Energy Technologies and Environment
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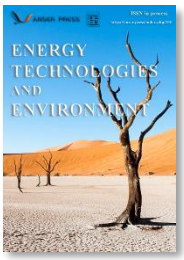

Pakistan's Energy Dilemma and Its Consequences on Economic Growth

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ABSTRACT

Technological advancements in the last few decades have created energy and cost-efficient power plants, but it is not a prominent feature in the electricity supply-chain. While many long-term and short-term energy alternatives are available, Pakistan still has a significant number of people who do not have access to electricity; as there are many areas that are neither connected to the national grid nor the provincial grids. This paper aims to find the reasons behind the energy crisis in Pakistan, keeping Islamabad as the focus of study, and to find the effect of use of renewable resources on the reduction of shortage of electricity. We will be focusing on the facts that how energy crisis has been affecting the economic growth of the country. Our data collection will be based on primary sources and secondary sources along with which we will be conducting pilot study to check the feasibility of using the solar energy as an alternative form of electricity.

KEYWORDS

Economic Growth; Energy shortage; renewable energy; Solar Energy

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ISSN 2972-4899
doi: 10.58567/ete01010003

Received 6 March 2023; Accepted 30 June 2023; Available online 15 July 2023

1. Introduction

Pakistan having a prime strategic position in south Asia, exceeding a total population of 0.212 billion people is considered to be one of the fast-growing populations, despite of having limited energy resources. Moving towards the electricity distributors, Pakistan has two major power suppliers, WAPDA and KESC operating mainly apart from which 42 independent power plants are operating too (Survey, 2006-2007)[1].

Electricity is one the most important component for the life of any economy and an important tool for any country's socioeconomic progress. Energy is fundamental in running the machinery in industrial and manufacturing units, for lighting up the cities and powering different means of transportation. Electricity lies at the core of monetary security, as energy is the pre-essential to create any financial movement. Along these lines' vitality is a major determinant of advancement and development of an economy particularly if there should arise an occurrence of creating nations. It implies adequate, solid, moderate and supportable supplies of regular assets for the cutting edge worldwide economy. Due to absence of union among different offices and services of the administration overseeing electricity segment, the energy resources need of the nation have never been examined from one point of convergence to define an incorporated arrangement with conferences from all sub-areas. Each sub-part has been seeking after its free strategies to meet the prerequisites which brought about an unbalanced blend with tremendous imports and absence of decent variety. According to one estimate power shortages have resulted in an annual loss of about 2 percent of GDP (Abassi, 2011).1Another recent study reports total industrial output loss in the range of 12 percent to 37 percent due to power outages [Siddiqui, et al. (2011)]. It has truly become a mess for fiscal managers to provide adequate energy in limited resources. The major portion of revenue generated is floated for the subsidies provided to the power sectors. As a matter of fact, around 7.6% of the revenues generated are used up for this during the fiscal period 2007-08, whereas these figures rose to 8.6% in the FY 2009(Malik A. , 2012)[2].

An energy dilemma can be defined internationally as a significant bottleneck supply of energy resources to the economy. In popular literature, it often refers to one of the energy sources used at a certain time and place, in particular those that supply national electricity grids or those used as fuel in vehicles (Klare T., 17 May 2001)[3].

In Pakistan energy crisis or energy dilemma is defined as "the energy scarcities that are shambling the economy and contributing to unrest. Thus, this impasse is slowing down the pace of economic prosperity and crafting turmoil in the public due to the prolonged shortages of electricity and gas"(H. Kazmi, 2013)[4].

This report is an exploratory study regarding the fruition of the concept of energy crisis in Pakistan by analyzing through the data provided to us by the World Data Bank. It explores the linkages between the energy crisis and the economic growth of the country. It will also trace the shortcomings that lead to the problem, and analyzing the wrong policies of the govt of the Pakistan which created such factors that are functioning over the last decade and have now clued to serious energy crisis. Through a detailed analysis this report will be studying the remedies for the problem by introducing the use of renewable energy resources mainly solar energy and by conducting the pilot study we will be able to provide the feasibility of using solar energy and the ease in implementing it.

The motivation behind the research is:

To examine the effects of limited electricity supply to urban and rural consumers.

to detect the correlation between electricity supply and the economic growth of country

to check the feasibility of using solar energy

[1] For more see Abbasi, Z. (2011) Energy Crisis Costs 2 Percent of GDP Annually. Business Recorder, July 07.

[2] For more information see, Power Crisis in Pakistan: A crisis in Governance, Afia Malik, 2012.

[3] For more information see, Resource Wars: The New Landscape of Global Conflict by Michael Klare.

[4] For more information see, Shabbir H. Kazmi, Pakistan's Energy Crisis, The Diplomat, 2013.

The objective of the study is to secure supply of electricity by discovering such methods that will harness it through the non-conventional energy sources. The exploitation of non-conventional energy, mainly the solar energy, will not only help in meeting electricity demands but also help in the economic development and prosperity of the country.

2. Background

The country of Pakistan after its independence in 1947 started with a 60kWh of energy which took impetus in 1970's. From an installed capacity of 636MW in 1970 to a total of 9094 MW in 1990-91. However the performance of the two public sector utilities in 1980's was satisfactory as they were trying to overcome the increasing needs. But the pace with which the development was done in the energy sector could not be carried along as the demand kept on increasing as far as 9-10% per annum.

After an adequate progression of around 4 percent per annum in the 1990s, the growth in the demand for electricity during the first seven years of 2000s was around 7 percent per annum. The electricity demands kept on increasing from 3 to 4 percent annually in 2003-04. It amplified in following years and stretched up to 10 percent in 2007- 08. This increase in demand of electricity was considered as to be the increase or growth in the economy of Pakistan. It was thought that the increase in demand will lead to considerable investment and speculation to maintain steadiness of resources. But the things didn't happen the way they were thought to be... But through statistical measures it has been seen that for the growth of 8 percent in electricity demand only 2 percent of GDP rose (Lynch, 2007)[5].

