Measuring Economic Cost of Electricity Shortage: Current Challenges and Future Prospects in Pakistan

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Abstract: The consistent energy supply is a big challenge for Pakistan. Pakistan's economy has been hit severely by energy crisis. The electricity shortfall rose to 6000 mega watts in 2013. This study visits the impact of electricity shortage on sectoral GDP such as agriculture, industrial and services sectors in case of Pakistan for the period of 1991-2013. The Ordinary Least Square (OLS) approach is applied for empirical analysis. Our estimates show that electricity shortage is inversely linked with agriculture sector output. Industrial sector output is negatively affected by electricity shortage. Electricity load-shedding deteriorates services sector output. The present study discusses current as well as future economic loss to be caused by electricity shortage. This study provides new insights for policy to devise a wide-ranging energy policy for sustainable agriculture sector, industrial sector and services sectors growth which not only enhances domestic output but will also speed up economic growth for better living standard for people of Pakistan.

Keywords: Electricity Shortage, Agriculture, Industry, Services, Pakistan

1. Introduction

Gross domestic product comprises of agriculture, industry and services sectors. These sectors are considered as the pillars of economic growth in Pakistan. In 2013-14, agriculture sector with 2.1% growth rate contributes to gross domestic product by 21.4% and agriculture sector provides employment to 43.7% of labor force over the same period (GoP, 2014). This sector is playing its key role in boosting economic activity. The industrial sector contributes to national gross domestic product by 20.8% while employing 13% of labor force in 2013-14 (GoP, 2014). Lastly, 53.3% of gross domestic product is contributed by services sector. This sector provides employment to 43% of labor force (GoP, 2014). Energy plays a significant role in stimulating economic activity like other inputs such as capital and labor. Electricity consumption is a major component of energy demand. Agriculture sector consumes electricity by 10% and electricity demand by industrial sector is 29% in 2013-14. Services sector consumes electricity by 61% during the same period of time (GoP, 2014).

In recent years, energy (electricity) crisis has become the hot issue in developing economies of the globe. Energy plays a vital role in economic growth process. Energy promotes economic activity and hence domestic output growth in an economy. Energy is considered as an important input like other inputs such as capital and labor in production function. The energy-growth nexus is well debated and empirically investigated but provides vague empirical findings and therefore is unable to facilitate the policy makers in formulating economic and energy policies to maintain long term economic development. Energy use plays a role of driver to wheel economic growth. Energy use not only promotes domestic output but also maintains living standard of nation via income effect.

The empirical evidence of energy-growth nexus supports four distinguished hypotheses. For example, domestic output is inversely affected by energy consumption. Many reasons can be coned for this unexpected outcome. For example, exogenous shocks, mismanagement of energy sources/natural resources, political will and poor quality infrastructure may affect energy use. In such a situation, a rise in economic growth may not positively impact energy use. This recommends for implementing the *energy-conservation* policies if the unidirectional causal relation exists running from economic growth to energy consumption. Similarly, if there is no causal relation between energy use and real GDP growth i.e. *neutral-hypothesis* then adoption of energy conservation policy will not have negative impact on economic growth and similar can be expected from opposite side. The *growth-hypothesis* reveals that energy use plays a significant role in enhancing domestic production and hence increases real GDP growth. In such a situation, policy making authorities should be careful in adopting energy conservation policies because it will affect not only domestic production but also economic growth. The bidirectional causal relation between energy consumption and economic growth is termed as the *feedback hypothesis*. This entails that a rise (fall) in energy demand (supply) will have positive (negative) effect on real GDP and similar outcome is expected from opposite side. Moreover, economic growth causes energy use and in resulting, energy consumption causes economic growth in Granger sense is which called bidirectional causal association between both variables. This recommends the consistent supply of energy for sustainable economic development in the long run. To support energy supply, government must adopt policies to explore alternative sources of energy.

Additionally, energy efficient technology should be encouraged during production process to maximize domestic production[1].

