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Pakistan Energy Outlook for Next 25 Years

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Abstract
This research aims to estimate the sectoral demand and supply of energy in Pakistan. It incorporates macro and microeconomic data to make reliable forecasting for each sector and sources of energy that is aligned with demographic, economic and industrial development of Pakistan. Box Jenkins methodology in which the ARMAX model is applied to use historical data for forecasting. This research used the time series data from 1990 to 2021. From the analysis, it has been found that estimated energy indicates that energy demand and supply will be continuously increasing, and the demand and supply gap will be minimized in the next 25 years. The overall estimates of the energy supply mix indicate that over-dependence on oil for energy production will be reduced from 23.3% in 2021 to 15.2% in 2046. Similarly, demand for oil will decline from 21.2% in 2021 to 10.7% in 2046. However, supply mix reflects an inclination towards the usage of coal and renewable energy sources for the production of energy. In addition, renewable energy sources demand increases from 1.0% in 2021 to 7.3% in 2046. The core finding of the research suggests that energy deficit will decline with the effective implement a government energy supply plan that result in the elimination of energy deficit in next seven years. There is a supply and demand gap even though both energy demand and supply will increase. Higher dependence on imported energy import bills is on continuous rise which burdened the economy with higher debt. However, by shifting it to renewable energy sources, this can be minimized and made the energy affordable and accessible. The energy estimates for the supply suggest that dependence on oil will decline due to higher environmental concerns. However, there will be more inclination toward sustainable sources of energy production.
Keywords: Pakistan Energy Sector, Box Jenkins Methodology, Energy Demand-Supply Gap, Energy Forecasting

1. Introduction

Energy sector play an essential role for the economic development of an economy. During recent decade, energy sector shown significant increase in demand for the energy. Notably there are three key element which lead to increase in energy demand such as increase in economic activities, growth in population and rapid technological development across the world (Jobling & Jamasb, 2017; Wiafe, 2018). However, recent increase in commodity prices due to global economic development, improved growth and Russia-Ukraine conflict also accelerate energy demand. Increase in cost of fuel and electricity has ultimately increase overall production cost which ultimately results in higher prices that increases cost of living and declines purchasing power of households across the world.

Pakistan is 5th largest country by population, 22nd largest economy by GDP PPP. Pakistan with the population of 242.8 million out of which 40 million people lack access to electricity which minimize opportunities for inclusive growth (IEA, 2021). In comparison to the data of the world, Pakistan's population is 2.97%, GDP (PPP) 0.55%, and primary energy supply 0.66%. The data of 2021 reported that primary energy supply is 9% less than the primary energy demand – Deficit in natural gas and electricity. Only 87% households have access to electricity and 31% have access to natural gas (pipeline gas connection). Among different sources of energy, more than half of energy supply is import-based as over 85% of energy supply is fossil fuel (Oil, Natural Gas, and Coal) based. while considering the need of each sector, 70% of energy is being consumed by industrial and transport sectors, over 20% by residential sector and remaining by others.

With consideration of different challenges to energy sector government of Pakistan has developed different policies such as National Electricity Policy 2021 which aims for providing affordable energy, energy security, sustainability along with its focus on indigenization. Additionally, National Electric Vehicles Policy 2019 was developed with the focus on aims to incentivize EVs, Two-wheeler motorcycles, three-wheeler motor rickshaws, other three-wheelers, buses and mini-buses are expected to include 50% of new vehicles as electric vehicles by 2030 and motor cars jeeps & station wagons, motor cabs/ taxis, and trucks are expected to include 30% of new vehicles as electric vehicles by 2030, increasing this rate gradually to 50% by 2046. Furthermore, Alternative and Renewable Energy policy was introduced in 2019 for providing assistance and promoting use of renewable energy sources across the country. The aim of this policy is to provide supportive environment for renewable power project and increase share of renewable energy sources by 20% in 2025 and 30% by 2030 through attracting private capital for development of green energy (Yoshida, and Saqib, 2011).

