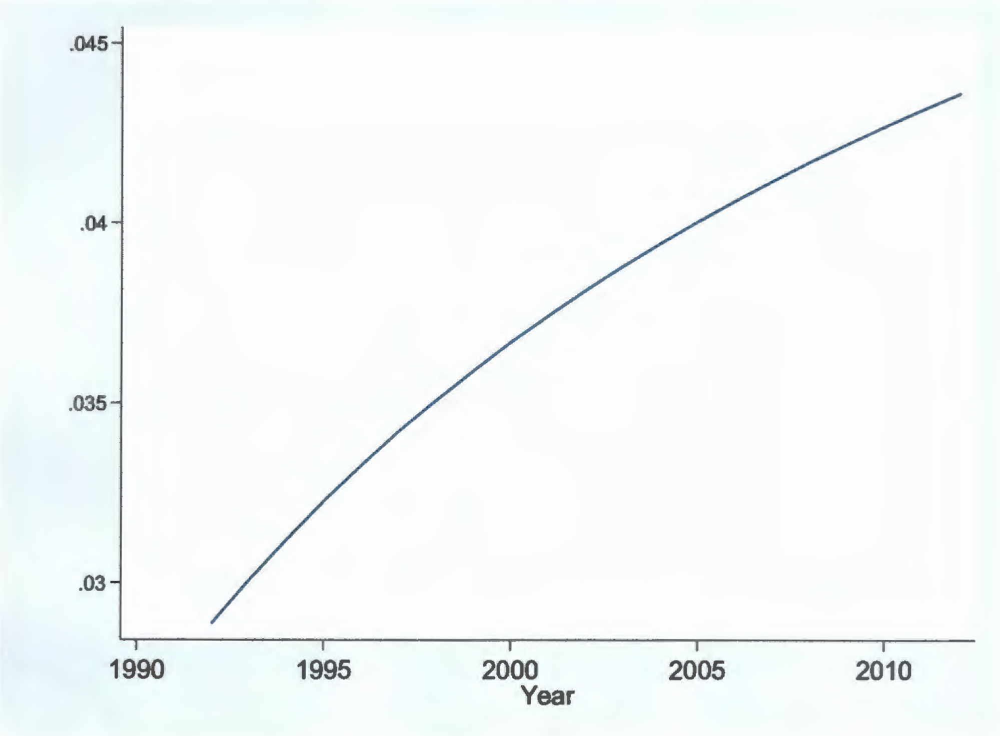

Figure 5.5: Estimated output loss over time for small scale manufacturing sector

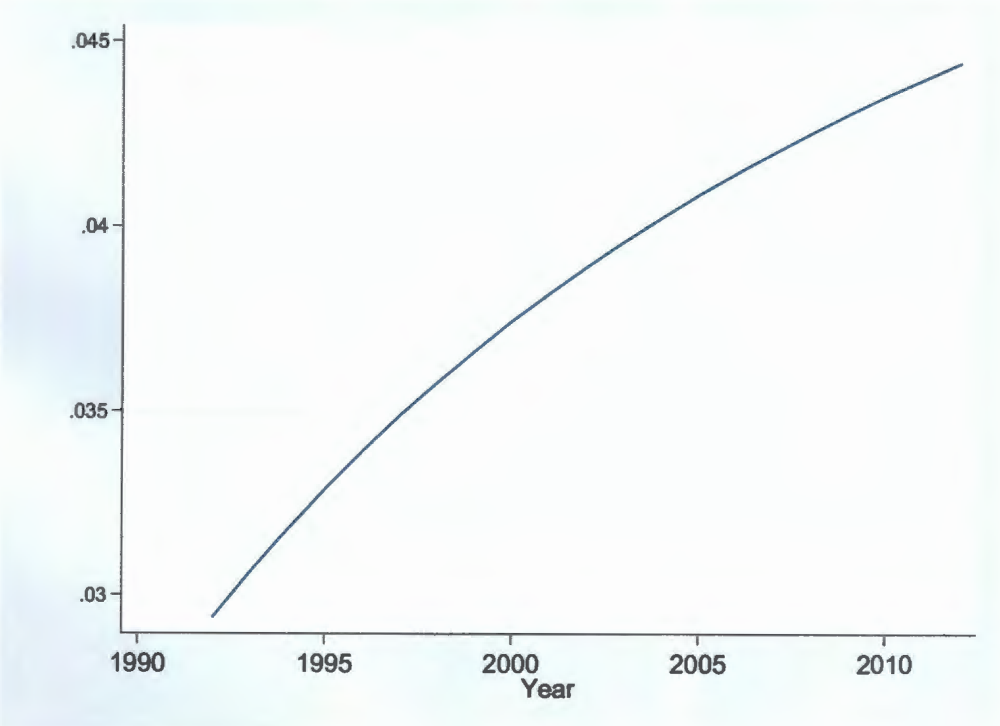

Figure 5.4 shows the estimated output loss of small scale manufacturing sector over time. On X-axis we have time period from 1991 to 2012 and on Y-axis we have output loss in the small scale manufacturing sector during this period. The graph shows that over period of time there is increase in the output loss which means that production of small scale manufacturing sector is also affected by the interruption of electricity supply.

Chapter-6

CONCLUSION AND POLICY RECOMMENDATIONS

Energy plays an important role in the development of any economy, while the shortage of energy is one of the main reasons of the downturn of the industrial sector of the country, particularly in the large scale manufacturing sector. As a result, plenty of small scale industries are shutting down and many of large scale industries are moving out of Pakistan. Regarding this issue, this study is about the relationship between the electricity consumption and the industrial production (output) and its impact on overall GDP.

The issue of electricity supply and demand is important not only for the economic prosperity of a country but also for the future because without electricity we cannot even live. From the above analysis, we can see that electricity is an important determinant of production at large and small scale manufacturing sector and economic growth as a whole. Therefore, its shortage can affect economic growth. However, in order to achieve economic growth rates, effective policies are required and these policies should not ignore the electricity as well as energy sector as a common. In order to improve availability of electricity and economic growth, alternative sources of electricity should be established. Based on the discussion above, we can outline following policy implications and areas for future research:

(1) The government have to construct big as well as small Dams for more generation of electricity. Because the use of electricity is increasing day by day while the supply is not increasing with that speed. The issue of load shedding should be taken on emergency basis and should not be politicize rather than work is needed.

(2) The alternatives for electricity like renewable and nonrenewable sources of energy, demand and supply of each component of energy, intensity and efficiency of energy use, availability of substitutes, pricing mechanism and balance of payment implications of energy use are important and the issue should be examined in detail.

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