Now-a-days Pakistan is on hotlines regarding energy crisis, disturbing the economic activity and progress of the country. Services, industrial and agriculture production have been severely hit by power outage. According to estimates, power shortages have resulted in an annual loss of about 2 percent of GDP[2]. Aziz et al. (2010) quantify the prohibitive cost to the economy of energy shortages, and convincingly demonstrate how these shortages are impeding Pakistan's economic development. As a result of power shortages in the industrial sector alone, the loss to economy was over $3.8 billion in 2009—about 2.5 percent of gross domestic product (GDP). Half a million jobs and exports worth $1.3 billion were lost—and this is only a small part of the overall problem. Other estimates show that energy shortages have cost the country up to 4% of GDP over the past few years. Another recent study reports that total industrial output loss in range of 12-37 percent is due to power outages[3]. Siddiqui et al. (2011) have also forced the closure of hundreds of factories (including more than five hundred alone in the industrial hub city of Faisalabad), paralyzing production and exacerbating unemployment. The persistent shortage of electricity in the country has also triggered social unrest and the nation has been convulsed by energy riots[4]. Protestors, angered by unscheduled outages, have often resorted to violence. In 2012, a large mob emerging onto the streets of Lahore, Faisalabad and other major cities of the country, is demanding an end to the rampant load-shedding that has been plunging entire cities

[1]See Shahbaz et al. (2012) and Ozturk, (2010) for more details
[2]Abbasi, (2011)
[3]Siddiqui et al.(2011)
[4]Kugelman, (2013)

into darkness for over 12 hours a day and rural areas for 18–20 hours a day[5]. They blocked roads and attacked the offices of WAPDA, thus creating law and order problems in many urban centers in the country.

The present crisis started in 2006-07 with a gradual widening in the demand and supply gap of electricity. Since then this gap has widened with the assumed proportions which are considered to be the worst of all such power crises that Pakistan has faced since its inception. Within two years, by 2009, power outages went up to 30 percent. Since then, the situation has become even worse. The electric power deficit had crossed the level of 5000 MW at many points during the year of 2010-11. At one stage during the month of May, 2011, this shortfall had surpassed 7000 MW. Electricity shortfalls reached a peak of 8,500 megawatts (MW) in June 2012—more than 40% of national demand (Dawn, 2012). This widening demand supply gap has resulted in regular load shedding of eight to ten hours in urban areas and eighteen to twenty hours in rural areas (FODP, 2010).

Today, trade has been expanded not only in domestic markets but also in international markets. Spreading economic activities create intense competition among industries. Each country has aim to boost the economic activities and acquire high economic growth. Production may be increased by utilizing factors of production efficiently such as labor, capital. Besides, these two factors, energy is also key factor to determine the level of production, because industries hugely depend on electricity (energy) supply. In such a situation, acute shortage of electricity and high cost of electricity may hurt economic growth[6]. Following biophysical theory, mainstream and

[5]Munir and Salman, (2011)
[6]Udah,(2010)

resource economics models of growth indicated that, energy is one of the prime input to accelerate economic growth[7]. But in case of Pakistan, there is an acute shortage of electricity since last few years. Besides, that energy prices have been hiked during the same period which caused in declining contribution of industrial sector to GDP. In 2008, there is negative growth rate for electricity generation which reduces GDP growth and performances of the companies have also been decreased significantly for last few years[8].

Due to hike in energy crisis, few studies have investigated the economic cost of power outage. For example, USAID and Planning Commissions of Pakistan, estimated that due to power outage, Pakistan faced a loss up to 10 percent of GDP for the last five years. In 2011-12, 3-4 percent of GDP loss is noted by Planning Commission of Pakistan due to electricity shortage as well as gas crisis. Recently, Ghaus-Pasha (2013) estimated the industrial economic cost of power outages engaging Karachi, Lahore, Faisalabad and Sialkot target cities for their sample survey. They surveyed 65 industrial units located in sampled cities. The estimates exposed that Pakistan faced a loss of Rs 210 billion and USD$ 1 billion of exports earnings due to load-shedding in industrial sector. This power outages also displaced more than 400, 000 workers. This provides a space for further investigation of the economic cost of electricity outage in other sectors like agriculture and services sectors. Still these sectors consume almost same amount of electricity like industrial sector.

The present study is unique contribution in existing energy literature generally and particularly for Pakistan by three ways. Firstly, this study estimated the current loss caused by electricity

[7]Stern and Cleveland, (2004)
[8]Abdullah et al. (2013)

crisis by employing ordinary least square (OLS) method. Secondly, the future sectoral loss has been computed if electricity shortage sustains. Furthermore, socio-economic cost of electricity outage has also been discussed.

