UNIVERSITI PUTRA MALAYSIA

USAGE INTENTION, ATTRIBUTE PREFERENCES AND ECONOMIC VALUE OF GREEN ELECTRICITY IN PAKISTAN

MUHAMMAD JAWAD IQBAL

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By

MUHAMMAD JAWAD IQBAL

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

December 2019

DEDICATION

"This work is dedicated to My Parents, My Wife, My Daughter and all those who take their chances to learn new things".

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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Chairman : Associate Professor Abdul Rahim Abdul Samad, PhD
Faculty : School of Business and Economics

The huge reliance on thermal power for electricity generation, power sector of Pakistan has become significant contributor to GHG emissions. The Government has plans to improve and upgrade the electricity infrastructure through generating more electricity from renewable energy sources. In order to evaluate the economic benefits which people are expected to gain if the green electricity sources are increased in the system, their intentions and preferences for any specific renewable energy sources are considered in this study. This thesis aims to explore usage intention, attribute preferences and economic value of green electricity in Pakistan. The objectives of this study were explored by employing three different methods namely; contingent valuation method (CVM), choice experiment (CE) and Partial least squares structural equation modelling (PLS-SEM). The respondents were divided into two broad categories of urban and rural. A total of 400 respondents from urban and 405 respondents from rural areas were selected for this study.

The PLS-SEM method was utilised to investigate the factors, which influence the consumer's intention to use green electricity. The moral obligation (Perceived moral obligation), New Ecological Paradigm scale (General environmental attitudes) and theory of planned behaviour (Attitudes, Subjective norms and Perceived behavioural control) were used to measure these factors. Moreover, the CVM calculated the overall price of green electricity for environmental improvement through increasing the share of electricity from renewable energy sources. The widely used WTP measure double-bounded dichotomous was utilised to elicit the appropriate value of green electricity from the bid price. Whereas, a choice experiment (CE) method employed to estimate willingness to pay for different sources of green electricity. The three main sources of green electricity (Hydroelectricity, wind and solar) along with load shedding attribute was explored. The Conditional Logit Model and Mixed Logit Models were employed to identify the consumer's preferences and estimation of the marginal values.

The PLS-SEM results showed that all these factors have a positive relationship with the intention to use green electricity, except for urban consumers who do not think that they are morally obliged to use green electricity. Whereas, results from the logit regressions showed that the respondents with high income and a higher level of education are willing to pay more for green electricity in both urban and rural models. Moreover, CVM results also revealed that the willingness to pay for green electricity is high in younger people than older people are. The mean willingness to pay has found 0.33 cents per kWh in the urban model, while it is 0.24 in the rural model. The results provided a guideline to the government to charge an appropriate surcharge for the green electricity from consumers. The results from CE further showed that the urban and rural consumers chose the solar source of green electricity as the most preferred source and marginal values for this source is 0.17 cents per kWh and 0.19 cents per kWh in urban and rural models respectively.

Finally the above findings and their implications have some policy relevance in that the development and promotion of green electricity in the renewable energy policy has been found to be pragmatic and workable. These findings are useful information for the policy makers, government and other agencies to enhance greater stakeholder participation in developing the green electricity. The results of economic valuation and choice experiment aid the government to gain insight about real value and the preferences of the sources of green electricity in Pakistan.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

NIAT PENGGUNAAN, PILIHAN ATRIBUT DAN NILAI EKONOMI BAGI ELEKTRIK HIJAU DI PAKISTAN

Oleh

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Tesis ini bertujuan untuk meninjau keutamaan atribut, niat penggunaan dan nilai ekonomi elektrik hijau di Pakistan. Objektif kajian ini diterokai dengan menggunakan tiga kaedah penilaian kontinjen (CVM), percubaan pilihan (CE) dan pemodelan persamaan struktur sekurang-kurangnya separa (PLS-SEM). Responden dibahagikan kepada dua kategori iaitu bandar dan luar bandar. Sejumlah 400 responden dari bandar dan 405 responden dari kawasan luar bandar dipilih untuk kajian ini.

CVM mengira harga keseluruhan elektrik hijau untuk kelestarian alam sekitar dengan meningkatkan bahagian elektrik dari sumber tenaga boleh diperbaharui. Pengukuran WTP yang digunakan secara meluas dikodotkan dua kali ganda digunakan untuk mendapatkan nilai elektrik yang sesuai dari harga bidaan. Keputusan dari regresi logit menunjukkan bahawa responden yang berpendapatan tinggi dan tahap pendidikan yang lebih tinggi sanggup membayar dengan kadar yang lebih tinggi untuk elektrik hijau untuk kedua-dua model bandar dan luar bandar. Walau bagaimanapun, keputusan juga menunjukkan bahawa kesanggupan untuk membayar kadar yang lebih tinggi bagi elektrik hijau adalah tinggi pada orang muda berbanding orang tua. Purata kesediaan untuk membayar adalah pada 0.33 sen per kWh dalam model bandar, manakala 0.24 model luar bandar. Hasilnya memberikan garis panduan kepada kerajaan untuk mengenakan bayaran tambahan yang sesuai untuk elektrik hijau dari pengguna.

Kaedah percubaan pilihan (CE) yang digunakan untuk menganggarkan kesediaan untuk membayar sumber elektrik hijau yang berlainan. Tiga sumber utama elektrik hijau (Hydroelectricity, angin dan solar) bersama-sama dengan sifat penumpahan beban diterokai. Model Logit Bersyarat dan Model Logit Campuran digunakan untuk mengenal pasti keutamaan pengguna dan anggaran nilai marginal. Hasilnya

menunjukkan bahawa pengguna bandar dan luar bandar memilih sumber solar elektrik hijau sebagai sumber yang paling digemari dan nilai marginal bagi sumber ini masing-masing adalah 0.17 sen per kWh dan 0.19 sen per kWh dalam model bandar dan luar bandar.

Kaedah PLS-SEM digunakan bagi menyelidik faktor yang mempengaruhi niat pengguna untuk menggunakan elektrik hijau. Kewajiban moral (Kewajiban moral yang dirasakan), Skala Paradigma Ekologi Baru (Sikap Alam Sekitar Umum) dan teori perilaku yang dirancang (Sikap, norma subjektif dan Kawalan perilaku yang dirasakan) digunakan untuk mengukur faktor-faktor ini. Hasilnya menunjukkan bahawa semua faktor ini mempunyai hubungan positif dengan niat untuk menggunakan elektrik hijau, kecuali pengguna bandar yang tidak berfikir bahawa mereka secara moral bertanggungjawab menggunakan elektrik hijau.

Akhirnya penemuan di atas dan implikasinya mempunyai beberapa kaitan dasar dalam perkembangan dan promosi elektrik hijau dalam dasar tenaga boleh diperbaharui telah didapati pragmatik dan boleh dilaksanakan. Penemuan ini adalah maklumat yang berguna bagi pembuat dasar, agensi kerajaan dan lain-lain untuk meningkatkan penyertaan pihak berkepentingan yang lebih besar dalam membangunkan elektrik hijau. Hasil penilaian ekonomi dan pilihan percubaan pilihan kerajaan untuk mendapatkan pemahaman mengenai nilai sebenar dan preferensi sumber listrik hijau di Pakistan.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

ATT	Attitude
CE	Choice Experiment
CO^2	Carbon Dioxide
CM	Choice Modelling
CVM	Contingent Valuation Method
GDP	Gross Domestic Products
GHG	Greenhouse Gases
NEP	New Ecological Paradigm
NGO	Non-Governmental Organization
PBC	Perceived Behaviour Control
PLS-SEM	Partial Least Square-Structural Equation Modelling
SN	Subjective Norms
TPB	Theory of Planned Behaviour
WTP	Willingness to Pay

CHAPTER 1

INTRODUCTION

1.1 Introduction

Pakistan intends to reduce its dependence on energy imports by increasing the share of green electricity (electricity generated from renewable energy sources) through its indigenous sources. The government set the target of 5% of total generation from green energy sources by 2030. These targets are expected to increase by up to 15% in the coming years. Government is not only investing in green energy projects through the technical and financial help of international institutions as well as promoting private investor to invest in green electricity projects by removing taxes on imports of related items. The energy sector of the country also has a boost from the $62 billion China Pakistan Economic Corridor (CPEC) initiative targeting infrastructure investments. The country is also aiming to reduce or minimise its electricity outages, especially during the summer season (Climatescope, 2017).