Regardless of the efficacy or efficiency of processes, demand of electricity is increasing day by day. Electricity is actively replacing other sources of energy e.g. gasoline for cars, natural gaze for home use etc., due to the technological advancement and thus forcing a surge in demand for the future. Along the macro shift in industry preferences over other forms of energy, more and more industries are experiencing digitalization; and all digital machines run on electricity, which again fuels an increase in demand for electricity. While the above mentioned reasons broaden the base of demand for electricity, increasing efficiency of industrial and manufacturing units mean increase in the consumption of electricity.

This illustrates an extremely important disparity between electricity demand and supply. Going forward this efficiency of supply and demand will be acting as a driver of growth in the energy demand and will be adversely affecting the economic growth.

The shortfall between energy supply and energy consumption can be seen from the fact that Pakistan's energy sector has to produce 15,000 to 20,000 MW of electricity per day whereas it only produces a total of 11,500 MW energy per day thus with a massive shortfall of 4000 to 5000 MW a day which is badly obstructing economy.

2.1. Causes of Energy Crisis

There are numerous causes that lead to serious electricity crisis in Pakistan. Lack of incorporated policy implementation is one of the most serious issue in Pakistan. Due to such reason no proper power plants are installed to overcome the shortfall. Apart from policy failures following factors can be seriously taken into account:

1. significant increase in the plea of electricity.
2. Amassed population which is unable to be controlled.
3. Industrial growth.

[5] For more information see, Merril Lynch (2007) cited from Energy Sector Assessment for USAID Pakistan prepared by Gordon Weynand, Energyteam , Bureau for Economic Growth, Agriculture and Trade, United States Agency for International Development, June 2007.

4. Imbalance electricity division.
5. Non-utilization of natural resources.

2.2. Effects of Energy Crises

Apart from lack of economic growth electricity has affected the following sectors also.

2.2.1. Agriculture Sector

The output of agriculture sector is decreasing day by day due to non-availability of electricity which is essential in running tube-wells, agricultural machinery and obviously for producing pesticides and other chemical ingredients.

2.2.2. Industrial Sector

There is a major shutdown of industrial units in both rural and urban areas of Pakistan due to the electricity scarcity. This has also reduced the investments by the private investors. Manufacturing units have been closing due to the fact that because of the absence of electricity the plants will not be working and thus there will be no production.

2.2.3. Unemployment

With the closure of production and industrial units new job opportunities have come to an end and people who used to work in these units have started to lose their jobs.

2.2.4. Poverty

Due to reduction in economic growth, there is an increase in the poverty. About 40% of population of Pakistan is living below the poverty line.

2.3. The Situation In Pakistan

For a country like Pakistan where population has exceeded 200 million provision of adequate energy has become a severe problem. It has been observed that energy production for the past few years has seen a major dip, but a steep incline in the production of electronics is putting a stress on the compensation between the two. The energy shortfall is posing a serious threat to the sustainability of the country, which has been pointed out by many past governments and legislations but the utmost dismay no major work has been done to revive this sector.

Even if the electricity shortfalls which range between 2500MW to 7000MW during the year are bridged, there is still a significant segment of the Pakistani population which will not have electricity available to them for use.

2.3.1. Electricity consumption (2015-2016)

Table 1. Electricity Consumption in Pakistan (Authority, 2015)[6].

Electricity consumption	*90.36TWh*
Electricity import	49%
Electricity consumption per capita	970kWh per capita

[6] For more information see "State of Industry Report 2015" (PDF). National Electric Power Regulatory Authority (NEPRA). National Electric Power Regulatory Authority (NEPRA). Retrieved 6 February 2017.

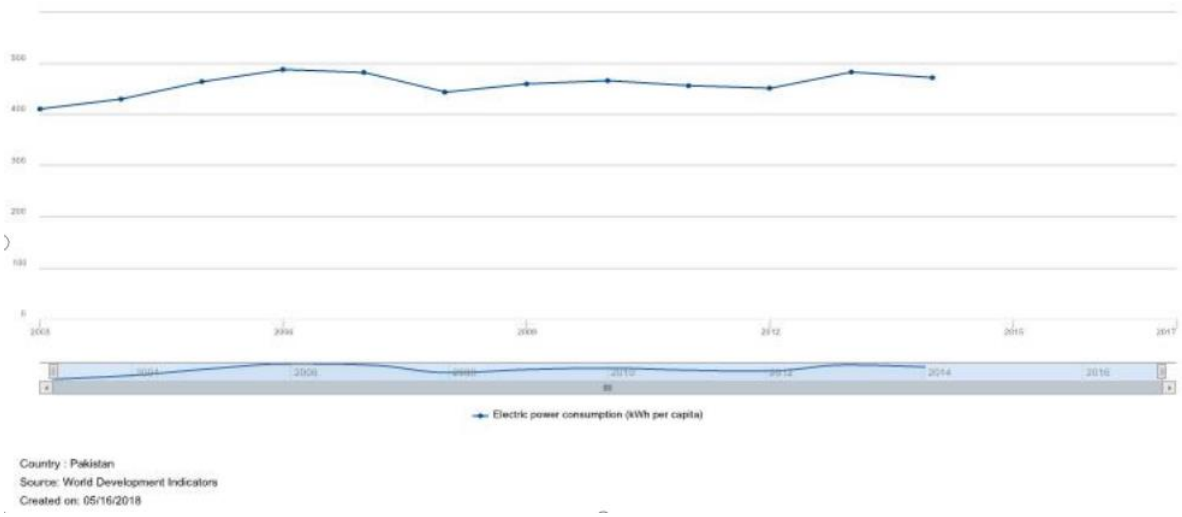

Figure 1. Electric Power Consumption (kWh per capita) in Pakistan (Bank, 2018).