2. Review of Relevant Studies

For Pakistan, few studies have investigated the impact of energy supply on real GDP growth but provided contradictory empirical findings. For example, Aqeel and Butt (2001) probed the association between energy sources and gross domestic product. They reported that total energy and petroleum supply is cause of economic growth but electricity supply contributes to real GDP growth and resultantly, economic growth is stimulated. On similar grounds, Siddiqui (2004) claimed that energy plays a vital role in productivity growth model like other inputs such as capital and labor. Siddiqui investigated the impact of energy supply on domestic gross production and found that electricity and petroleum supply (electricity and petroleum shortages) affect real GDP growth positively (negatively). Later on, Shahbaz and Lean (2012) used production function to test the nexus between electricity use and economic growth. Their empirical evidence indicated that a 1 percent increase in electricity use, capital use and labor will increase real GDP by 0.31 percent, 0.11 percent and 0.29 percent respectively. This entails that electricity supply is playing a critical role in enhancing domestic production like other inputs such as capital and labor in Pakistan. Shahbaz et al. (2012) investigated the affectivity of renewable and non-renewable energy use on economic growth. They highlighted that both energy sources are important and have positive impact on economic growth. Their empirical exercise reported that a 1 percent reduction in renewable (non-renewable) energy will decline real GDP and hence economic growth by 0.09 (0.14) percent in long run. But in short run, real

GDP is lost by 0.07 (0.11) percent due to reduction in energy (renewable and non-renewable) supply[9]. Shahbaz and Feridun, (2012) noted that electricity demand is cause of economic growth and electricity supply does not seem to play its role in increasing economic growth. Liew et al. (2012) noted that agriculture growth is led by energy supply but energy supply seems not contributing in industrial and services growth. Although, industrial and services sectors contribute to gross domestic product significantly. Qazi et al. (2012) investigated the impact of disaggregated energy consumption on industrial growth. They found that energy conservation policies would be detrimental for industrial growth because energy (electricity, gas, oil and coal) supply increases industrial output and hence industrial growth.

Afzal, (2012) indicated the importance interest rate while investigating the effect of electricity crisis on textile industry. Author mentioned that a rise in interest rate adversely hits the performance of industrial sector more than electricity crisis. The estimates reveal that impact of electricity crisis and interest rate on industrial productivity is 612.953 and 27.43 million square meters. Zeshan, (2013) probed the relationship between energy generation and economic growth (proxies by private business investment). The empirical results showed the positive impact of energy supply on economic growth. This entails that a 1 percent reduction in energy generation will lower private business investment and hence economic growth by 1.58 percent in the long run and 0.51 percent in the short run by keeping other things constant. In comparative study, Abbas and Choudhury (2013) used aggregated and disaggregated time series data to test the validation of energy-growth nexus in Pakistan and India. They reported that in Pakistan, electricity demand and economic growth are interdependent i.e. electricity use causes real GDP growth and in resultantly, real GDP growth causes electricity use in Granger sense. Furthermore,

[9] Capital and labor have also contributed to domestic production positively.

electricity use in agricultural sector is cause of agricultural growth. Tang and Shahbaz, (2013) used sectoral level data to analyze the relationship between electricity use and real GDP by employing the TYDL Granger causality test. They found that manufacturing growth causes electricity consumption growth and similar is true from opposite side. Services sector growth has causal impact on electricity use in services sector and the neutral effect is noted in agricultural growth and electricity use. The causality analysis does not help policy makers in formulating consistent energy and economic policies for sustainable economic growth. Khurshid and Anwar, (2013) investigated the industrial cost of energy outage using data of KSE listed companies. They noted that a hike in energy crisis severely affected the performance of textile and cement industries in Pakistan. Textile and cement industries add in GDP via contributing exports. Energy crisis affected sugar and chemical sectors but its impact is minimal. Yildirm et al. (2014) scrutinized the impact of energy (electricity) consumption on real GDP growth in next 11 countries including Pakistan. In case of Pakistan, they noted that reduction in energy supply will decline real GDP i.e. a 1 percent decline in energy supply lowers real GDP by 0.610 percent if else is remain same. Naz and Ahmad, (2013) applied logit-model to estimate impact of power outage on urban households in Sindh. They noted that rich households are less affected from power outage compared to poor households. Rich households make alternative arrangements of power supply but poor households are handicapped due to less financial resources[10].