Pakistan started to develop its local green electricity sources by adding 244 Mega Watt (MW) wind power, 85 MW of biomass, 300 MW of solar and 48 MW of small hydropower plants in 2016. The country has few more renewable electricity projects, which are still in their initial phases. Moreover, 10.4 Giga Watt (GW) of generation plants from solar, natural gas and coal are announced to fund through CPEC project. Government is also supporting private sector participation in the energy sector development by issuing licenses for transmission and distribution. The government also allowed private electricity generation firms to sell electricity directly to consumers to reduce the burden on electricity distribution companies.

Asian Development Bank has approved two loans for the energy sector of Pakistan on November 2016 and June 2017. The first loan has taken to connect off-grid areas with the national grid in two provinces of Pakistan. It has also supported by the Government of France through its program of Access to Clean Energy Investment. On the other hand, the second loan is to support power sector stabilisation measures in the short run and its restructuring in the long term. Furthermore, according to the Climatescope (2017) World Bank, Agence Francaise de Development (AFD) and Japan International Cooperation Agency (JICA) are also agreed to fund for the Sustainable Energy Sector Reform Program in Pakistan.

The State Bank of Pakistan also helping to support small scale power plants (4 KW to 50 MW) by allowing commercial and development banks to provide loans for 10 to 12 years to the green energy power plants with 6% fixed interest rate. The government of Pakistan also introduced net metering regulations on September 1, 2015, that allows consumers to sale their surplus solar and wind electricity to the national grid up to a certain generation capacity.

Moreover, Pakistan ratified the Paris agreement on November 11, 2016 (Climatescope, 2017). It intends to reduce its 2030 projected Greenhouse Gas (GHG) emissions by up to 30% as per its Nationally Determined Contribution (NDC). This commitment is subject to the provision of international grants to meet the total abatement cost, which the country estimates at about $40 billion at current prices. Despite so many action taken by government, Pakistan is still unable to achieve its renewable energy targets due to some issues like lack of investment, delay of project implementations, foreign investment, lack of public awareness and less public participation.

1.2 Overview

Electricity generated by fossil fuels refers to conventional energy means of non-renewable generation, having a bad impact on the environment and leads to climate change. However, world is facing worsening environmental change which requires a global attention to reduce carbon emissions (Choi, Ritchie, & Fielding, 2016). In Pakistan, energy sector is one of the most prominent sector in CO2 emission. If the attention will not be given to the transition of this sector, it can contribute more in increasing emission in future. The energy sector can be transformed through dependence on local renewable energy sources for electricity generation which are in abundance in the country. The ‘‘green’’ electricity is generated from renewable energy sources. These sources can be solar, wind, hydro, geothermal and biomass which have no or very less harmful impact on the environment (Hansla et al., 2008).

Rapidly growing economies are seeking to secure stable energy supplies in a time when the environmental impacts of energy production are coming under growing scrutiny. More countries are focusing on developing technologies beyond traditional resource extraction. The development of these clean or renewable energy technologies can provide economic opportunities to countries with substantial traditional energy resources and countries that lack such resources by offering an alternative means to power their economies and generate jobs for their citizens. Renewable energy is rapidly growing sources now a days and several predictions have been made about the fast expansion of these resources in near future (Amer & Daim, 2011). Renewables delivered nearly 20% of global electricity generated in 2010. Large hydropower made up more than 80% of global renewable power and 16% of global power generation overall (Renewables: Global Status Report, 2016).

“Air pollution caused by electricity generation, industrial activities and transportation is a global issue and is becoming most obvious in dense population centers in Asia” (Maxim, 2015). Future climate and environment of the world depends on the energy choices that are being made today. Renewable energy sources will not only greatly affect the reduction of greenhouse gases emission but also will play vital role in future energy security (Aini & Goh Mang Ling, 2013). Moreover, Energy also plays an important role in industry, infrastructure, transport, agriculture, household uses and overall in country’s growth and development. Any country, which wants to improve its economy and living standard of its people, must ensure the reliable energy supply.

Energy uses increases with the increase of income. Energy demand of rapid growing economies like Pakistan, India and Bangladesh is also very high. Pakistan's energy and transport sectors are the country's largest source of emissions, together making up half of the national total (see Figure 1.9), while agriculture produces 39 per cent, according to a 2008 national greenhouse gas inventory (Reuters, 2015). Mirza et al., (2007) and Amer & Daim (2011) stated that historically, Pakistan is energy-deficient country and facing problems due to energy shortfall. Its main sources of energy is imported fossil fuels and hydroelectricity as a primary energy supplies. According to Economic Survey of Pakistan, there is a need of low cost energy supply in fast growing economies. Especially country like Pakistan whose major source of energy is from import of oil. Moreover, In 1980s in Pakistan, energy generation was a mix of two-thirds hydro and one-third thermal. Today, the mix is only 30 percent hydro and 70 percent thermal (World Bank, 2015). The huge amount of oil in energy mix is causing severe greenhouse gas emissions which is not only contributing in global climate change but also affecting the health of huge population within the country.

Pakistan's energy requirements is very high due to its increasing population which already crossed over 200 million. The country is an energy importer, and facing energy shortages due to growing population, economy and fluctuating oil prices in the world markets. Therefore, Pakistan have to reduce its dependency on import of fossil fuel for energy production and to emphasis on sustainable and environment friendly sources of energy. Pakistan is blessed with abundant sources of clean energy which are yet to be exploit (Ministry of Water and Power, 2006). According to Mr. Qamar uz zaman, former director general Meteorological department of Pakistan, "Emissions of CO_2 in Pakistan were 147.8 million ton in 2008 which is increasing by 6 percent annually. This will be expected to reach 400 million tons by 2030 if no steps will be taken to reduce it," (Reuters, 2015).

1.2.1 Definition of Green Electricity

"Renewable electricity, also termed green electricity, is generated from renewable energy sources such as solar power, wind power, small-scale hydroelectric power, tidal power, and biomass power" (X. Guo et al., 2014). "Green electricity is also defined as the electricity that is produced from renewable energy sources and is distinguished from other forms of electricity with regard to environmental sustainability" (Yoo & Kwak, 2009).

1.3 Current Energy scenario in Pakistan

The gap between the electricity demand and generation is around 5000–8000 MW. This gap is increasing by 6–8 % per annually (Raheem, 2016). Country is sixth highly populated in the world, which ranked at 37th according to the energy consumption status. Pakistan is dependent on imported oil to fulfill its ever-increasing energy demand. In 2011 the oil import comprised 40% of total imports (Zaki, 2014). However, Pakistan aims to ensure an uninterrupted, affordable and clean energy by 2025. It also aims at completing Gaddani Energy Park with 6,600 MW capacity and

two main hydel projects: Dasu (4,320 MW) and Diamer-Bhasha (4,500 MW) dams. Many energy projects are currently under construction under the China Pakistan Economic Corridor (CPEC). However, Growth of proportion of power generated from green energy sources has become very important to achieve reduction targets of greenhouse gas (GHG) emissions.

1.4 Electricity demand and supply scenario in Pakistan

According to Qudrat-Ullah, 2015 the domestic consumers have major share of electricity consumption with the growth annual average growth rate of 15.1%. The commercial sector with 11.1% annual average growth rate become the second highest electricity consumption sector in Pakistan. On the electricity supply side, the generation capacity is increasing only by 6% whereas the average consumption is increasing by overall 10% including all type of electricity consumers. This is alarming situation for the country's economy where the demand and supply gap crossed 5000 MW in 2014.

1.5 Fuel consumption in Power Sector

The share of thermal power installed capacity in the country was 65.50% in 2015-16, and the electricity generated by the thermal power plants was 64.01% in 2014-15. The detail statistics of different fuel used in thermal generation and their percentage share to the total fuel used for the country's total electricity generation from 2010-11 to 2014-15 are given in Table 1.1 and Figure 1.1 depicts the comparison of installed capacity and generation. Moreover, the figure 1.1 is only describing the facts about installed capacity of electricity generator and yearly generation from them. Furthermore, Figure 1.2 showing the two year comparison of main sources of electricity generation from different prominent sources in Pakistan. This also shows that the electricity generation from fossil fuels are on increasing turn.