Energy forecasting for the country play an important role which contributed for defining the future demand and power optimization along with minimizing losses. Forecasting contributed for risk mitigation and making more informed decision which ultimately reduce transmission and distribution losses. This ensures energy and cost efficiency decision for power generation capacity, reliability of energy-based projects and power optimization (Kateule et al., 2023). Forecasted energy contributed for planning and operations for power sector. Forecasting allows power generation companies to efficiently allocate resources and assume that system is in control for balancing the demand and availability of electricity (Tawari, 2024; Attiwal & Indora, 2024; Hong, et al., 2020). Regardless of its imperative role in economic analysis of power sector, sometimes demand forecasts are unclear. Demand forecast is critical for developing least cost power generation plans and investment appraisal for each power generation project. There are multiple efforts made by the research and regulatory authorities for energy forecasting. However, it has been observed that mostly forecast has been made for 5 years or 10 years. Although short term forecasting is essential for the immediate decision making and planning for daily operations however, this paper contributed for forecasting energy for next 25 years which will support strategic planning and policy formulation of the energy sector.

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Forecasting the long-term energy demand and supply contributed for understanding the need for capacity which is used for further analysis and energy composition of electricity supply expansion project. This paper is the continuation of the paper which estimates the sectoral demand of energy in Pakistan (Okurut and Mbulawa, 2018; Khan, Faizan, and Naz, 2023). Moreover, this contributed for understanding reasons for uncertainties and how these can be minimized. This research incorporates macro and microeconomic data to make the reliable forecasting for each sector and sources of energy that is aligned with demographic, economic and industrial development of Pakistan.

2. Literature Review

Energy serves as a crucial foundation for every nation, playing a significant role in its socio-economic progress and recognized as an essential resource. Energy sector of Pakistan is one of the impediments for the economic growth. With the support for international assistance, there were major strides has been developed for overcoming these issues (Rehman et al., 2017; Iqbal, 2018; Awan and Sohail, 2018). Since 2013, Pakistan making effort for capacity expansion in order to mitigate power outrage issues that influence the country overtime due to expensive fuels, dependance on imported energy, depletion of natural gas resources, circular debt, old an++ d ineffective distribution and transmission system which negatively influence the sector from growing and making improvement in the productivity (Raza et al., 2022; Zhan, 2018). Other than this, weak governance structure, uncoordinated energy policy and lack of planning contributed to current energy distress. It is indicated that without major reforms in energy sector it is difficult to develop prosperous energy sector of Pakistan (Planning Commission, 2021).

According to the Pakistan Bureau of Statistics (PBS) report, that overall trends in electricity generation has evolved over time from 2006-07 to 2020-21. Primary energy supply is mostly from oil and Natural gas. From renewable energy supply, hydropower is the main source along with solar and wind power projects with slower growth in it. As per the Economic Survey of Pakistan 2022-23 the energy mix include 58.8% share of thermal, 25.8% hydel and 8.6% of nuclear power along with 6.8% of alternative power sources in overall energy mix. Moreover, International Energy Agency identified the energy mix of Pakistan as presented in the figure below;

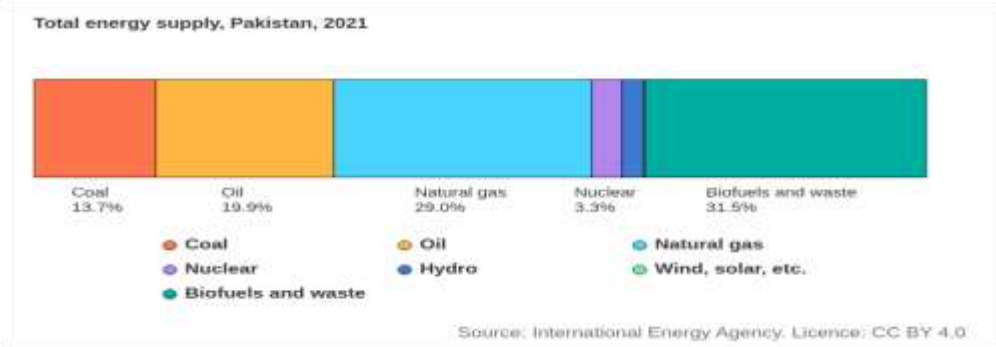

Figure 1:Total Energy Supply

(Source: International Energy Agency)