Agile

In case of Sri Lanka, Morimoto and Hope (2004) tested the contribution of electricity supply in gross domestic product. Using cost-benefit analysis, they noted that electricity supply has

[10] Kessides, (2013) indicated that current electricity crisis in Pakistan is due to political failures as well as institutional inefficiency. He suggested that radical decentralization is key option to overcome the electricity outage in Pakistan. Ansar et al. (2014) argued that electricity crisis can be overcomed by building in new dams for consistent supply of hydropower on priority basis.

positive impact on gross domestic product. They exposed that a 1 mega unit decline in electricity supply will reduce gross domestic production by 38 200 LKR[11]. Mozumder and Marathe, (2007) examined the direction of casual association between electricity supply and domestic output growth in a developing economy like Bangladesh. Their estimates showed that electricity supply does not play its role in enhancing domestic output growth and domestic output growth causes electricity supply growth. On contrary, Paul and Uddin, (2011) engaged Bangladesh data to examine how much energy shock affects output shocks. They noted that output growth in Bangladesh is energy dependent and reduction in energy supply will not only decline domestic out but also impede economic growth in the long-run. In US economy, Hatemi-J and Uddin (2012) tested the causality between energy supply and economic growth by employing bootstrap causality test. Their findings indicate the importance of energy supply for production process and noted that energy supply shocks impact adds in real GDP growth and vice versa. Filiz et al. (2012) applied the production function to test the effect of energy supply. They noted that reduction in energy supply impedes domestic production and causality is running energy supply to domestic production. Chen et al. (2013) investigated how much electricity outage hampers economic growth in case of China utilizing pre and post reforms' period. Their results indicated that a 1% decline in energy supply will lower GDP growth by 0.6% if other things remain same and the unidirectional causality is found running from electricity supply to GDP growth. For Hong Kong economy, Woo et al. (2014) estimated the residential cost of power outages by applying logit-ordered regression. They reported that an increase in power outages increases the residential cost of households. Qasim and Kotani (2014) empirically investigated the electricity shortage in Pakistan. They noted that consumer's energy demand is affected by energy prices and underutilization of power plants encourages for fossil fuel consumption to maintain the

[11]Sri Lankan Rupee

consistent supply of electricity. Their analysis indicated that growth in income per capita is main driver of electricity demand in Pakistan.

Recently, Shahbaz (2015) examined the linkages between electricity use and economic growth in Pakistan and found that electricity consumption experts positive effect on economic growth. Reza et al. (2015) also explored the relationship between energy consumption, trade and economic growth. They noted that energy use spurs trade which in resulting positively affects economic growth in Pakistan.

3. Research Hypothesis

i. Electricity crisis significantly impacts agriculture value-added to GDP

ii. Electricity crisis significantly affects industrial value-added to GDP

iii. Electricity crisis has significant effect on services value-added to GDP

4. Methods and Data

There are many studies available in energy economic literature investigating the relationship between energy (electricity) supply and economic growth but empirical literature on energy (electricity) crisis and economic growth is very scarce. The prime objective of this paper is to examine the impact of electricity crisis on economic growth at sectoral level. For this purpose, we employ production function to test the relationship between electricity shortage and economic growth. We have added capital and labor as additional determinants of domestic production that contribute to economic growth. The general form of production function is constructed as following:

$$Y = AE^{\alpha_1} K^{\alpha_2} L^{\alpha_3} \mu_i \quad (1)$$

where, Y is domestic production, E is electricity shortage (kWh)[12], K is capital use and labor is indicated by L. A is technology and μ_i is residual term. We have transformed all the variables into per capita units but keeping the impact of labor on real domestic output constant[13]. The empirical equation of production function after taking log is modeled as following:

$$\ln Y_t = \beta_1 + \beta_2 \ln EC_t + \beta_3 \ln K_t + \mu_t \quad (2)$$

where, $\ln Y_t$ is log of real GDP at sectoral level i.e. agriculture, industrial, services sectors. $\ln EC_t$ is log of electricity shortage, $\ln K_t$ is log of capital use in agriculture, industrial and services sectors and μ_t is normal distributed residual term.

For empirical analysis, we utilize economic survey of Pakistan (various issues) to collect data for real GDP contribution by agriculture sector, industrial sector and services sector. The data on capital use has also been collected from economic survey of Pakistan (various issues). Pakistan energy statistical year book will be combed to obtain data on reduction in electricity supply for each sector. The present study uses time period of 1991-2013.