Table 1.1 : Fuel consumption for Thermal Power Generation in Pakistan

Fiscal Year	Unit	Gas	Furnace Oil	Diesel Oil	Coal	Total	Annual Growth Rate (%)
2010-11	TOE	6,493,766	7,827,500	105,160	43,169	14,469,595	-8.22
	%share	44.88	54.10	0.73	0.30	100.00	
2011-12	TOE	6,732,876	7,206,839	203,072	46,800	14,189,587	-1.94
	%share	47.45	50.79	1.43	0.33	100.00	
2012-13	TOE	7,084,177	7,342,755	218,584	28,204	14,673,720	3.41
	%share	48.28	50.04	1.49	0.19	100.00	
2013-14	TOE	6,602,422	8,486,744	304,994	71,902	15,466,062	5.40
	%share	42.69	54.87	1.97	0.46	100.00	
2014-15	TOE	6,847,894	8,234,479	565,953	67,638	15,715,964	1.62
	%share	43.57	52.4	3.60	0.43	100.00	

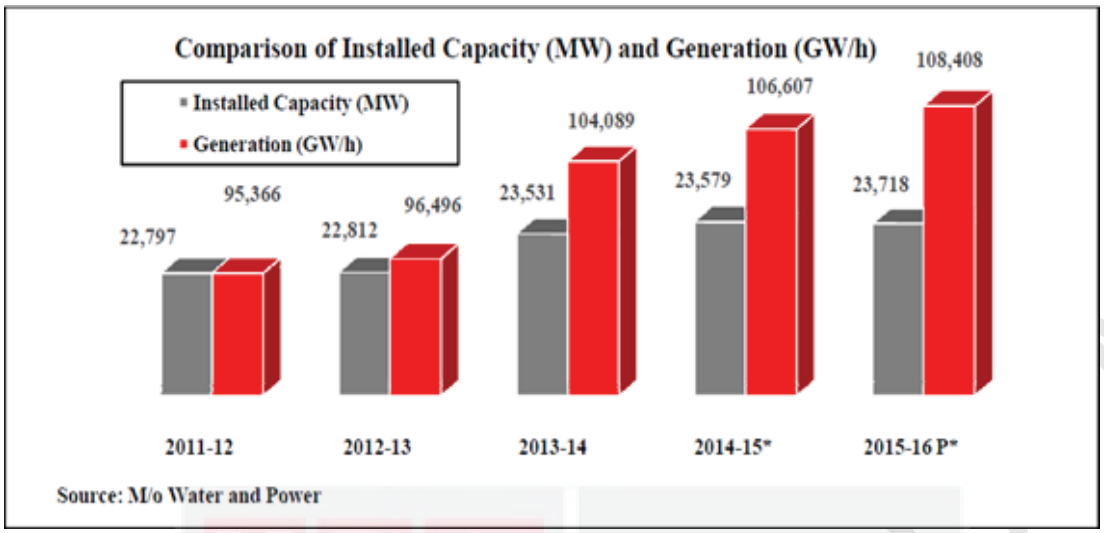

Figure 1.1 : Comparison of Installed Capacity (MW) and Generation (GW/h)

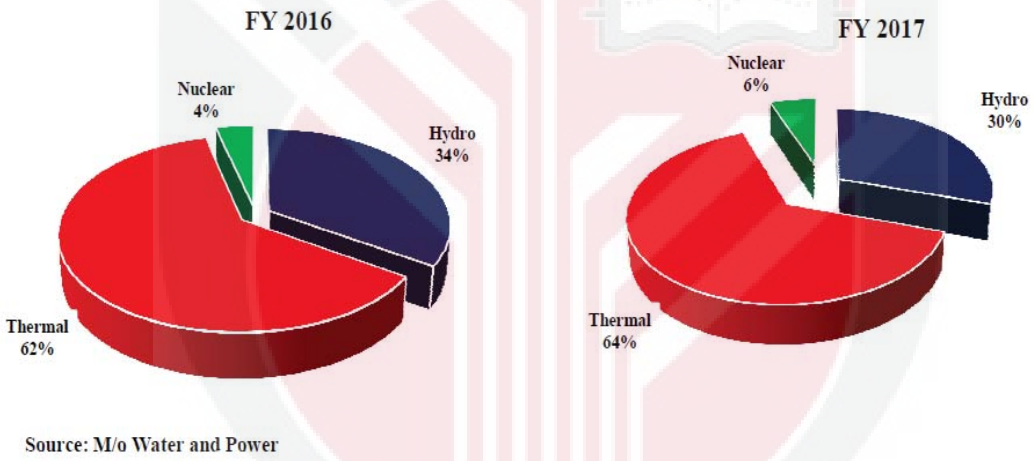

Figure 1.2 : Share of Energy Source in Electricity Generation

However, during July 2017, the share of household in electricity consumption has been increased which is also indicating that economy growth has switched general public to use advance technological products (Pakistan Economic survey, 2017), as shown in Figure 1.3. However, the sectoral share of oil consumption is also shown in Figure 1.4, which depicts that the power sector is the major oil consuming sector in Pakistan.