Pakistan has reserves of fossil fuels in form of coal and natural gas. The natural gas reserve and coal in Pakistan is 0.30% and 0.29% of total world reserves. However, the oil reserve is the minimum then the world such as gas reserves is 37 times less than the Qatar and coal reserves are more than 45 times and less than the Australia. Addition to conventional gas reserves, Pakistan also has reserves of shale Gas and tight oil. According to the 2022 reported data, reserves by fuel types include coal 77.9%, gas 19.4% and oil 2.7% (Durrani, Khan & Ahmad, 2021).

Moreover, hydropower has strong position in terms of renewable energy installed capacity with more than 77% that is higher than wind energy 10.3% and solar energy of 8.4%. Hydropower plays an essential role for sustainable power generation in Pakistan which contributed for 26% of overall energy production in 2021 however, these plants are not utilized to its full potential. This also applicable to solar and wind power generation (Malik et al., 2019). Under-utilization of power generation can also observe in wind and solar power plants which has higher production capacity due to suitable climate conditions (Jones, and Warner, 2016). This is due to the fact that solar activity in Pakistan is around 5.5 to 5.7 kWh/m2 per day and on an average wind speed is 4.0 to 5.5 m/s. The province of Baluchistan in Pakistan has the higher renewable energy generation potential which is located in southwestern part near to Iran border (Sheikh, 2010). This is due to the reason that solar intensity reaches to 6.2 to 6.3 kWh/m2 each day and wind speed exceeds to 7.5 m/s with the higher of 50 m.

International energy statistics (2021) specified that total primary energy production in Pakistan was 1.927 Btu while consumption was exceeded to 3.350 Btu that generated demand supply gap. Domestic energy production share in primary energy was 57.5%. This indicates that Pakistan is highly dependent on energy for meeting its increasing consumption needs. Pakistan primary energy consumption distribution in 2021 was highly dependent on gas that was 41.7% that was followed by 26.4% oil, 17.4% coal, 9.35% hydroelectricity, 3.6% nuclear and 1.3% other renewable (World Energy Report, 2021).

Total electricity generation in Pakistan shows the growth of 60% in last decade. In 2021, electricity produced by different sources that includes 59% from thermal power plant, 26% from hydroelectric power plants and 10.5% from nuclear power (Khatri et al., 2022). Moreover, renewable energy also has significant contribution to the overall electricity generation that reach to 5% in 2021. Compared electricity generation in 2010 from the renewable sources, it is 6 times less in 2021 (The-Nation, 2022). Production from the fossil fuels in Pakistan is less than the demand, in 2021 coal and oil consumption also increased than the production. The overall electricity generation from different sources overtime presented in the figure below;

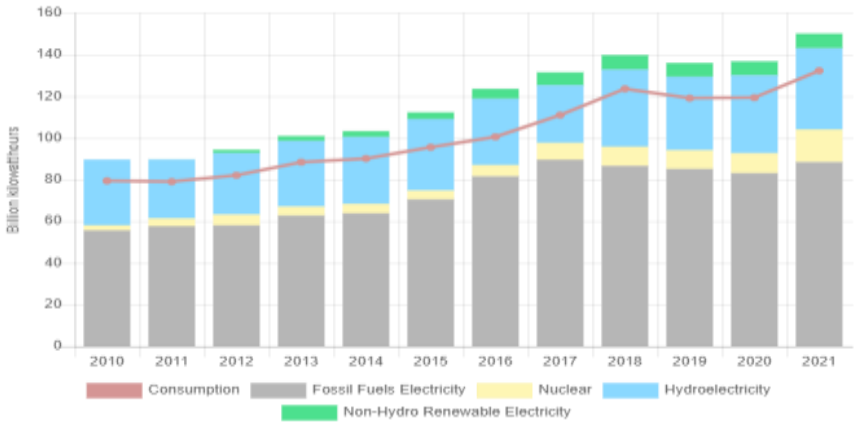

Figure 2:Electricity Generation in Pakistan
Source: U.S. Energy Information Administration (Dec 2022) (www.eia.gov)