5. Results and Discussion

[12] Electricity Shortage (MW) = Peak Power Demand (MW) - Installed Generation Capacity (MW)
[13] For more details see Shahbaz et al. (2013)

We have applied the Ordinary Least Squares (OLS) method to estimate the elasticities. We find that agriculture gross domestic production is affected both by electricity shortage and capitalization. The impact of electricity shortage on agriculture output is negative and significant at 1% level. A 0.169% of agriculture output is reduced by 1% increase in electricity shortage by keeping other things same. The link between capitalization and agriculture output is positive and significant at 1% level. A 1% increase in capitalization leads agriculture output by 0.146%.

Agriculture sector

$$\ln Y = 7.007 - 0.169 \ln E + 0.146 \ln K$$

(26.553) (-3.302) (3.063)[14]

$\mathbf{R^2} = 0.5977$ $\mathbf{Adj.R^2} = 0.5977$

Industrial Sector

$$\ln Y = 3.543 - 0.707 \ln E + 0.272 \ln K$$

(11.200) (-6.015) (3.176)

$\mathbf{R^2} = 0.8721$ $\mathbf{Adj.R^2} = 0.8654$

Services Sector

$$\ln Y = 7.792 - 0.321 \ln E + 0.027 \ln K$$

(38.142) (-13.832) (3.156)

$\mathbf{R^2} = 0.8398$ $\mathbf{Adj.R^2} = 0.8312$

[14] All the variables are statistically significant at 1% level.

The estimates show that electricity shortage affects industrial sector inversely. This relationship between electricity shortage and industrial out is statistically significant at 1%. A 0.707% of industrial output is decreased by 1% increase in electricity shortage. Capital is positively and significantly related with industrial output. A 0.272% of industrial sector output is led by 1% increase in capital use. Lastly, electricity shortage is inversely and significantly related with services sector output. A 0.321% of services sector output is declined due to 1% increase in electricity shortage. Capital has positive and significant effect on services sector output. A 1% increase in capital increases services sector output by 0.027%. The coefficient of R^2 shows that models are well explained by independent variables.

[Insert Table-1 here]

Our estimate shows that agriculture, industrial and services sectors loss is PRS 27.11 billion, PRS 104.49 billion and PRS 110.62 billion respectively (see Table-1). A PRS 242 billion of GDP (agriculture, industry and services sector) is loss caused by electricity shortage in 2013. We note that electricity shortage declines agriculture output less compared to industrial and services sectors' loss. In Pakistan, almost 75% of land is irrigated by canal system[15] and electricity shortage could not affect the productivity of agriculture sector severely. After 2011, electricity shortage hits services sector more compared to industry. In Pakistan, electricity crisis impeded the supply of social services i.e. education and health, supply and purification of water, sanitation and refrigeration of essential medicines (Khan et al. 2012). Over the period of 1992-2014, average interest rate in Pakistan is 12.55%. This rise in interest rate affected the trust of investors which further lowered down investment activities. In such situation, demand for financial

[15] See for more details http://www.bookhut.net/canal-system-of-pakistan/

services have been affected which further declined the financial sector's growth and hence financial development. Furthermore, electricity crisis inversely hits tourism sector, restaurant business as well as insurance sector (Siyal et al. 2014). Ghaus-Pasha, (2009) investigated the economic cost of electricity shortage following survey-based study and reported that in 2009, national loss caused by power outage was PRS 210 billion but over the same period, our estimate show that economic loss due to electricity shortage was PRS 214 billion. The difference in estimates may be due to use of econometric approaches[16]. This ensures the stability and reliability of our empirical analysis in investigating the economic loss caused by electricity crisis.

The government has been trying to overcome the issue of electricity shortage by overhauling the existing and running power projects to enhance their generating capacity since the takeover. Moreover, government is also launching new power projects to reduce the supply-demand gap and hence to control the giant of electricity load-shedding. Recently, government has signed new power projects with China, Norway and Asian Development Bank. The projects such as Jamshoro Coal Power Project, Grange Holding Group Power Plant, Star Power Project, KE Coal Power Plant, Sindh Engro Thar Coal Power Project, Sahiwal Coal Power Project and Port Qasim Coal Power Project are at various stages of implementation. The proposed power projects are Kandra Power Project, Gadani Energy Park, Gadani Coal Power Plant and Thar Coal Power Plant. A successful completion of mentioned projects will help Pakistan to overcome the issue of electricity load-shedding for achieving sustainable development and better living standard of people in future. Otherwise, agriculture loss would be increased to PRS 90.75 billion (almost 235%) and industrial loss would be jumped to PRS 146.90 billion with 41% growth in 2050. Over the same period, loss in services sector would be caused by electricity outage is PRS

[16] We observe that residual can be ignorable i.e. PRS 4 billion.