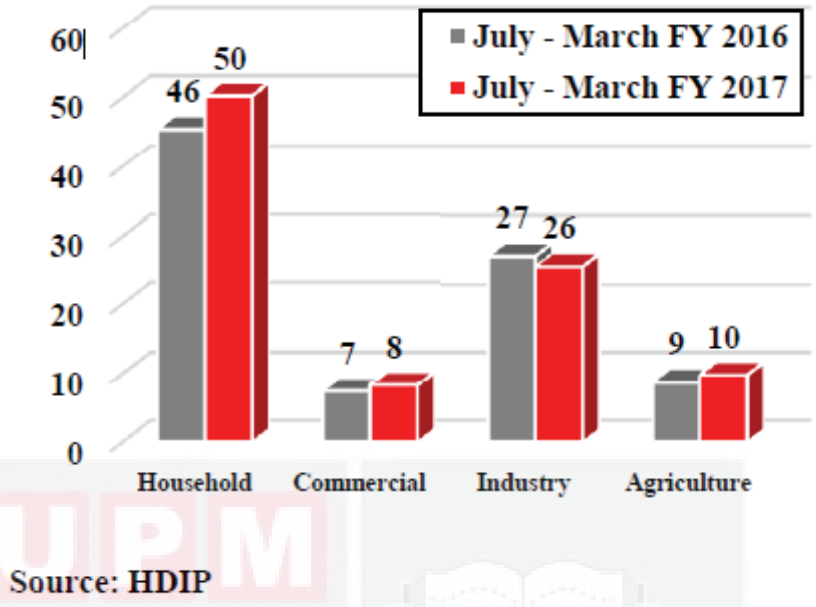

Figure 1.3 : Sector wise Electricity Consumption

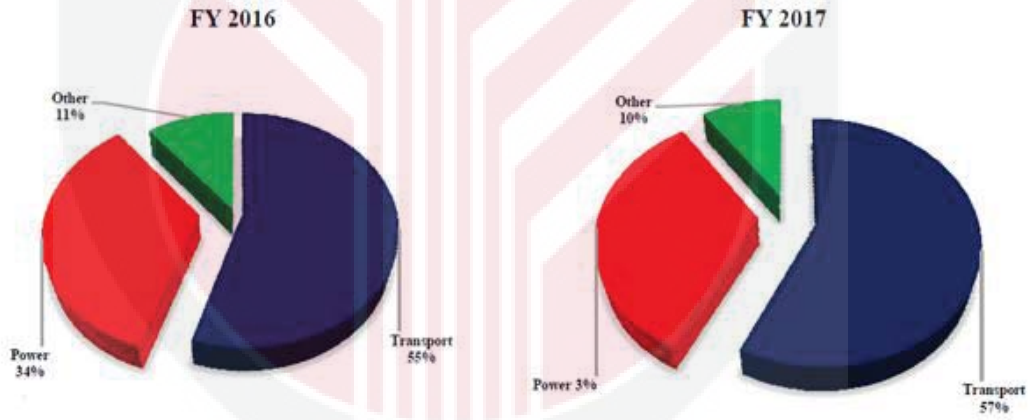

Figure 1.4 : Comparison of Sectoral Share in Oil Consumption during July-March

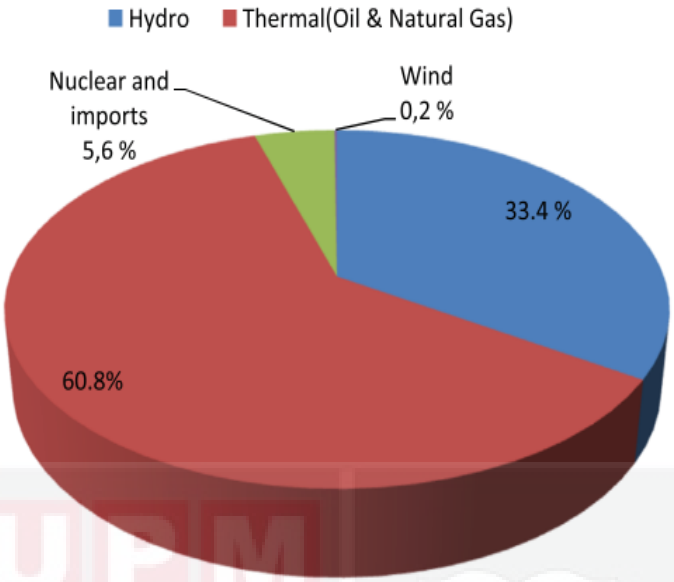

Figure 1.5 : Total Electricity Generation by Source in 2015
(Source: Shakeel, Takala, & Shakeel, 2016b)

According to the information given in figure 1.5, 60.8% of the total electricity generated by thermal sources, 33.4% by hydro and 5-6% from other sources.

1.5.1 Impact of energy production on environment in Pakistan

Currently energy and transport sectors are the biggest sectors of producing GHG emission in Pakistan. The Big cities of the country like Lahore are badly affected by the smog resulting in spreading respiratory diseases among mases. For a brief period on October 29, 2019 Lahore was ranked the most polluted city in the world on the global Air Quality Index (AQI). The major cause for this is the energy generation from fossil fuels and transport sector within and in the vicinity of the city. The energy contribution comprises of oil (27.5%), gas (40.9%), liquid petroleum gas (0.3%), coal (5.4%), hydro energy (7.7%), nuclear energy (1.3%) and renewable 0.4 Mt. Lin and Ahmad (2017) investigated that about two decades ago; Pakistan's power supply mainly comprises from claiming hydro vitality (Lin & Raza, 2019). According to the climate change threat to Pakistan, CO2 emission, global warming and transboundary pollution sources collapse the glaciers of Hindu Kush-Karakoram and Himalayan (HKH)(NCCP, 2012) which can cause major floods in future.

Moreover, Increased burning of fossil fuels (Coal, oil, and gas) to meet the energy demand has not only resulted in the Greenhouse Gases (GHGs) emissions but also caused the global warming leading to climate change. This situation demands for exploring alternatives to fossil fuels for achieving targets of energy supply, security, and sustainability. In this context, the government Pakistan has been taking various measures, including restructuring of the electricity sector, developing future strategies,

which ensures affordable and clean electricity with efficient generation, towards sustainable development in the country.

1.6 Current sources of power generation

1.6.1 Natural Gas

Natural gas has contributed as a main source of power generation in Pakistan from so many years. Gas production has increased almost 50% from 1989–99 to 2012. Almost 50% of the country's primary energy supply has contributed by natural gas in 2012. The huge dependence on natural gas makes it essential ingredient of Pakistan's energy mix. The local reserves of Natural gas already reached to its peak which causing difficulty to increase its production level. New local reserves have been discovered but their size is not enough to fulfil the increasing demand. The existing resources are anticipated to exhaust in coming seventeen years if the consumption continues with current rate. However, the consumption rate is anticipated to increase four times which will cause earlier depletion of reserves. In this situation, Pakistan needs to increase its natural gas imports from neighboring and other countries. The two major gas pipelines are proposed which includes Turkmenistan, Afghanistan, Pakistan, India (TAPI), and Iran Pakistan (IP). However, both proposed pipelines are delayed due to worsening law and order conditions.

1.6.2 Oil

Oil is still playing an important role in any country's economy. Total oil reserves in Pakistan is around 22 million barrels. This level is not enough to feed high level of demand of the country. As per statistics provided by EIA (2016), in 2015, the local production of crude oil was 95000 barrels p/day but the consumption was 431,000 barrels per day in the same year. So, the country has to rely on oil imports to fulfil the ever increasing oil requirements. Only the Crude oil imports increased around 12 % only from the year 2014 to 2015. Moreover, Transportation and power sector are the major consumers of oil in Pakistan. Major proportion of the country's oil consumption comes from imported oil. Oil and oil related products are expensive commodities and the country's economy cannot allowed to import oil on this massive level because it is not only the heavy burden on the economy but also resulting in trade deficit. However, Pakistan's trade deficit has hit a record level of 30 billion US dollars in the first 11 months of 2016-17, showing a jump of 42 per cent as compared to the same period in the previous financial year. Exports have declined by three per cent to 18.5 billion US dollars while imports have gone up by 21 per cent to 48.5 billion US dollars. Never before in the country's history have imports been over two-and-a-half times of exports as they are now. One of the main reason for this unprecedented trade deficit was country's biggest import i.e. oil.

1.6.3 Hydro

The electricity generation from the movement or flow of water is called hydroelectricity. Hydro is not only the biggest source of renewable energy all over the world but also it has remained the main source of renewable electricity in Pakistan since many decades. Around 70% electricity comes from hydro in 1960's in the country. However, the share of hydro in the total electricity generation is decreasing. In 2017 only 30% share of electricity was generated by hydro. The main reason for the declining share of hydro is instead investing further in hydroelectric dams the government changed its priorities towards thermal source of electricity due to its short time and low cost of installation. However, indigenous thermal sources are not enough which put more import burden on the economy of Pakistan. According to IPCC (2011) the global share of hydro power in total electricity was 16% in the year 2008 and more than 160 countries are generating electricity from hydropower in their electricity mix.

Pakistan is a plenty of rivers and so many natural sites where the dams can be built easily. There are so many feasibility reports are also completed in this regard. The geographical location of water flows makes the potential of hydroelectric generation through water very high. According to Ministry of water and power (2006), Pakistan can store on 13% of its available water in the reservoirs and more than 80% water flows down to Arabian Sea. Therefore, extra reservoirs are required not only for electricity generation but also for irrigation purposes in the long run (Raheem, 2016).

1.6.4 Coal

Pakistan is considered as a coal rich country but unluckily the enormous reserves of coal never been utilized for power generation at least three decades (PPIB, 2004). The reasons for not exploiting coal reserves are government lack of interest, improper policy making and insufficient financing and lack of technology. The government of Pakistan is now facilitating the private sector in order to exploit coal for power generation so that the current electricity demand can be met. Moreover, the recent discovery of coal reserves in Thar Desert of Pakistan made coal potential increased manifold. According to the PPIB (2014) these reserves are accounts for approximately 175.5 billion tons which can generate 100,000 MW electricity for the next 30 years.

1.6.5 Nuclear

Pakistan total installed capacity of nuclear energy is 650 MW which is still very less. Pakistan got the nuclear technology in 1970s' but started to generate electricity after three decades especially after the successful test of atomic bomb in 1998. However, the share of nuclear energy is still very low in the power supply of Pakistan. The government of Pakistan intend to enhance its capacity and for this reason the government asked the institution dealing in nuclear energy named; Pakistan Atomic Energy Commission, to propose a framework in order to generate 9000 MW electricity from nuclear till 2030 (Husain, 2010).