2.3.2. Electricity generation (2015-2016)[7]

Table 2. Electricity Generation in Pakistan from Different resources (NEPRA, 2015).

Electricity generation	*109.25 Twh*
Electricity generation source	
Fossil fuels	64%
Hydroelectricity	30%
nuclear	5%

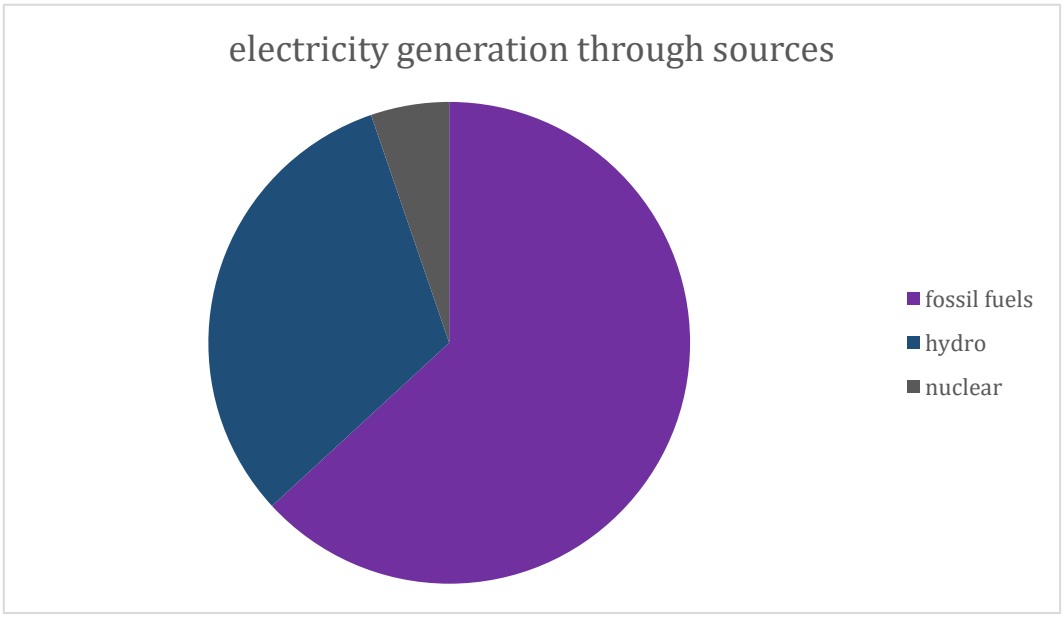

Figure 2. Electricity Generation from Different Sources (NEPRA, 2015).

[7] For more information "State of Industry Report 2015" (PDF). National Electric Power Regulatory Authority (NEPRA). National Electric Power Regulatory Authority (NEPRA). Retrieved 6 February 2017.

2.4. Location selection

The focus of our research will be on Islamabad Capital Territory (ICT) and Rawalpindi. Although there are several cities throughout Pakistan which are facing serious issues regarding electricity, but keeping Islamabad as priority was due to shortage of time and to reduce the cost of our research.

Secondly, the district selection was carried out taking Punjab as the province. The selection was carried out on the basis of population density, HDI and on the number at which it is ranked. The reason why district-wise human development scores are considered to identify which areas are less likely to have electricity.

Following were the results:

Table 3. District Classification and Selection (Districts of Pakistan , 2000).

DISTRICT	*POPULATION DENSITY*	*HDI*	*RANK*
Attock	274.65	0.51	3
Bhawalnagar	335.88	0.53	28
Bhawalpur	147.73	0.53	35
Bhakkar	202.44	0.48	18
Chakwal	229.30	0.67	5
Chinniot	518.25	0.56	11
Dera Ghazi Khan	240.92	0.52	33
Faisalabad	1,344.37	0.61	13
Gujranwala	1,384.44	0.57	9
Gujrat	863.44	0.64	7
Hafizabad	488.79	0.45	12
ICT	2,214.76	0.87	1
Jhang	311.43	0.57	20
Jhelim	340.86	0.59	4
Kasur	720.39	0.48	24
Khanewal	671.88	0.47	29
Khussab	196.79	0.52	8
Lahore	6,278.94	0.71	19
Layyah	289.97	0.63	26
Lodhran	612.17	0.41	34
Mandi Bahuddin	596.07	0.64	6
Mianwali	264.74	0.51	14
Multan	1,275.57	0.53	31
Muzzafarhgarh	523.94	0.53	32
Nankana Sahab	458.23	0.60	16
Narowal	731.60	0.57	25
Okara	694.34	0.63	23
Pakpattan	669.49	0.65	27
Rahim Yar Khan	405.22	0.37	37
Rajanpur	162.02	0.51	36
Rawalpindi	1,022.63	0.66	2
Sahiwal	786.49	0.66	22
Sargodha	632.66	0.56	10
Sheikhupura	580.61	0.57	15
Sialkot	1,291.01	0.62	17
Toba Tek Singh	673.44	0.54	21
Vehari	663.94	0.54	30

Thirdly, as we have to carry out a pilot study to check whether planting solar panels will help us generate energy or not and whether it is a convenient and low-cost alternative energy source we had to choose a location that was near to us so as there would be less transportation and that low budget has to be put in.

Despite being the capital of Pakistan there are some localities in the twin-cities, e.g. Tench Bhata, Dhoke Sayedan, Adiala Road, Mumtaz Colony, I-10 etc., which face a lot of electricity breakouts. In summer mainly, there are unannounced power cuts which lasts longer than 8 hours that makes the life of people miserable. All of the small localities in Rawalpindi and Islamabad plunge into the darkness when load shedding era begins. It not only affects the life of people living in that area but also makes the life of students dejected and affects their educational activities.