Electricity consumption exceed from the generation in Pakistan, however, it only taken into an account that only 79% of population has access to electricity. Furthermore, electric grid and power station are outdated which lead to greater transmission and distribution losses that approximately more than 17 billion kWh per year (Rauf et al., 2015). This estimation implies the needs for reconstruction, maintenance and installation of additional equipment for power generation and distribution capacities.

Comparatively, Pakistan has good elements for the fossil fuel reserves, however, domestic oil and coal-based energy products not utilized appropriately which naturally creates the demand supply gap. Pakistan's primary statistics reflects good generation to consumption ratio if transmission and distribution losses and lack of accessibility to energy are not taken into account (Ministry of Finance, 2019). These statistics does not reflect into real output of the economy as per capita energy consumption and per capita usage, the ranking is below average. Along with this, GDP to energy usage ratio also substantially low then the world average.

The growing population in Pakistan increase the demand for the energy. However, energy mix of the country is significantly depending on imported fuels which result in increasing energy prices that poses challenges to the competitiveness of Pakistan's product in international market (Wakeel, Chen & Jahangir, 2016). The current energy mix include thermal 58.8%, Hydel 25.8%, Nuclear 8.6% and alternative sources are 6.8% in overall mix.

The more reliance on thermal power indicates higher dependence on finite and costly fossil fuels as source for energy generation (Bauer, 2016). There is under-utilization for the renewable energy sources which is comparatively economical and cleaner option.

The main gas fields are located in southeast province of Baluchistan and Sindh, while key oil fields are located in the northern region. The conventional oil infrastructure consists of various medium sized refineries in operations along with relatively large refineries and some refineries are under construction. Specifically, there are six operating refineries with 425,400 bpd capacity for the crude oil and 4 refineries with the planned capacity of 483,000 bpd that is under construction (Rehman et al., 2017). Moreover, there are two large oil terminals and 2 LNG import terminals that are located in southern region near to Karachi. Additionally, coal mining also carried out Baluchistan and Sindh Province.

Pakistan government and other organization has significant interest in development of the Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline, and gas pipeline from Iran. This was expected to be completed in 2014 but the latest data reflects that this project will be completed in 2024 (Saira & Javed, 2022). However, construction of TAPI contain greater risks that is primarily depends on the Afghanistan situation.

Pakistan has developed huge network of hydropower plant that mainly focus in the northern region. These power plants produce more than 26% of total energy generation. Contrarily, fossil fuel plants primarily based on eastern part. In South, there are two to three nuclear plants (Uddin et al., 2019). The third and largest nuclear power plant is located in Punjab with the capacity of 1300 MW.

Hydropower has the largest share of 78% in renewable energy capacity that is followed by wind energy of 10%. The solar plant capacity was 9% in 2021 and bioenergy accounts for 3.5%. Similarly, volume generated from the hydroelectric power plants was around 86% of total renewable energy in 2020. Most of the wind power plants are located in southern part among which some plant has the capacity of more than 100MW (Shahid et al., 2020).

There is great potential for the renewable energy production for which different policies has been made to realize its potential. However, as per the government policy of alternative and renewable energy, the goal is to increase portion of solar and wind power to 30% of total electric capacity till 2030. Additionally, indicative generation capacity and expansion plan 2021 – 2030 aims with the large-scale hydropower development which indicates increase in hydropower capacity to 14,353 MW by 2025 and to 23,035 MW by 2030 that would account for 45% of total electricity generation capacity in Pakistan (NEPRA, 2021).