236.46 billion i.e. 114%. In South Asian region, annual population growth in Pakistan is considered higher compared to her competitors such India, Bangladesh, Sri Lanka, Nepal etc. Pakistan's population growth rate is 1.6% while India (Bangladesh) has 1.2% (1.2%) population growth rate in 2013. This higher population growth will further increase electricity demand. In 2050, Pakistan will be the 4th largest country in the world and population would be 309 million after USA with 349 million over the same period. The government must also consider population growth while designing energy policy in achieving sustainable economic growth.

6. Socio-Political Cost of Power Outage

Power outage such as electricity crisis accompanied with gas crisis affects economic activity. For example, the hike in energy crisis affected industrial sector of Pakistan adversely. Various textile mills had failed to run their exports operations due to sever electricity and gas crises. In international market, Pakistan failed to compete with their trading partners because China, Vietnam and Bangladesh have better infrastructural facilities and low cost of production due to availability of inputs at cheaper rates. The massive power outage also made it difficult for Pakistani exporters to maintain orders in time which lowered the demand for Pakistani products in international market since the European and Latin American importers believe on "just in time". The persistent rise in energy demand-supply gap leads inflation which increases the cost of production. In such a situation, Pakistani manufacturers face difficulty to cover their cost of production due to high competition in international market. India, China and Bangladesh produce same products at cheaper rates to their trading partners such as Europe and Latin American countries. European retailers manufacture their products at cheaper rates in Bangladesh and Vietnam and meet their order deadlines. This led the Pakistani textile mills' owners to focus on

local markets where almost 30 million people are available as potential consumers for their products. In 2013-14, growth in exports of textile sector is restricted to 3.9% but textile sector's exports growth increased to 18% to European countries but rest of world paid less attention to Pakistani products (textile sector) and negative textile exports growth is noticed i.e. -3.5%. There are various reasons for sluggish progress in textile sector of Pakistan such as insufficient financial resources, poor economic performance, high competition in regional as well as in global markets and sever power outage.

Energy crisis also increased unemployment in Pakistan[17]. Just in textile sector almost 500, 000 workers have been unemployed for last few years due to factories shut down or sluggish business sourced by power outage. More than 400 and 600 factories have been closed in Lahore and Faisalabad but situation in Karachi may not be hopeful. On similar grounds, Payne (2009) exposed that reduction in energy supply impedes economic activity and hence lowers domestic output which resultantly reduces employment opportunities and unemployment is increased. He noted that unemployment is cause of reduction in energy supply in Illinois (USA). Energy crisis adversely impacts total factor productivity. Total factor production is mixture of technological advancements in production as well as efficiency and improvements in managerial skills. Total factor productivity is key concept of the growth accounting framework i.e. production function developed by Solow (1956, 1957). Technological advancements in energy sector such energy efficient technology declines energy intensity and enhances the domestic total factors production at optimal level which in resulting increases total factor productivity. For example, Hisnanick and Kymn (1992) noted that energy supply accompanied with energy efficient technology is major reason of growth in total factor productivity for US manufacturing sector. Technological

[17]The correlation between unemployment and electricity shortage is 0.80

advancement in energy sector improves energy efficiency which increases the productivity and hence total factor productivity is increased. For example, Adenikinju (1998) reported that efficient energy use has positive effect on productivity of Nigerian manufacturing sector. Boyd and Pang (2000) exposed that improvements in energy efficiency is cause of total factor productivity. Energy crisis impedes total factor productivity via lowering research & development activities in energy sector. In case of Pakistan, energy intensity is declining due to improvements in energy efficient technology[18] but India and China have been implementing more advanced energy efficient technology to enhance domestic production. Comparatively, total factor productivity in Pakistan (due to hike in power outage) is not encouraging compared to India and China. As discussed above, how power outage affected performance of textile sector and failed Pakistani exports to meet their order on time. We may say that power outage in Pakistan not only affected the trade performance of textile sector but also lowered its productivity.

Pakistan is an agrarian country and more than 60 percent of her population is settled in village areas. More than 90 percent portion of rural population is directly and indirectly involved with agriculture economy. In agriculture sector, agriculture machinery such as tube wells as well as pesticides and fertilizers production consume energy. In such situation, reduction in energy supply impedes agricultural activity and resultantly, agriculture productivity is declined. This contributed to rural unemployment. An increased unemployment contributed to increase in poverty in rural areas. In such situation, rural population migrated to major hubs of country for employment opportunities. This further increased urban unemployment and mostly migrated people involved in begging and criminal activities which in result increased urban poverty.