ISECO Company usually encounters the statements of residents by saying it is a technical fault or there is some sort of up gradation work going on. But from 6 hours load shedding a significant gap between demand and supply can be observed. According to the electric power analysts the major issue is not of the policy making the major issue is of the implementation; the policies are not executed. The other concern is that there is no proper infrastructure for the transportation purposes.

Solar energy- as an alternative form of energy:

Solar power energy is basically when black electro-voltaic cells are used to convert the solar light into the normal electricity capable of being used at residential and commercial levels (Ashok, 2021). PAKISTAN has a potential of producing 100,000 MW of electricity from solar energy. Islamabad is located in the province of Punjab where it experiences about 5.0-5.5 kWh/m2/day of normal solar radiations that are considered best rays to operate solar cells. If in Islamabad alone solar panels are installed it can operate about 500,000 street lights of 400 MW which can replace the sodium lights mounted. Apart from this many small localities that are far from the national grid can be facilitated from the solar energy. According to a given estimate, if solar panels are installed in the outskirts of Islamabad they can lighten up to 40,000 villages 24/7 that are even not provided with electricity even for about 10 hours in a day (Adnan, Hayat, Haider, & Mahmood, May 2012).

3. Literature review

The main objective of this research is to figure out the uncontrollable energy dilemma in Pakistan, its impact on economic growth and how solar energy plants would impact it. Several works in shape of books, articles, dissertations, thesis, magazines, and government sponsored studies and journals have been done to figure out the relation between energy crisis and economic growth and to enhance the reduction of energy consumption. The central point of the researches is as follows:

The energy sector of Pakistan fails to secure its energy needs. This energy crisis has stopped the economic progress of the country. Vast potential of Pakistan for producing energy cannot be attained without a powerful, productive, successful and operative energy policy (Naseem, 2015)[8].

Michael Kugelman (Kugleman, 2021)[9] in his article also pointed out the political instability for the energy crisis faced by Pakistan. Lack of political and governance determination is the root cause of Pakistan's energy problems. The short term solutions like getting loans for increasing the economy finance should be adopted.

The access of energy at affordable price and energy security a main tool of modern economics. There are 7 policies regarding energy sector are being implemented in Pakistan presently. All of them are focused on the resources like gas, nuclear, renewable, coal and hydel. Lack of inefficiencies and funds, law and order situation resulted in non-completion of energy plans in time (Malik & Sheikh, April 2010)[10].

Pakistan possess vast amount of renewable energy potential which is enough to reach the demand of electricity by the citizens. Lack of policies and government infrastructure are the reasons for not utilizing these new resources properly and relying on imported fossil fuels (Rafique & Rehman, 2016)[11].

[8] For more information see Malik Naseem research on Failure of Energy Sector.
[9] For more information see Kuggleman's commentary on Energy Crisis and Political Instability.
[10] For more information see Malik& Sheikh country report on Energy Security and Power Crisis.
[11] For more information see Rafique and Rehman's article on National energy scenario of Pakistan – Current status,

The research on power generation resources of Pakistan concluded that the demand for energy is rapidly increasing and for meeting the requirement renewable energy sources should be look on to while increasing the gas and coal production along with importing it from other nations (Memon, Uqaili, & Valasai, November 2006)[12].

Qasim and Kotani (Qasim & Kotani, June 2014)[13] suggested in their research paper that the Government of Pakistan should make amendments for improving the exercise rate of power plants that are already installed and the production for public electricity through oil and gas should be monitored by the government.

According to Dr. Azam Chaudhry (Dr. Chaudary, 2015)[14] article over dependence on fossil fuels for energy production, climate disparity, inadequate technological evolution, and high price of oil and poor alternative resources of energy are the main reasons for the large demand and supply gap of energy in Pakistan.

M. Javed, R. Raza, N. Shaheen and J. Iqbal (Javed, Raza, Hassan, Saeed, & etall, 2016)[15] in their research article highlights energy demand, the solution for meeting this requirement from available energy resources and the opportunity of energy from biomass and its advantages.

Karner T. Dunn (Dunn, December 1991)[16] points out in his survey article the prospects and problems of energy in Pakistan. Energy resources are available but the gap between demand and supply of energy is widening due to less production, weak allocating system, poor technical development and poor consumption of resources. This threaten the economic development in long term.

R. Lodhi, M. Siddiqui and Ume Habiba (Lodhi, M, & U, 2013)[17] expounds in their research paper that industrial production, standard of living and economic growth is in direct relation with energy consumption.

Khan and U. Ahmed (Arshad, Muhammad, & Usman, 2019)[18] in their article studied energy consumption at the disaggregate rank (coal, gas and electricity). The results was that coal and electricity directly related with income and inversely related with price while for the gas the price and income elasticity's are higher.

Dr. Akif Hassan (Syed, Feb 2012)[19] in his research reported the dynamics of electricity shortage by collecting data of Karachi. The large load shedding timings is harming the country's economic activities. It concluded that vast power breakdowns cannot lessen the shortfalls yet it is effecting the price.

H. Qudratullah (H, June 2001)[20] renders in the study about the rich resources available in Pakistan that aren't being consumed like hydro power and evaluation of existing policies regarding the limited resources.

A. Bilal Awan and Z. Ali Khan (Awan & Khan, May 2014)[21] suggested us to use the renewable energy resources by studying about the potential of energy production in Pakistan through renewable energy resources. As by using non-renewable resources for a long time would end up causing environmental pollution, depletion of fossil fuels and global warming. The energy crisis is influencing the hydro-carbon resources prices.

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future alternatives, and institutional infrastructure: An overview.