Increased in energy generation from the renewable sources contributed for cost reduction and meeting increasing demand for the energy in the region. As accessibility and tariffs are an important element for the prosperity of any nation (Reitler et al., 1987). Furthermore, long term energy planning is essential for making sustainable solution for business in order to overcome demand supply gap (I.E. Agency, 2018). Other than this, ministry of planning Pakistan developed vision 2025 that consider reforms and development of government (Planning Commission, 2015). This vision emphasizes on generating 42,000 MW near future which made the energy affordable and accessible till 2025 in Pakistan. Along with this, it focuses on cost reduction per unit and minimize distribution losses by promoting efficient equipment for each sector (Planning Commission, 2015). This plan represents that it will

reduce the poverty by 50% and increase in private investment in energy sector. The core element for increase in energy demand in Pakistan is higher population growth by 1.98% (Nadimi, 2018).

Population growth increase leave no space for denying the fact that it led to increase in energy demand. The significant population growth brings higher challenge for decision makers as it results in severe economic downturn (Baloch, 2022). Moreover, energy sector require investment in long term and effective policy for it. For overcoming this gap, it is important to estimate the long-term energy demand and supply and identify various economic factor which influencing the energy level in Pakistan. This estimate has been based on different economic variables for forecasting short term and long-term energy demand and supply while considering different scenarios.

3. Methodology

This research aims to forecast the energy demand and supply by using historical data and adopting box Jenkins Methodology. This research retrieved the secondary sources includes Energy Outlook 2022, world bank databank, Pakistan bureau of statistics and ministry of finance for estimating the future demand and supply with consideration of various scenarios. This research used the time series data from the 1990 to 2021. Estimation of model also based on the demand supply side assumption mentioned below;

Demand Side Assumptions

- Demand and supply of Oil, Coal and LPG are equal in future
- Historical electricity deficit is equally attributed to Coal and Natural Gas
- Access to electricity will be 100% of population by 2030
- Renewable energy covers net electricity deficit
- Oil and gas based electricity generation reduces gradually
- Electricity transformation losses for oil, gas, and coal will reduce from 60%, 53%, and 46% to 55%, 45%, and 40% respectively in next ten years
- Additional increase in energy demand due to CPEC by 0.15% every year to 1.5% in ten years,

Supply Side Assumptions

- Supply of Hydro, Nuclear, Imported Electricity are determined as per planned project
- Final supply of coal is import based
- Supply of natural gas from TAPI (Turkmenistan-Afghanistan-Pakistan-India) and IP (Iran-Pakistan) may take some additional time to complete
- Domestic Gas supply will deplete gradually by 3% on annual basis

- **Figure 3: Demand and Supply Side Assumptions**

Forecasting energy include the first step of identifying the data stationarity by unit roots testing which applied Augmented Dickey Fuller, Dickey Fuller, and Philips perron test for stationarity. Second, parameter selection of sample ACF and PACF function which help for the selection of autoregressive (AR) process and a moving average (MA) process and conduct goodness of fit test in order to ensure that model sufficiently describe the series. After finalization of model and checking its fit for forecasting the series. Demand estimation in this research has been done through ARMAX (Autoregressive Moving Average with Exogenous Variables) model. The reason for using this model is because the pattern of data is not only depended on the historical data but influenced by external variables.

3.1. Energy Demand Estimation

Estimation for demand of electricity and gas for industrial and residential sector using econometric model using dummy variable for identifying the impact of shortage. ARMAX models is used for forecasting growth rates of final energy demand by sector (six sectoral demand are estimated which comprises of 85% of the total final demand). Moreover, for other sectoral demand it uses CAGR. Final energy demand calculation also incorporates the impact of CPEC and GDP scenarios incorporated through the impact of GDP on final energy demand (regression based). GDP under each scenario is given in the table below;