1.7 Renewable energy sources in Pakistan

Renewable energy resources can be one of the best and long term solution not only for the current energy crisis of Pakistan but it can also fulfil country's energy demand in future. Pakistan has plenty of natural resources including water resources which make Pakistan agricultural country. Pakistan can also utilize its agricultural residue, wastes and crops to generate electricity. Potential of electricity generation from wind is also become very high after the discovery of wind corridor in the coastal belt of Sindh and Baluchistan provinces of Pakistan. Wind corridor is regarded one of the best place install wind farm because of the air circulation throughout the air. Moreover, Pakistan is also favorable for solar power because of duration of sunshine is higher than normal average in Pakistan.

Pakistan is also highly populated country around 220 million population according to the census 2017. There is a large sector of population which is still not connected to the national grid due to their disperse nature of location and weak government infrastructure. Mostly the rural population is not connected to the national grid. On the other hand, government is facing difficulty to fulfil the electricity demand of the people connected to the national grid. In this scenario, it has become essential to exploit indigenous renewable energy resources not only to fil the existing energy supply and demand gap but also to bring the communities without electricity into the national grid. Renewable energy sources (RES) with their potential in Pakistan will be discussed in details below. See Figure 1.7 for general idea.

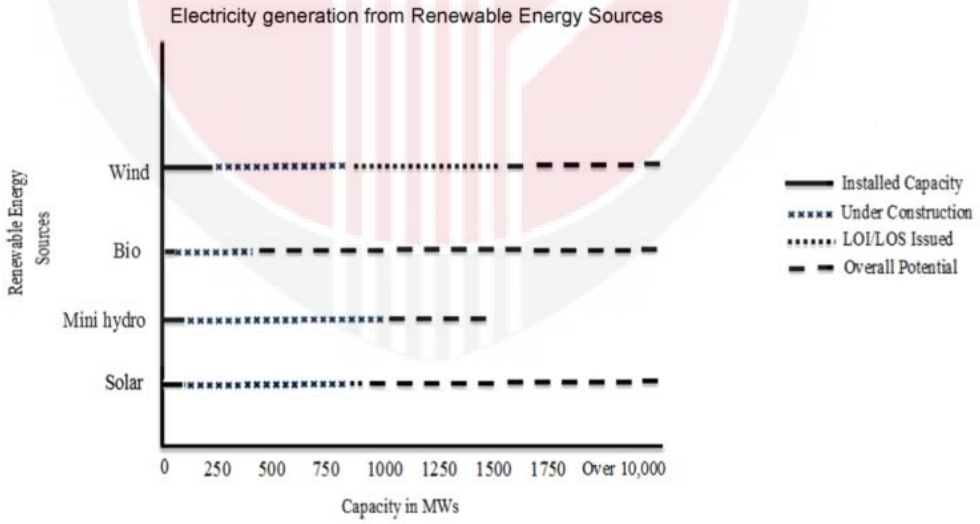

Figure 1.6 : Actual and Potential Electricity Generation from Renewable Energy Sources (Source: Shakeel et al. 2016)

1.7.1 Hydro

Pakistan has an enormous hydro power potential which approximately accounts for 40,000 MW, whereas country only installed 7,116 MW up till now. The share of hydroelectricity in the total electricity generation in Pakistan is almost 30%, whereas this share was 70% in 1960's. The hydroelectricity generation is mostly owned by the government, which according to Nepra (2016) only 214 MW is owned by private sector. Figure 1.8 depicts the declining rate of hydroelectricity in Pakistan.

However, Major share of hydel power is installed and owned by public sector whereas only a small portion is owned privately including micro hydro power projects (Nepra, 2016). Presently, renewable electricity is generating through large hydropower dams in Pakistan. The consequences of the construction of large hydro dams comes in displacement of local people and also changes in land use for the dam construction area. Recently, few of the projects also have got political involvement and become controversial in Pakistan due to major impact on rivers, ecosystems, and dislocation of local communities. Large hydropower dams were initially built in 1970s but the share has been declined continuously over the last two decades due to the above stated causes (Asif, 2009).

Hydro power technology is comparatively matured among other renewable energy sources and it has the potential to compete with other conventional energy sources like coal, oil and gas. Currently, hydro power is the main source of green electricity production in Pakistan. The country's known potential for hydro electricity generation is around 100 GW. Whereas the discovered sites for hydro dams is 59 GW (PPIB, 2011). The country can get rid of the dirty sources of electricity production by giving more attention on the local sources of clean electricity like hydro, wind and solar.

Moreover, government is also focusing on the mountainous area where water flow is available and local communities are still not connected to the nation electricity grid. These locations mostly found in northern areas of Pakistan which are near to Himalia region. Government involving local and private investors to install small hydroelectric turbines to generate enough electricity for the local residents. In this regard, 300 micro and mini dams have installed in these remote areas by public-private joint venture. Moreover, Water and Power Development Authority (WAPDA) intend to enhance its hydroelectricity by generating 16000 MW electricity till 2025. The decreasing trend of electricity generation from hydro source can be seen in the Figure 1.8 below, which has been taken from world bank website.

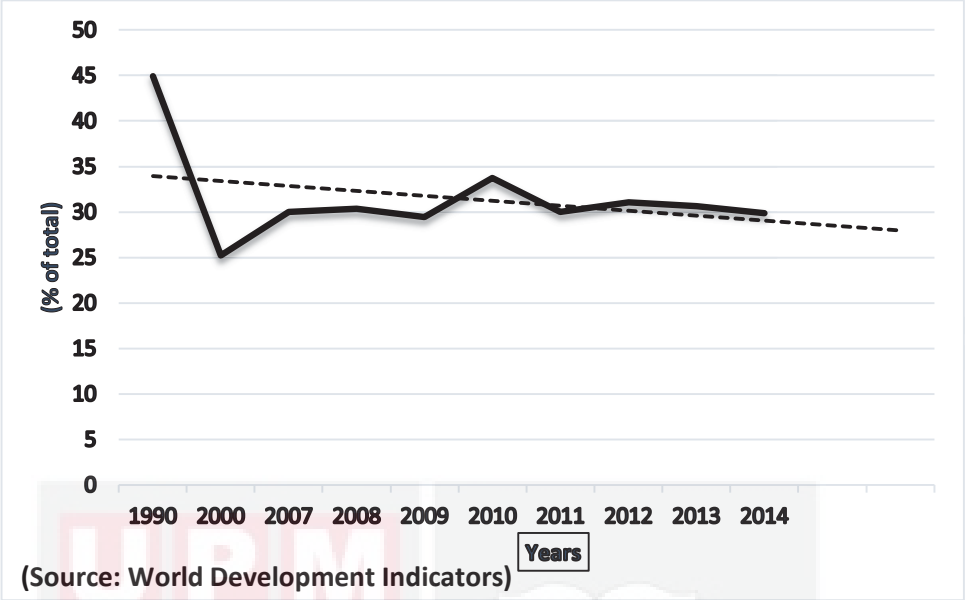

Figure 1.7 : Electricity Generation from Hydroelectric Sources in Pakistan

1.7.2 Solar

Energy obtained through sun light is recognized as solar energy (Shakeel et al., 2016). This energy can be converted to electricity or heat according to requirement. Sun light can be transformed into electricity either by solar photovoltaic directly or through generating steam to run steam turbine power plant in order to generate electricity which is known as solar thermal conversion. Electricity generation from solar technology is gaining its pace and has become popular worldwide. Whereas, the solar photovoltaic capacity has been increased up to 55% in the last five years (REN21 Steering Committee, 2013).

Pakistan has great potential to develop solar energy because of its geographical location which comes under the sunny belt. According to the survey report of United States National Renewable Energy Laboratory (NERL) the land of Pakistan receives extensive solar radiations because of long sunny days which makes its land ideal for solar energy. According to (Harijan et al (2009) the country has 1600 GW electricity generation potential which is almost 40 times of current energy generation. Several regions in Pakistan provide ideal location to install solar power projects as Baluchistan province is regarded best in term of average sun light per day (Ashraf Chaudhry et al., 2009). Moreover, the barren deserts of Sindh and Punjab provinces which are mostly infertile, are also desirable for the solar power generation due to the high solar radiation.