12 For more information see conference paper Analysis of the Power Generation Energy Sources in Pakistan.

13 For more information see Qasim & Kotani research on "AN EMPIRICAL ANALYSIS OF ENERGY SHORTAGE IN PAKISTAN".

14 For more information see Dr. Chaudary research on Fossil Feul and Energy Production.

15 For more information see Javed and co research on the energy crisis in Pakistan: A possible solution via biomass-based waste.

16 For more information see research of Karen on Pakistan's Energy Position: Problems and Prospects

17 For more information see Lodhi, M & U research on Empirical Investigation of the Factors Affecting Foreign Direct Investment in Pakistan: ARDL Approach.

18 For more information see Arshad, Muhammad and Usman research on Energy Demand in Pakistan: A Disaggregate analysis.

19 For more information see Dr. akif research on The Energy Short Fall and its After Effects (A Case Study for Karachi City in context to Karachi Electric Supply Corporation).

20 For more information see Qudratullah research on Understanding the dynamics of electricity supply, resources and pollution: Pakistan's case.

21 For more information see Bilal and Khan's research on Recent progress in renewable energy – Remedy of energy crisis in Pakistan.

Farhat Hayat and Dr. Danial (Hayat & Pirzada)[22] discussed the energy potential and major issues of energy sector of Pakistan. They assessed the energy potential in Pakistan deeply and concluded the energy sources that could influence the issue of energy crisis.

Various studies and works have been conducted about current energy, renewable energy and their sources, solar energy and power generators in Pakistan. Pakistani and oversees authors viewed various analytical angles in their studies. The existing literature is more focused on the current energy and energy scenario but very little work has been conducted on the effect of energy dilemma on the economic developments. The problems of economic development and energy utilization seems to be the major interest of parties especially policy makers, in current years. The results of earlier researches analyzing the relationship of economic development and energy consumption is incomplete and contradicting due to various and dissimilar variables used, sample periods, econometric procedures adopted and countries considered. The sample period taken for this research is 10 years from 2008-2018. Various recommendations advised by previous researchers and authors has been analyzed in this report. This research study is based together on primary as well as secondary sources of data. Secondary data is obtained from World Bank while the analysis has been developed from the data obtained from surveys conducted from people living in Islamabad, Pakistan. Unlike the previous researches pilot study on Islamabad has been conducted for the first time in order its impact in the study area.

4. Framework of research

Pakistan is facing serious energy crisis. According to the research published by United States Institute of Peace, Pakistan does not produce adequate energy to meet demand. As a result, it currently has an electricity downfall of approximately 5,000 megawatts (MW) per day (Mills, June 2012) [23]. Despite the country huge solar and hydroelectric potential, the country still faces energy crisis at large.

Kessides (Kessides, 1993)[24] noted that power shortage may damage the overall welfare of a country in number of ways, for example, by decreasing total output of energy exhaustive sectors. Siddiqui (Rehanna, Summer 2004)[25] said that power shortage may slow down or stop altogether economic growth of the country if the issue remains unsolved. The paper provides two reasons for the ongoing and worst energy crisis in Pakistan and the gap between demand and supply. Michael Kulegman (Kugleman, 2021)[26] in his research describes and links Pakistan energy crisis to policy inadequacy, lack of revenues, and unwillingness of the political leadership. According to research article published by NDU, due to lack of cohesion between the ministries of the government, an integrated energy policy and framework has never been formulated. (Qureshi, ENERGY CRISIS IN PAKISTAN: A threat to National Security , 2009)[27].

Energy and electricity are the backbone of any economy. It is an essential driver for economic stability and prosperity of the country. It is the principle agent in increasing trend of GDP and plays a dominant role in development of IT, manufacturing industries etc. (Kraft & Arthur, Spring 1978)[28]. The findings indicated that for long term economic growth efficient use of energy is needed thus a positive relationship was established. A study conducted by IEA concluded that in case of some developing countries use of energy led to faster economic development in the production agencies as compared to any other factor.

[22] For more information see Hayat and Pirzada research on Prevailing Energy Crisis in Pakistan.
[23] For more information see Elizebeth's research on Pakistan's Energy Crisis.
[24] For more information see Kessides research on The Contributions of Infrastructure to Economic Development: A Review of Experience and Policy Implications.
[25] For More information see Rehanna's research on Energy and Economic Growth in Pakistan.
[26] For more information see Michael's research on Political Instatbility and Energy Crisis.
[27] For more information see Mehwish's research on ENERGY CRISIS IN PAKISTAN: A threat to National Security.
[28] For more information see Kraft & Kraft research on the Relationship Between Energy and GNP.

Chang and Chiang in their study used capital stock, labour, and energy consumption for Asian economies. They found affirming results that positive relationship exists between energy consumption and economic growth (Chiang & Chung, January 2008)[29]. Barleet and Gourdner (2010) using the bivariate & multivariate models found causality between energy consumption and economic growth, for the study done on New Zealand. They found that real GDP, energy consumption, and employment were interrelated in in the long-run term, finding the causality between the GDP and energy use (M & R, 2010)[30]. According to a report by United States Energy Information Administration (2013) as a country economy develops its energy consumption increases, in 2010 the developed countries of the world consumed about 54% of the total energy produced this figure is expected to rise to 60% by 2040 (Woody, 2013)[31] From the studies and concepts previously above we can establish that for that the energy consumption and use drives and speeds up the country economic growth and is a stable factor in increasing trend of the GDP. Moreover, we will examine Pakistan energy crisis and its effects on economic growth using Islamabad as the focal point of our discussion.

Of the many factors that influence energy and electricity production in Pakistan today, several can be easily identified as having a positive correlation, while others maintain a negative one. The same can be said about the causes behind this increasing crisis, their corresponding effect being the depleted store of electricity in Pakistan. A majority of Pakistan's electric supply comes from hydroelectric plants, however now is the time to look into alternatives, such as solar power, to fulfill this depletion.