Table 1: Basic Scenarios

Factors	Scenarios Baseline – S1	Baseline with improvements – S2	Optimistic – S3	Optimistic with improvements – S4	Pessimistic – S5	Pessimistic with improvements – S6
Real GDP	4.13%	4.13%	5.13%	5.13%	3.13%	3.13%
Improvements*	No	Yes	No	Yes	No	Yes

* Improvements include Off Grid Power Generation (5% of total power generation by 2046), T&D Losses (reduced to 16% in next eight years), and targets of National Electric Vehicle Policy 2019

4. Finding and Analysis

4.1. Overview

This research forecast the energy demand and supply for the future in order to make future policy recommendation for bridging energy demand and supply gap. The applied methodology is box Jenkins model in which ARMAX model has been applied for making projection. However, this paper is the continuation of the paper Raza, Faizan, & Naz, (2023) that provide the details on the applicability of initial steps, therefore this paper discusses the last steps of the model i.e. forecasting. The forecasting of energy demand supply is based on different scenarios along with consideration of domestic and imported energy.

4.2. Forecasted Energy Demand and Supply

Energy is an important input for economic growth for sustainable commercial and industrial activities. Approximately, 30 million (15% of total population) lacks access to electricity which minimize opportunities for inclusive growth for the country (ADB, 2015). Forecasting demand for the energy is essential but critical task as it is affected by multiple internal and external factors.

Accurate forecast results in development of cost-effective electricity generation plan and create several opportunities for different projects in future. The major interest of policy makers, private investors, and utilities are essential for professional project development. In relation to this, inaccurate forecasts whether it is underestimated or overestimated, it led to significant social and economic consequences.

Forecasting energy is essential for efficient planning in order to balance the supply and demand side. It plays an important role for short-term and long-term planning for different energy related stakeholders and policy makers for both government and private sectors entities.

Energy demand management become more vital during recent decade as overall energy resources are depleting with increase in carbon emission and global inclination towards adoption of renewable energy are not fully implemented. Therefore, energy forecasting is an important aspect for demand management in a country.

Energy demand can be forecasted by using different methodologies; however, this paper utilized the socio-economic variables for forecasting the energy demand including population growth, inflation, real and per capita GDP growth, growth in the number of households, industrial GDP growth, high-speed diesel (HSD) and gasoline prices growth, and inflation.

The results shows that energy demand and supply will be continuously increasing for the next 25 years. The major reason behind this will be unprecedented population growth, industrial development, shift towards sustainable transportation system and other. With consideration of demand, it is important to note that supply will also increases but at a lower rate as compared to demand which gain created energy demand and supply gap for the country. interestingly, the forecasts show that till the end of this decade, energy demand and supply will be at the equilibrium point which might be due to development and investment in energy sector. Contrarily, sufficient energy cannot be produced from the plants which can sustain for the long-term period that results in energy demand supply gap of around 130 MTOE.