Though soil of Pakistan contain great potential for solar energy but the country is still in its initial phases in harvesting solar energy. According to South Asia Regional initiative for Energy Integration (as stated in Shakeel et al., 2016) Pakistan government

felt the importance of solar energy in 1980 and installed 18 photovoltaic systems of 450kwh capacity of electricity generation but due to miss management and poor understanding of technical issues could not get desired results and abandoned the project. Later in 2003, Government established an institution named; Alternative Energy Development Board (AEDB), in order to ensure the development of renewable energy technologies in Pakistan. AEDB initiated the development of renewable energy technologies (RES) by installing solar photovoltaic (PV) and providing electricity to 30 villages in rural areas of Punjab province. Moreover, the government has also initiated the Quaid-i-Azam solar power project which is expected to generate 100 MW electricity in its first phase. Moreover, Government also waived off taxes and duties on the import of renewable technologies like solar in order to promote these technologies. So that the target of 5% of solar energy can be achieved in the energy mix till 2030.

1.7.3 Wind

"Wind power is leading the charge in the transition away from fossil fuels; and continues to blow away the competition on price, performance and reliability", said Steve Sawyer, GWEC Secretary General. "Both onshore and offshore, wind power is key to defining a sustainable energy future" (Global Wind Report, 2017).

Rapid development and penetration of wind power has been seen in recent years. According to facts and figures about countries provided in the Global Wind Report (2017) that the share of wind power has been reached up to 44% and 30% in Denmark and Uruguay respectively, in 2017. Overall share of wind power reached 11.6% in Europe in 2017. It further stated that few states of US, Germany and Australia are using wind power more than 30% of their energy mix.

Rapid development of wind power has been seen in recent years all over the world. According to Shakeel at al., (2016) wind power is consumed by more than 83 counties of the world and the capacity of onshore wind power generation increased up to 282 GW globally with an expansion of almost 25% over the past five years (Shakeel et al., 2016).

Pakistan is also enriched with wind high wind power potential. Alternative Energy Development Board (AEDB) is working to develop wind energy in Pakistan by the collaboration of some international institutions like USAID and National Renewable Energy Laboratory (NREL). These institutions pointed out several location feasible for installation of wind turbines. Most of the suitable areas are located near the coastal line of Sindh and Baluchistan provinces of Pakistan (Shakeel et al 2016). For example, the wind speed has been identified at 7 m/s as average above 50 meters to the ground level in the Ghoro-Keti Bandar site in Sindh province which makes it perfect for wind power production on large scale, and the total identified potential for electricity generation is more than 60 GW (AEDB Pakistan, 2010).

However, despite of the great potential of wind power, the share of wind power in the total energy mix is less than one percent which is negligible. Government has shown an interest to develop the wind power in recent years but could not achieve its targets due to financial and technical issues. However, Government decided to develop more wind power generation because of the opportunity of having wind corridor in the coastal region of the country. According to Economic Survey of Pakistan (2009) the government has revised the renewable energy targets in 2008 and set a new target of 5% of total installed capacity from renewables by 2030 including solar and wind (Alternative and renewable energy policy, 2011).

1.8 Electricity sales and consumer-wise electricity consumption

The share of domestic consumers in the consumption of electricity is highest followed by industrial and commercial sectors, which can be seen in the statistics provided in Table 1.2 from 2011-12 to 2015-16. However, the comparison among different types of consumers in the year 2015-16 is explained in figure 1.8. According to the table 1.2, the trend of domestic type of consumers and their consumption is increasing every year. The consumption increased from 42.69% in 2011-12 to 46.14% in 2015-16. All the other types of consumers are also increasing with different trend. This information also given in graphical representation in figure 1.8, which is very easy to understand the nature of electricity consumers and their consumption trends.

Table 1.2 : Category-wise Consumers and their Electricity Consumption (%)

		2011-12	2012-13	2013-14	2014-15	2015-16
Domestic	Consumers	84.69	84.85	84.91	85.07	85.25
	Consumption	42.69	43.5	44.13	44.84	46.14
Commercial	Consumers	12.68	12.51	12.44	12.32	12.19
	Consumption	6.99	7.30	7.16	7.16	7.52
Industrial	Consumers	1.32	1.32	1.32	1.31	1.30
	Consumption	26.7	27.14	27.42	27.71	26.47
Agricultural	Consumers	1.25	1.26	1.27	1.25	1.21
	Consumption	10.49	9.46	9.43	8.91	9.04
Public Lighting	Consumers	0.04	0.04	0.04	0.04	0.04
	Consumption	0.59	0.61	0.56	0.56	0.49
Bulk Supply	Consumers	0.02	0.02	0.02	0.02	0.02
	Consumption	4.18	5.03	4.85	4.73	3.76
Others	Consumers	0.00	0.00	0.00	0.00	0.00
	Consumption	1.38	0.25	0.26	0.05	1.22
Supplied to K-EL by PEPCO	Consumption	6.98	6.71	6.19	6.03	5.36

(Source: Nepra, 2016)

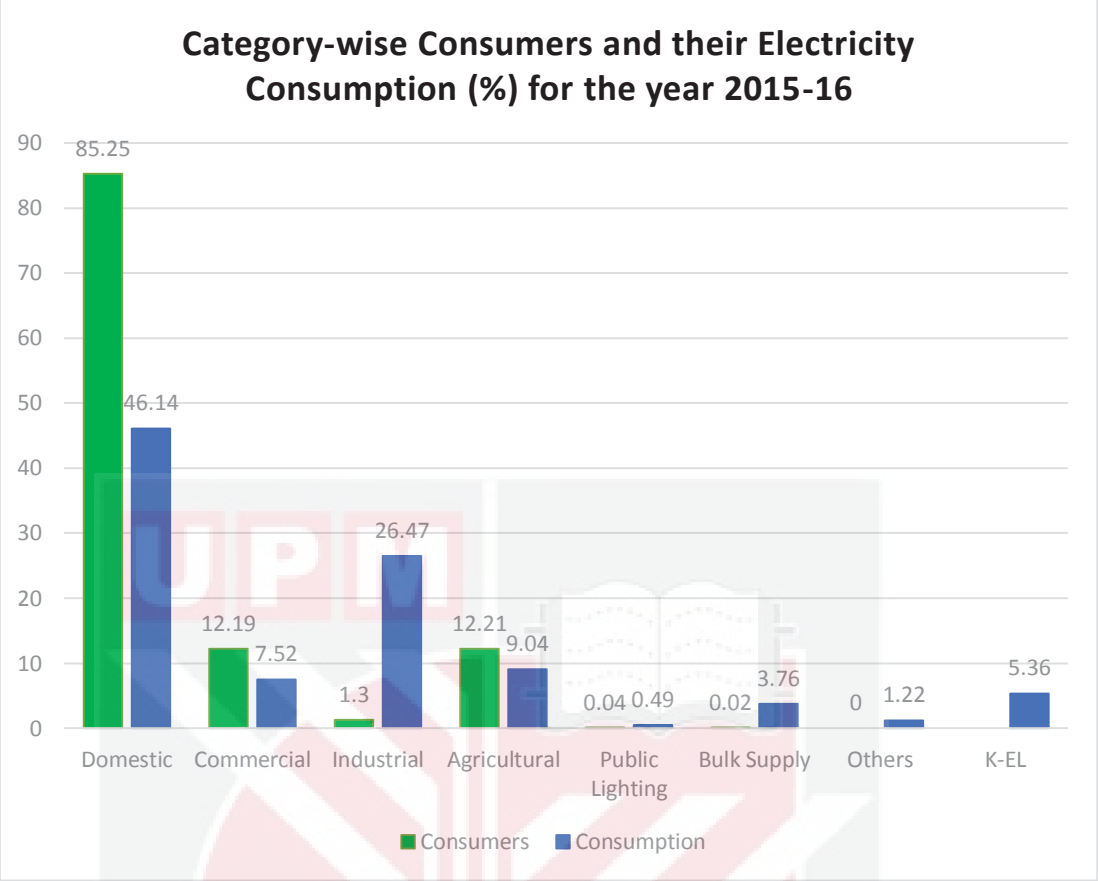

Figure 1.8 : Category-wise Consumers and their Electricity Consumption (%) for the year 2015-16

1.8.1 Annual growth rate and demand of electricity consumption

The electricity consumption of the country was growing steadily since 2000. However, during the FY 2017-18 electricity consumption in the country excluding K-Electric area increased by 12.00%. This is showing the increasing demand of electricity in the two major sectors which are domestic and industrial. The sector wise electricity consumption and their share in total electricity consumption of the country, for the years 2013-14 to 2017-18 are given in the following table 1.3.