Pakistan has a reported solar energy potential of up to 2.9 million MW. This however, has not been utilized and capitalized yet, as the installed capacity is only 210 MW. Causes behind this range from budgetary and developmental constraints to political and demographic ones.

The greatest of these causal factors is the country's GDP- also an easily identifiable positive correlation. GDP, by definition, reflects the total value of goods produced and services provided annually. The higher the GDP, the higher the production and consumption of energy that produces said products and services. According to World Bank, Pakistan currently has a GDP of 283.7 billion USD, and produces 14419 GW-h of electricity currently (an all-time high, but still insufficient) (Mariam, 2017)[32].

Even with a 5.7% annual growth rate, Pakistan is facing its worst energy crisis to date with a current shortfall of more than 6000 MW. This in itself causes a major retardation in the development of Pakistan economically, industrially, socially, etc. The energy crisis effects the following major sectors perversely as dependent variables:

4.1. Industrial development

The bottleneck energy supply is the cause of deductions in production and manufacture in various industries around the country. Furthermore, outdated infrastructure (never updated due to lack of resources) further leads to transmission losses, power theft, and inefficient consumption. Collectively, these also leave no room for new, innovative industrial advancements. Major industries that are affected include the agricultural industry, the textile industry, etc. As the energy crisis causes inflation in prices of energy resources such as oil, gas, coal, etc., the mining and quarrying processes themselves are jetlagged with inflation and lack of funding. This vicious cycle brings down the entire GDP of the country. For example, the production of solar energy is possible because with up to 9 hours of sunshine per day, Pakistan has one of the highest levels of insolation. Geographically, Pakistan holds major deserts

[29] For more information see Chang and Chiang research on Energy consumption and economic growth in Asian economies: A more comprehensive analysis using panel data.
[30] For more information see Barleet and Gourdner research on Energy Consumption and Economic Growth in New Zealand: a Multivariate and Trivirate Model.
[31] For more information see Woody's periodical in The Atlantic.
[32] For more information see Mariams documentation on Pakistan has '2.9 million MW solar energy potential'.

such as Thar and Thal, and extensive areas in Baluchistan which may be utilized for solar energy production. The monthly solar radiation intensity is 136.05 to 287.36 W/m2. Still, only 6% energy is produced through solar energy, due to lack of funds, resources and industrial direction.

4.2. Population

Pakistan has a total population of 193.2 million (World Bank census 2016). Over 140 million of these do not have access to the national grid, hence are not even counted as consumers. Domestically used electric power is consumed by both households and cottage industries, however a projected 67% of electricity used for lights and fans is inefficiently used, and can possibly be saved. Furthermore, an annual 30 billion is used for private, off-grid production of electricity through UPS systems and batteries. As with solar energy, due to high costs of installation and maintenance, only 6% of energy comes from solar plants. Hence, the energy crisis affects both domestic living and small scale industries, and brings down the standard of living of a population that has an astounding 40% living below the poverty line. With energy as a prerequisite of any industrial production, its depleted supply also leads to unemployment as industries close down and lay off employees. This also leads to a multitude of psychological and social issues in an already uneducated population.

4.3. Policy

Until 2013, there was no uniform policy on renewable energy especially solar energy. The growing energy crisis and its effects on both industrial and social sectors, has made it a vital part of the government's development agenda, to such an extent that development projects are being pushed. Locally, the Ministry of Water and Power has made policy changes for mainstreaming renewable energy in development sectors of the country. Internationally, the International Energy Agency (IEA) implemented "Pakistan net metering policy for solar PV and wind projects." (Pakistan, 2007)[33].

These factors collectively show how changes in energy levels affect industrial development, population, policy, and hence the overall GDP of Pakistan. Simultaneously, we can argue that while energy crisis brings a change in the industry with grassroots effects down to individuals, the total energy production and consumption of energy from the current store acts as a moderating variable. The production itself fluctuates in different alternative and renewable sources of energy; both through seasonal and policy changes. Consumption also changes seasonally, but whereas it shows a steady increase, energy production does not always do the same. Hence the energy crisis has come into being.

The above correlation prove that energy crisis is a cause of said variables, and can operationally be defined as,

"The restriction of energy supply and a bottleneck of energy resources creates an energy crisis which is an increased demand but decreased supply of energy in the economy."

The inverse correlation between energy crisis and industrial development, among other factors, is greatly affected by one moderating variable: policy. The reason behind this is that policy directly affects consumption and production of energy at both domestic and industrial levels. Simultaneously, the effect on the population is showcased when the total wealth of an average citizen decreases when the value of currency falls and prices rise; industrial production falls as well.

[33] For more information see GoP's final report on Review of the International Energy Policies and Actions and the Latest Practice in their Environmental Evaluation and Strategic Environmental Assessment.

A cycle ensues which shows how this energy crisis ultimately has a negative effect on industrial growth.

5. Research methedology

This is an empirical study, based on both primary and secondary sources of data. The framework of analysis on which primary data i.e. survey has been conducted is that how well do people know about the energy crisis and how often do they get affected by the electricity load shedding. Secondary data has been collected keeping in view the factors i.e. availability of electricity to urban and rural population, renewable energy consumption and production and the time required to deliver electricity. A small attempt has been made in order to know about the growth, viability, cost efficacy and practicality of using solar energy. The scope of our research is related to the demographic, economic and political aspects. It focuses how the citizens are being affected by the problem.

5.1. Variables

For the purpose of this research Energy crisis, has been kept as a dependent variable whereas economic prosperity, industrial sector, agriculture sector, unemployment rate and growth rate of GDP has been kept as independent variables. In order to acquire pertinent survey results, the control variable was the level of education. Only those strata of the society were targeted who had sufficient knowledge regarding the variables.