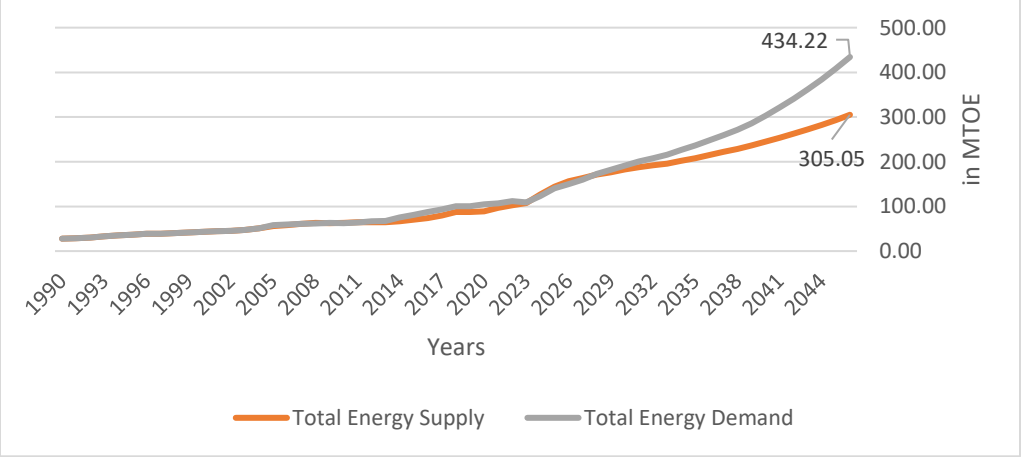

Figure 3: Total Primary energy Demand vs Supply

4.3. Forecasted Sectoral Energy Demand

Total energy demand in Pakistan is further divided into different consumer who demand for the energy along with different sources of energy that has been used in each sector. Sectoral energy demand estimates the variation in demand as per the changes in price level and other market condition. This applies the theory of demand which infer downward sloping demand curve due to decline in prices. However, in some cases demand for energy may changes when the prices remain stable. Estimated sectoral energy demand presented that share of each sector in total energy demand. Overtime, demand has been increased significantly which reflecting that there is higher growth in transportation and industrial sector for the energy in future as shown in the figure 5;

4.4. Scenario Analysis

For the projected estimates of energy demand and supply for each fuel type, demand from each sector and supply from indigenous and imported sources in Pakistan. Six scenarios have been developed under these reports based on the GDP values along with consideration of improvements such as off grid power generation, reduction in Transmission and distribution losses and National Electric vehicle policy 2019. These scenarios mainly include three scenarios such as Baseline Scenario with real GDP of 4.13%, optimistic Scenario with real GDP of 5.13%, pessimistic Scenario with real GDP of 3.13%. Moreover, remaining three scenarios considering same scenarios along with improvements in it. These scenarios lead various forecasted demand in next 25 years as presented in the figure 6.

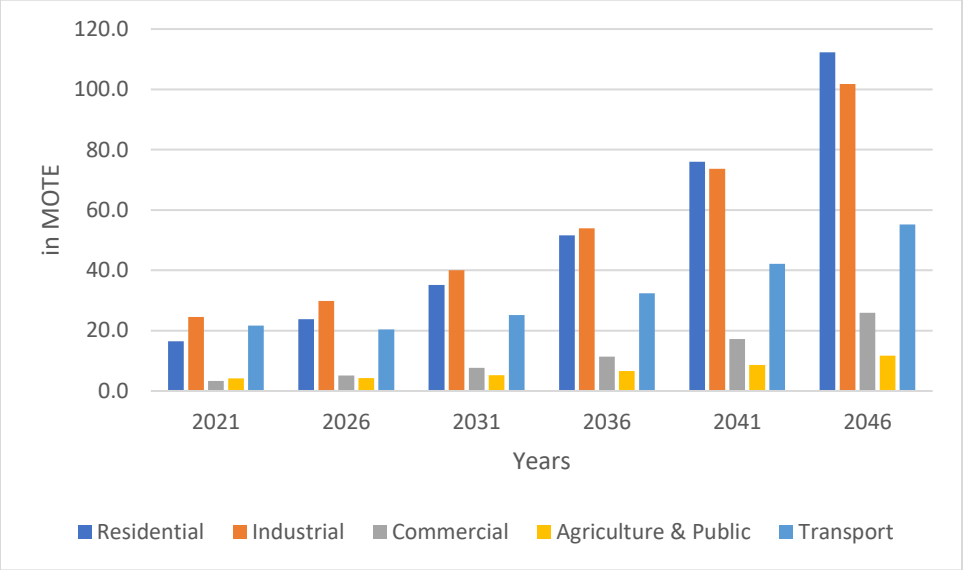

Figure 4: Final Energy Demand by Sector (Baseline Scenario – S1)