[18]See for details Shahbaz and Lean, (2012)

Similarly, productivity decline caused by power outage in industrial and services sectors also increased urban unemployment and in resulting urban poverty is increased that also impedes income inequality in the country (The correlation between urban poverty and electricity shortage is 0.70)[19]. It concludes that energy crisis hit economic activity raises unemployment which deteriorates income inequality and increases poverty (The correlation between overall poverty and electricity shortage is 0.63). For example, Poveda and Martinez (2011) argued that poverty reduction depends upon the performance of macreconomy and economic activity is based on energy supply. They exposed that energy supply declines poverty by boosting economic activity that stimulates industrialization which generates new employment opportunities and hence poverty is decreased in Columbian economy. The agriculture sector is considered as backbone of industrial and services sectors. This not only produces raw material for industrial sector but also supplies food to both industrial and services sectors. The decline in agriculture productivity due to energy crisis raised the problem of food crisis in the country.

Electricity crisis adversely affected investment in textile sector. Many Pakistani exporters budged their business from Pakistan to Bangladesh for last five years. It is noted that almost 40% of textile industry moved to Bangladesh which affected almost 60, 000 (200, 000) families in Southern Punjab (Punjab) who were directly and indirectly linked with power looms business. Bangladesh has also been facing energy crisis but Bangladeshi government is managing energy crisis with the help of big economic powers like the Europe and United States. Foreign investors prefer Bangladesh for investment in productive investment projects. The availability of cheaper and skill labor, favorable political climate, social stability, required infrastructure and supply of electricity to textile sector is playing a key role in attracting foreign investment in Bangladesh.

[19]Rural poverty is positively correlated with electricity shortage by 0.57.

The Europe and United States are helping Bangladesh economy to provide mentioned facilities to foreign investors as well as local investors to develop textile sector in Bangladesh. In Pakistan, wages are 30-40 percent higher than Bangladesh and labor force is not highly skilled and efficient compared to Bangladesh. Furthermore, political violence, bad governance, Talban uprising, consistent electricity and gas shortages to textile sector hampers the trust of foreign investors to step in Pakistan. This shows that electricity outage adversely hit textile exports in Pakistan and exports restricted to $ 13.1 billion in 2013 but in Bangladesh, India, China, Sri Lanka textile sector's exports rose to $21.5, $40, $127 and $4.3 billion over same period[20].

Energy demand is increasing day by day due to increase in population growth, urbanization and growth in commercial activities. In such situation, energy crisis affects cost-push inflation. The reason is that in Pakistan, electricity is the main input of production to run any plant in the country. This increased cost-push inflation further pressurizes consumer prices and overall inflation is increased (The correlation between inflation and electricity shortage is 0.89). For last few years, Pakistan is facing double-digit inflation which is an indication of social and economic instability in the country. Inflation accompanied with persistent rise in unemployment increased economic misery in Pakistan[21]. Economic misery reached to 1600% in 2012-13 which is still going to high due to increased inflation and unemployment rates caused by energy crisis. Further, economic misery impedes life expectancy in the country.

Finally, energy crisis is also a source of political instability. In recent election, Pakistan Peoples' Party (PPP) clean swiped and Pakistan Muslim League (N) is still trying to overcome the

[20] Sri Lankan government targets to increase textile sector's exports to $10 billion in 2016.
[21]Economic misery is combination of inflation and unemployment rates.

problem of energy crisis[22]. The shutdown of industries and consistent failure to overcome the problem of load-shedding forced the people for protests and public riots. This has increased frustration and people destroy the public property that has led to poor law & order condition in the country. This poor law & order condition discouraged the local and foreign investors for investing in energy sector of Pakistan. Energy crisis affected economic activity of Pakistan which increased inflation and unemployment jointly. This has led unrest and frustration among the mass which in resulting, confrontation against government has reached to enormous level. In such situation, political stability may be a dream as one can see that political situation of Pakistan is not hopeful due to persistent power outage now-a-days.