Table 1.3 : Annual Growth and Demand of Electricity

		2013-14	2014-15	2015-16	2016-17	2017-18
Domestic	GWh	38,811.30	40,327.90	43,537.29	48,061.48	53,283.72
	%	9.62	3.91	7.96	10.39	10.87
Commercial	GWh	6,299.50	6437.89	7096.43	7769.63	8511.33
	%	6.04	2.20	10.23	9.49	9.55
Industrial	GWh	24,118.80	24,917.32	24,977.75	23,951.60	27,398.17
	%	9.20	3.31	0.24	-4.11	14.39
Agricultural	GWh	8289.49	8015.97	8525.27	9222.16	10128.62
	%	7.66	-3.30	6.35	8.17	9.83
Public Lighting	GWh	495.90	501.31	457.64	485.30	475.95
	%	-0.44	1.09	-8.71	6.04	-1.93
Bulk Supply	GWh	4263.55	4256.07	3550.90	3878.82	5485.16
	%	4.09	-0.18	-16.57	9.23	41.41
Others	GWh	228.40	46.02	1149.49	1169.71	479.18
	%	13.53	-79.85	2398.02	1.76	-59.03
Supplied to K-EL by PEPCO	GWh	5441.00	5427.00	5059.00	5077.00	5128.00
	%	-0.40	-0.26	-6.78	0.36	1.00
Total	GWh	87947.93	89929.48	94353.76	99615.70	110890.13
Percentage change	%	8.06	2.25	4.92	5.58	11.32

On the other hand, the share of (LESCO, FESCO and MEPCO) is more than 51% out of ten distribution companies in Pakistan (NEPRA, 2018). LESCO comprise of Lahore city and nearby areas like Kasur, Okara, Shaikupura and Nankana, which makes LESCO one of the biggest company in Pakistan. Whereas, QESCO is the smallest distribution company in terms of its consumption and consumers. However, QESCO covers the biggest in Pakistan. Main Industrial areas of Pakistan are located in Karachi, Lahore and Gujranwala. However, other cities also have industrial areas but main hub is near big cities of the country.

1.9 A glance on the demographics of Pakistan

According to the census 2017, Pakistan population is 212 million, which makes it fifth most populous country of the world. The average population growth rate stood at 2.40% between 1998 to 2017. However, dramatic social change in the country led to rapid urbanization. In the result, mega cities has been emerged all over the country like Karachi, Lahore, Faisalabad and others. Only the Karachi population exceeds 16 million. Whereas. Lahore's population exceed 11 million. On the other hand, the age structure of the people can be divided into three categories. Almost 35% people are in between 0-14 age group. Approximately 60% of the population falls in the age group of 15-65 years, and only 2.4% of the population is above 65 year. Whereas, the life expectancy is only 67.7 years. Sex ratio of the males are higher than females. 48.5% of the population is female. Whereas, 51.5% of the population is male. The literacy rate of Pakistan is 65%, where male literacy rate is 69% and female literacy rate is 40%. Moreover, the GDP per capita of the country was 1196.60 in 2018.

1.10 Motivation of the studies

The huge reliance on thermal power for electricity generation, power sector of Pakistan has become significant contributor to GHG emissions, as shown in Figure 1.9.

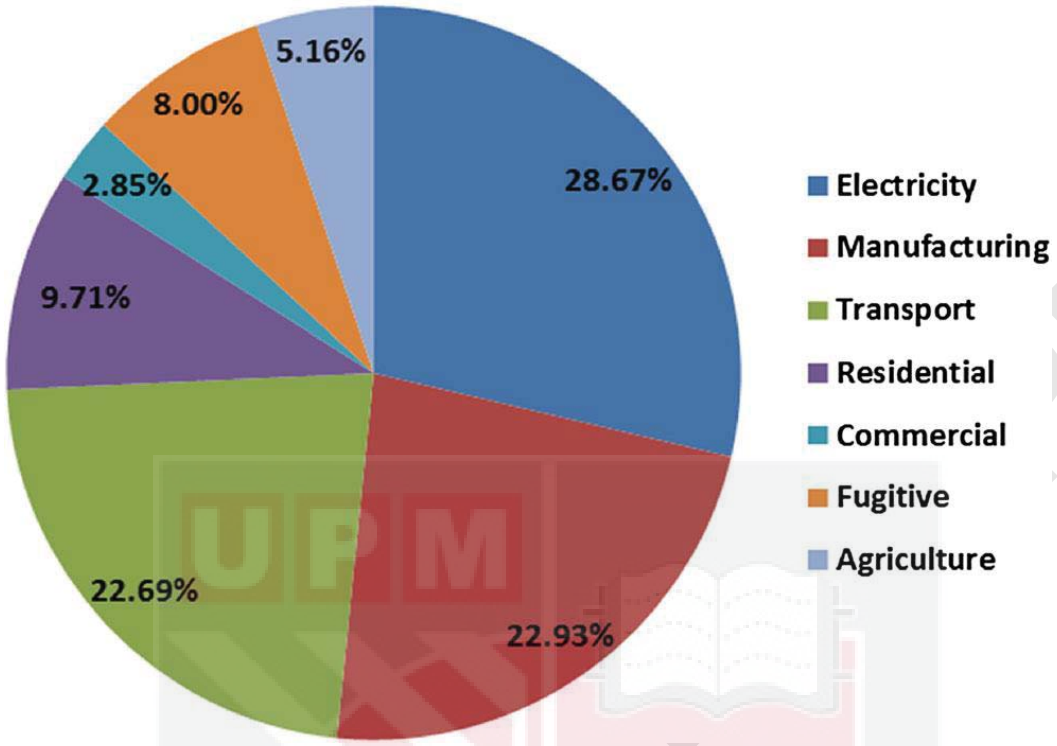

Figure 1.9 : Sector wise Co2 Emission in Pakistan
(Source: Mir, Purohit, & Mehmood, 2017)

In Pakistan, the Government has plans to improve and upgrade the electricity infrastructure through generating more electricity from renewable energy sources. In order to evaluate the economic benefits which people are expected to gain if the green electricity sources are increased in the system, their preferences for any specific renewable energy sources will considered in this study. There are no existing estimates of willingness to pay (WTP) for better service of electricity found in Pakistan. A small number of such studies have been found elsewhere in the world but according to our knowledge there are no valuation studies found in energy sector in Pakistan.

1.11 Problem Statement

An increasing population, growing industrialization, and rising Household incomes are consistently fueling the increasing demand of electricity in Pakistan. Pakistan has a very limited fossil fuel resource base. The poor economy does not allow the import of fossil fuels, particularly oil, on a large scale. As Pakistan's trade deficit has hit a record level of 30 billion US dollars in the first 11 months of 2016-17, showing a jump of 42 per cent as compared to the same period in the previous financial year. Therefore, too much reliance on imported oil is not only critical from energy security point of view but also for the country's trade deficit because Oil is the biggest import of Pakistan and oil prices are gradually on rise. If oil prices go up in the international market, the import bill starts to climb at a fast pace, which will cause more burden on

economy of highly populated country. Only the Power sector of Pakistan consumed 33% share of oil for the generation of electricity in 2017.

Moreover, a fraction of the population also lives in remote areas and is still waiting to be connected to the national electricity grid. However, to overcome these issues, Pakistan needs to develop its indigenous energy sources like hydropower, solar and wind, which require more investment and more research and development. It is yet to be measured that people of Pakistan are willing to pay for electricity from renewable energy sources which are comparatively expensive in context of Pakistan.

Due to the ever growing electricity demand in Pakistan, government realized that meeting this much demand by the public sector plants alone was not possible in short time period for various reasons, resulting the introduction of Independent Power Producers (IPPs) into the electricity supply market. However, most of the IPP's are based on fossil fuels resulting in air pollution and environmental degradation. Therefore, to address the severe electricity shortage in Pakistan, Government of Pakistan is trying to bring other renewable (e.g., solar and wind) sources of electricity to the gird now. However, despite the huge potential of renewable generation in Pakistan, only a very small capacity has been realized. The government of Pakistan has revised the renewable energy targets in 2008 and set a new target of 5% of total installed capacity from renewables by 2030 including solar and wind. Whereas, the current share of electricity from wind and solar in still less than one percent (1%) only. This target is still not yet achieved because of not implementing the concrete steps towards the goal and due to shortage of funds.