5.2. Data collection

This study is empirical, in view of both primary and secondary sources of data. The secondary data on the economic and national development of Pakistan has been collected from the World Bank for the ten years (2008-2010). Secondary data, with respect to net accessibility of energy, distribution of energy supply under state and all-Pakistan level have been World Bank. Respective data for the energy dilemma, energy production and its effect on economic and nation development was collected from the World Bank. The structure of the study has been developed from the data gathered through essential overviews by field visits covering different areas of Islamabad and through reaching people on-line. A survey was made on-line on the website named Qualtrics. Hence primary data has been collected through survey and pilot study method. The primary data assembled from the survey is from Islamabad. It was researcher’s practical restriction to center around Islamabad. In light of the shortage of time it wound up required for the analysts to investigate exclusively Islamabad rather than whole Punjab. The survey consisted of 33 close ended questions. The response of the survey was very good. We got 100% response from the people. An attempt has been made to focus on the solar power sector growth and distribution in the study area.

The data we collected through World Bank was centralized on the variables; electricity access to people in Pakistan, electricity access to urban and rural population, electricity consumption by people, renewable energy consumption, final consumption expenditure at the start and at the end year, time required to get electricity, renewable electricity output and the electricity production from renewable sources. This study was further done by keeping in mind these variable that help us to achieve a specific result. According to the data electricity consumption by the rural population has been drastically increased with the increase in electricity production. In total the electric consumption in Pakistan has been increased in the last 10 years. The data shows that renewable energy consumption has not shown any change in the last 10 years while the electricity production in the last 5 years by renewable energy has been raised.

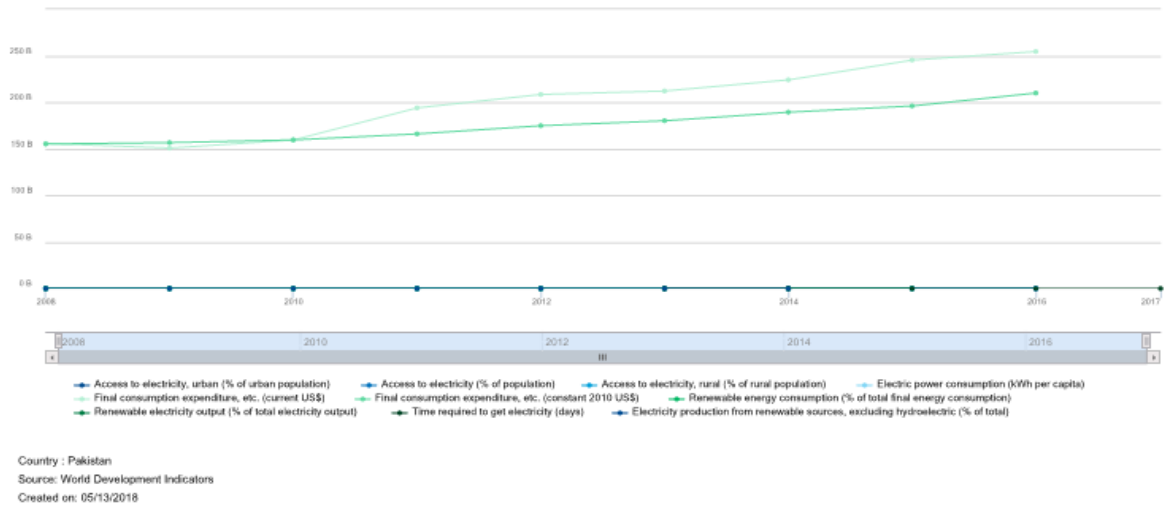

Figure 4. Comparison between access to electricity in urban and rural areas.

The target of the survey was to get the understanding of how many people living in Islamabad really have the knowledge about the current electricity issue faced by Pakistan and till what extent. We are trying to get an insight of how the public perceive it as an issue and how much it's impacting their life. Through this survey we are able to know what the society thinks of this issue, about the circumstances they face due to it, how much it's influencing the nation and its people, what solutions people can think of and what they think is the major cause of this issue. The main focus of this survey was to know how much people believe that we can resolve this problem by implanting more solar energy plants and utilizing new renewable energy sources.

5.3. Pilot study

5.3.1. Scope

To encapsulate the ambitious initiative into a single pilot project which can be executed and monitored within the span of a few months is not an easy task to accomplish; however, the best possible pilot was still designed, pitched, implemented and monitored for the purposes of the project which we aim to summarize. After much discussion it was decided to keep the scope of pilot study limited to meeting the partial or full energy demand.

5.3.2. Pilot Project Plan

The plan was as follows:

- Estimate the usage of electricity at the location.
- Determine the optimal technology setup within the applicable constraint.
- Estimate economical and technical scaling space.
- Determine any regulations and make a compliance plans.
- Determine monthly payments.
- Draft contracts, agreements and declarations.
- Procure the needed equipment.
- Install equipment on the location.
- Maintain records.

- Make a timeline for maintenance checkup.
- Conducting final decision after analyzing the results for larger feasibility

5.3.3. Equipment Design

The equipment that is installed is a portable frame which provides ease for the users so that they can adjust it according to their requirements. The adjustable frame also provides security for thee apparatus in a way that it can be folded and kept inside after sunset and in stormy weathers. The apparatus contains following:

1. Photovoltaic solar panels.(2)
2. Acid batteries.(2)
3. Battery case.(1)
4. Solar charge controller.(1)
5. Inverter.(1)
6. Heavy duty wires.(50 meters)
7. Adjustable metal frame.(1)
8. Ground mounts.(4)

5.3.4. Costing

The following table summarizes the total cost for the setup including the framework.

Table 4. Direct Pilot cost (ASSET).