7. Conclusions and Policy Options

The present study examined the effect of electricity shortage on sectoral economic growth using Pakistani time series data over the period of 1991-2013. In doing so, we have employed the ordinary least square approach. We find that electricity shortage is inversely related with agriculture sector growth, industrial sector growth and services sector growth. Agriculture sector is low victim of electricity shortage but power outage affects services sector productivity severely after 2011. Industrial sector is highly affected by electricity shortage instead of services sector. We conclude that overall electricity shortage is harmful for gross domestic product and hence for economic growth.

Measuring the economic cost of energy crisis at sectoral level enables the policymakers to formulate a wide-ranging energy and economic (sectoral level) policies to promote not only sectoral GDP but also aggregate output. To support the sectoral growth as well as aggregate

[22] They know they would be treated like PPP if the energy crisis is not solved.

GDP, the cheapest option to produce electricity should be utilized. The hydel is the cheapest source of electricity production but it is a long term project. So, government must build new but small dams on priority basis to cover power outage. The cost of these dams can be covered by reducing the unnecessary administrative expenditures (expenditures on ministers' protocol, government lavish functions etc.). Domestic finances can be generated by the implementation of equitable taxes and allocated finance via taxes to electricity generation projects. The financial and infrastructural incentives should be announced and provided to attract investment by local and foreign sources. Furthermore, energy efficient technology should be adopted to help in handling the issue of power outage.

Furthermore, unnecessary energy usage should be discouraged and adoption of electricity saving devices and electricity saving responsiveness must be encouraged at household level via strong television campaign. Pakistan should develop strong public transport system to reduce the unnecessary transportation. In doing so, Pakistan railway should be strengthened on priority basis. To control electricity prices, government should not depend on rental power projects. In doing so, new sources of energy should be explored as Pakistan is full of natural resources. For example, Pakistan is 4^{th} economy in the world which has the largest coal reserves. The government should convert coal into natural gas via adopting apposite technology. Pakistan should follow German's strategy adopted in 1920s to convert coal into low-polluting liquid fuel by implementing Fischer-Tropsch Technology. The Fischer-Tropsch Technology has also been adopted by various firms working in Pennsylvania and Montanato convert coal into low-polluting liquid fuel. By adopting Fischer-Tropsch Technology, Pakistan can save huge amount of foreign reserves spending on oil imports (Kumar and Shahbaz, 2012). This will not only be

helpful in reducing the energy demand-supply gap but also enhances domestic production by spending foreign reserves on importing advanced and energy efficient technology from developed countries.

The failure to manage energy crisis has led to increased load shedding in recent times affecting business activity in general and manufacturing in particular. The crisis has also affected agriculture sector, the most populous economic segment of the country, by raising the cost of irrigation. The current energy crisis has impacted all segments of the economy and country alike. In the wake of this situation short term measures planned and executed by some individual ministries will not succeed in comprehensively addressing the problem. The need of the hour is a well-researched multi-pronged approach formulated in conjunction with federal and provincial governments, relevant ministries, national power generation and distribution companies and the experts on traditional and alternate energy sources. This kind of mechanism will ensure that the capabilities and shortcomings of existing system are fully comprehended and future endeavors are based on a long term vision considering the country's growth requirements and technological developments in energy sector.

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Table-1: Economic Cost of Electricity Shortage

Years	Agriculture Sector Loss	Industrial Sector Loss	Services Sector Loss
	PKR in Billions	PKR in Billions	PKR in Billions
1991	11.96	39.25	41.39
1992	11.87	41.19	43.32
1993	12.61	42.78	45.16
1994	14.57	44.59	47.34
1995	14.96	46.71	49.71
1996	17.84	46.57	51.52
1997	15.77	49.42	52.37
1998	18.54	51.85	54.99
1999	13.89	52.51	57.27
2000	14.39	53.81	59.82
2001	15.36	56.69	62.41
2002	14.72	59.78	65.74
2003	15.07	62.59	65.74
2004	18.81	70.09	69.68
2005	16.10	88.50	80.42
2006	15.20	96.37	86.09
2007	16.71	97.81	91.27
2008	16.51	96.02	92.76
2009	16.27	100.77	97.02

2010	24.27	100.52	100.28
2011	20.80	101.57	103.63
2012	25.11	102.61	106.95
2013	27.11	104.49	110.62
Electricity Shortage and Future Loss			
2015	29.82	106.38	117.33
2020	38.52	112.17	134.33
2025	47.23	117.96	151.35
2030	55.93	123.75	168.37
2035	64.64	129.53	185.39
2040	73.34	135.32	202.42
2045	82.05	141.11	219.44
2050	90.75	146.90	236.46