Renewable energy sources (RES) are not only consider as very important for the production of green electricity (GE) but also it has a huge potential in the reduction of environmental emission and burden of fossil fuel imports. In this regard, government has started to promote renewable energy technologies all over the country and motivating consumers to generate their own small scale electricity which can be sold to the government through implementing net metering system at homes.

Green energy has several sources like Wind (air), Hydro (water) and Solar (sun). Hence, it is important to know which sources of green electricity is preferred by Pakistani people and how much are they willing to pay extra for that source of green electricity. Different previous studies on renewable energy listed potential attributes of renewable energy which are preferred by people in different settings. Some of the attributes included (% of electricity from solar, % of electricity from wind, mixtures of renewable energy sources, location of renewable energy projects, size of power plants, local biodiversity, land scape and many more). Each attribute comes with different levels and with several benefits. They found difference preferences of people in order to increase the share of electricity from renewable energy sources. Some preferred solar, some preferred wind, some preferred mix of sources and some are more willing to pay for jobs, land scape and preserving local biodiversity. These issues are still uncertain.

Moreover, consumption of green electricity is influenced by many tangible and intangible factors. There are many factors including social and psychological factors like values, attitudes and personal norms which are also influencing green electricity consumption decision apart from tariff. We don't know which factors are contributing more in influencing green electricity consumption in Pakistan. Moreover, Environmental values is an important part of our decision making process and influences our behavior towards a situation that concerns environmental issues. However, no research has examined the connection and possibility of pro-environmental and social psychological attitudes and moral values in the prediction of consumption intention of electricity from renewable energy sources in Pakistan.

1.12 Research questions

In the light of objectives of this study, the research questions are as below:

1. What are the factors that Influence the use of Green electricity?
2. How much is the value of WTP for the green electricity?
3. What is the value of the attributes of green electricity?

1.13 Objectives

The general objective of this study is to assess the usage intention, attribute preferences and economic value of the green electricity in Pakistan.

1.13.1 Specific objectives

1: To investigate Factors Influencing the consumption of Green electricity
2: To Examine the consumer's Willingness to pay (WTP) for Green Electricity
3: To Estimate the Value of Attributes for Green Electricity

1.14 Scope of the study

The research will be conducted based on primary data, which will be collected within Pakistan. One of the justifications for selecting Pakistan is that due to its geographical location Pakistan is prone to Environmental and climate changes and due to rapid population growth its energy need is increasing day by day and environmental quality is becoming worse. Secondly, Oil and other oil related products dependency are making Pakistan more vulnerable causing economic burden and only due to oil imports the total imports exceed exports in Pakistan. Third and most important, A little focus is given on consumption of electricity from clean sources through the participation of people. This study will focus specially on the consumer's perception and preference about green electricity and their Willingness to pay. Moreover, as per literature review this study will be first of its kind in the Energy sector of Pakistan.

1.15 Significance of the Study

The environment is the world's largest and most valuable non-market resource but consumers, firms, and governments worldwide are deriving utility from the environment at a rate that is unsustainable but are unwilling to mitigate climate change. Trees are being cut quicker than they can regrow, soil erosion faster than new soil formation, C02 is being released into the atmosphere faster than nature can absorb it, and habitat destruction and climate change are destroying plant and animal species, launching mass extinctions (Brown, 2005). Increased burning of fossil fuels (Coal, oil, and gas) to meet the energy demand has not only resulted in the Greenhouse Gases (GHGs) emissions but also caused the global warming leading to climate change. This situation demands for exploring alternatives to fossil fuels for achieving targets of energy supply, security, and sustainability.

In this regard, government Pakistan has been taking several measures, including reestablishing of the electricity sector on strong grounds, developing future strategies which ensures affordable and clean electricity with more reliable and safe way of clean electricity generation, towards sustainable development in the country. According to the current scenario of Energy sector, Environment and Economic condition in Pakistan, it is need of the hour to develop Renewable Energy sources and technologies in Pakistan by including public participation. Figure 1.10 explains the reasons that why electricity from renewable energy resources are important in Pakistan.

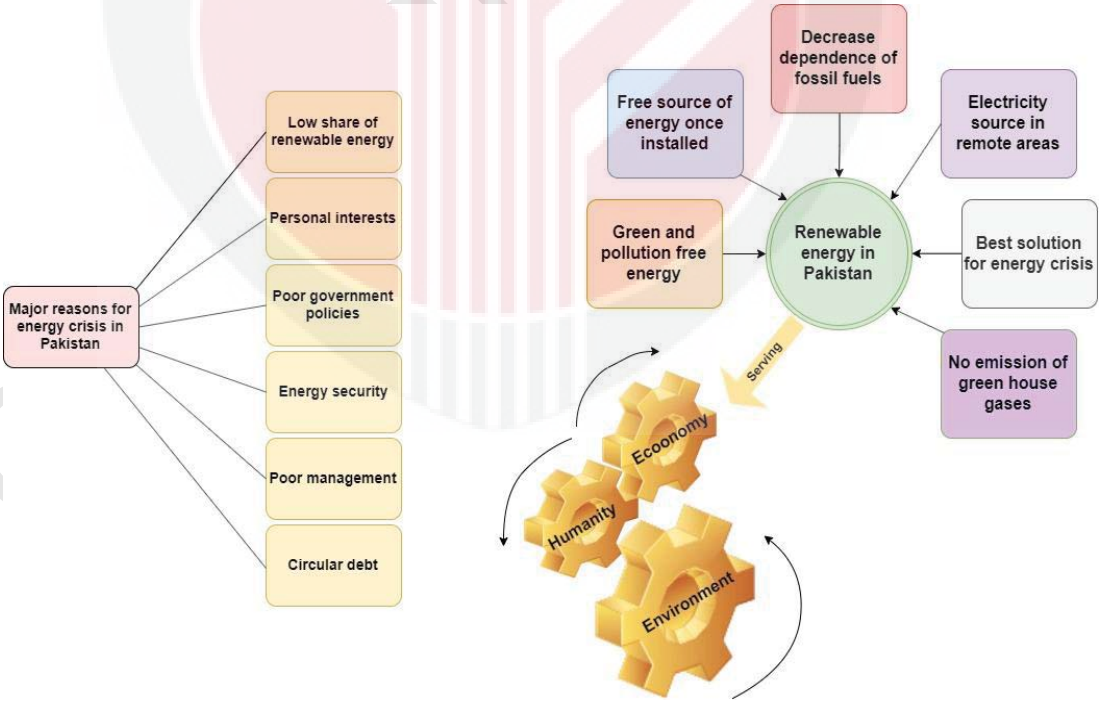

Figure 1.10 : Why Electricity from Renewable energy sources is important in Pakistan (Source: Rafique & Rehman 2017)

In addition, the electricity providing authorities may impose a surcharge on the electricity bills in order to develop more green electricity from indigenous renewable sources. This research will provide extensive information about the electricity consumer's willingness to pay from green electricity. This information will also provide better understanding to the higher authorities of the country to estimate the charges to be imposed for green electricity.

Furthermore, identifying the preferences related to green electricity and its different sources and the factor influencing the use of green electricity, will also provide important information to the government and its related agencies that the consumers preferred which green sources of electricity. The government agencies may also get insight for the future green energy development policies by getting valuable information from this study, as this study will also focus on the public intention about the green electricity usage.

To the extent of the researcher's knowledge there has been no valuation study on electricity from clean sources of energy in Pakistan; most studies have been directed to health, environment, and public transportation. Hence, the primary justification of this study is to pioneer research on the preferences, consumption intention of green electricity, and willingness to pay of consumer's for the electricity from renewable energy sources. This research will be added in the body of literature in the application of Contingent Valuation Method and Choice Modelling for the estimation of consumers' willingness to pay for green electricity in Pakistan. As per literature review this study will be first of its kind in the Energy sector of Pakistan.

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