Component	*Quantity*	*Cost (PKR)*
Photovoltaic solar panels	2	30000
Acid batteries	2	28000
Battery case	1	2500
Solar charge controller	1	000
Inverter	1	15000
Heavy duty wires	5	1500
Adjustable frame	1	4000
Ground mounts	4	1200
Total cost		83,200

5.3.5. Monitoring

Regular visits have been planned and are to be made as per the predetermined schedule to ensure the safety of the equipment as well as its functionality. All monitoring activities will be carried out by the group members.

5.3.6. Analysis

It can't be said that pilot will be successful but it will be safe to say that certain factors can still be used as proxy to determine if the project will be successful or not. If the security of equipment is ensured then the project can be on the road to success.

5.3.7. Some steps for large scale generation

1. Site selection.
2. Large scale climatic, technical and financial stimulation.
3. Creating an implementation plan to be approved by government.

4. Procuring and installing equipment's.
5. Operation and marketing plans.
6. Monitor progress.
7. The above mentioned steps here briefly gives a holistic picture of the probable future plans if any to be implemented.

5.4. Data analysis

The primary data has been analyzed through Stata. The main factors taken into account were energy crisis, impact on economic growth, impact on future, impact on industrial growth, issue in Islamabad and lastly how energy crisis can be overcome by the use of renewable resources. After careful investigation, we have seen that there is a negative relationship between electricity crisis and economic growth, industrial growth, and issues in Islamabad. Whereas there is a positive relationship between electricity crisis and unemployment rate, issues in Islamabad and need for alternative resources.

Out of 97 respondents only 1 responded in the negative way regarding the electricity crisis in Pakistan. The defendant was with the opinion that it is not the serious delinquent that Pakistan is facing and that it may not be impacting the prosperity of Pakistan. Similarly the 1 respondent was with the view that the electricity crisis will definitely not be affecting the future of Pakistan. Out of 97 people 64% agreed that economic growth is affected by the electricity crisis and that it decreases with an inch of increase in the crisis. 74% people in Islamabad agreed that the increase in electricity crisis does adversely affects the industrial sector of Pakistan. 68% believed that it is an important issue persistent Islamabad and it always affects the daily routine of the residents of Islamabad. While talking about the need of alternative resources 93% strongly agreed that there is an urgent need for a substitute and most of the people opted for the solar energy.

Lastly, through the survey we came to know that there are no campaigns or educational advertisements which emphasizes on the need to save/ conserve electricity or telling the populate about the seriousness of the issue.

6. Conclusion

Electricity Crisis has distraught all divisions of Pakistan's agencies varying from inflation to starvation, economy to production and cultivation to socializing and it is holding up the country's development in a severe manner. Focusing on Energy sector should be the first priority of Pakistan's government. Energy dilemma can be abridged by:

- Informative movements and causes for energy saving.
- Utilization of power sparing devices.
- Reduction in industrial uses with establishment of compelling equipment's/energy productive and with expanding effectiveness of workforce (practical).
- Lessening in irrelevant transportations by growing great open transport frameworks and fortifying Pakistan railways.
- Power sparing responsiveness must be supported at household level by means of advertisements and campaigns.
- Diminishing dependence on rental power ventures, in light of the fact that as opposed to doing any great, they are expanding costs of power.
- Besides, energy productive innovation ought to be embraced to help in dealing with the issue of energy

blackout.

- To control electricity costs, government ought not to rely upon energy power ventures. In doing as such, new sources of energy ought to be explored as Pakistan is overflowed with natural resources.
- The monetary and infrastructural incentives should be issued and given to draw in local and foreign investors.
- Domestic funds can be created by the usage of fair taxes and assigned fund by means of taxes to power generation programs.
- Using substitute energy resources like Solar, Wind and Biodiesel.
- Solar based energy is less expensive, renewable energy and less harmful for us and environment. Sunlight t is free and easily available source in Pakistan. The result of our research has demonstrated that solar energy is a best for Pakistan. So more solar energy plants should be focused and developed more in the areas of Punjab, Sindh and Baluchistan.

Concluding remarks: the implementation process can be speed up only if government and NGO's work hand in hand. The subsidies should be provided to those production sites and major companies which install solar powered plants during construction process of the offices. A bunch of Campaigns should be initiated with a prime motive to educate the people about the seriousness of the issue and the best possible solution to curb the crisis and to be part in making ones country progress.

Funding Statement

This research received no external funding or grant.

Acknowledgments

Special regards to the district government for lending us space to carryout our pilot project which paved way for our research.

Conflict of interest

All the authors claim that the manuscript is completely original. The authors also declare no conflict of interest.

Author contributions

This section should be included in original research articles and review articles. Authors are recommended to use the following specific descriptions to show each contributor's specific contribution to the academic production in the Author Contributions section, such as, conceptualization, data curation, formal analysis, funding acquisition, investigation, methodology, project administration, resources, software, supervision, validation, visualization, writing–original draft, and writing–review & editing.

Here are some examples in Author Contributions section written based on the above descriptions: Conceptualization: Ali Jackson, Helen Meyer; Investigation: Ali Jackson, Tom Lewis-Hans, Han Xiang; Methodology: Dolores Hans; Formal analysis: Han Xiang; Writing – original draft: Ali Jackson; Writing – review & editing: Helen Meyer, Joshua O'Brien.

Appendix

A1 LIST OF ACRONYMS

HDI	Human Development Index
NGO	Non-Governmental Organization
IESCO	Islamabad Electric Supply Company
WAPDA	Water and Power Development Authority
KESC	Karachi Electric Supply Corporation
GDP	Gross Domestic Product
FY	Financial Year
MW	Mega Watt
ICT	Islamabad Capital Territory

A2 LIST OF FIGURES

A3 LIST OF TABLES

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