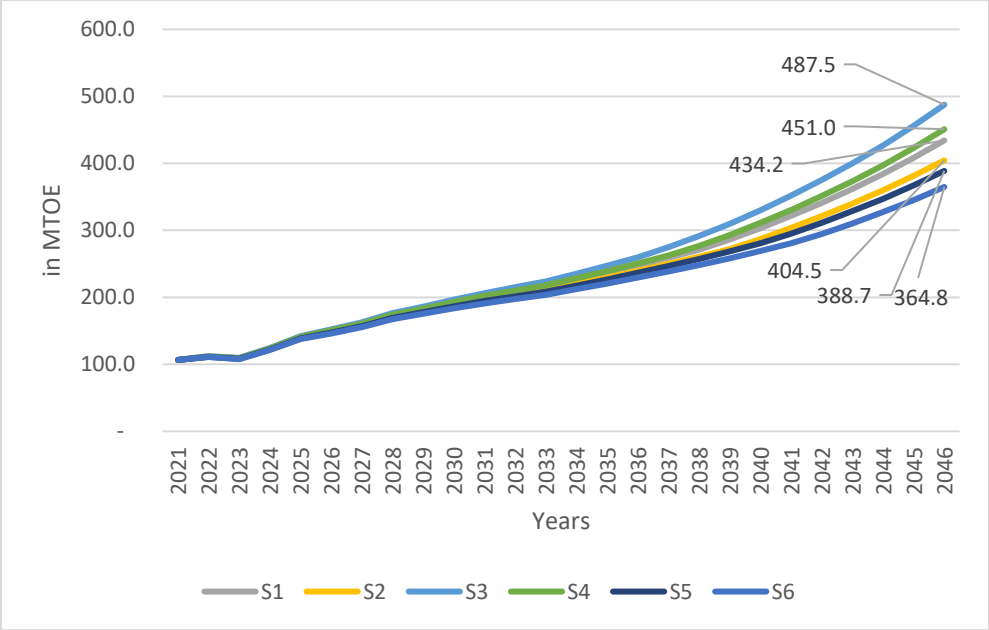

Figure 5: Comparative Total Primary Energy Demand by Scenario

From the above result, considered scenario based on GDP results in various forecasted demand in the future. By considering the current level of GDP of 4.13% the demand will 434.2 MTOE. Gradually, the influence of other factors leads to continuous increase in level of demand in Pakistan. However, considering baseline scenario with improvements (S2) presented the maintained level of forecasted demand of 404.5 which is less than baseline.

Third scenario is optimistic scenario with GDP of 5.13% which estimates the higher level of demand in the future 487.5 MTOE without considering any improvements. This is due to the fact that higher GDP led to increase in production which ultimately increase demand for the energy. Comparatively, if there will be improvements as presented in scenario 4, then the demand will be 451.0 MTOE due to efficient power utilization in different sectors.

Scenario 5 is pessimistic scenario which take GDP of 3.13% that estimates 388.7 MTOE of energy demand in 2046. While pessimistic scenario with improvements leads to lower level of energy demand that is 364.8 MTOE. The overall scenarios development considers different aspect along with improvements in structures and reduction in transmission and distribution losses than demand will be comparatively varies in each scenario.

4.5. Indigenous vs Imported Energy

Current energy mix in Pakistan contain, oil, natural gas, coal and other sources. Due to insufficient investment in exploration and development in country make the Pakistan heavily dependent on imports which made around 40% of total primary energy supply from import (Haq, 2023). However, there is abundant access to renewable sources such as sunlight, wind, hydropower and biomass in different areas on which it can uncover great potential in indigenous sources. With consideration of this, there are several policies and initiatives has been taken for shifting towards the renewable sources of energy. The projected share of imported energy and indigenous energy by each scenario is presented in table 5 and figure 7:

Table 2: Projected share of imported energy by scenario

Year	S1	S2	S3	S4	S5	S6
	Supply					
2021	52.6%	52.6%	52.6%	52.6%	52.6%	52.6%
2026	50.9%	50.7%	51.2%	50.9%	50.7%	50.5%
2031	49.1%	48.4%	49.6%	48.9%	48.7%	48.0%
2036	51.8%	50.5%	52.5%	51.1%	51.0%	49.8%
2041	54.6%	52.7%	55.7%	53.6%	53.6%	51.8%
2046	58.5%	56.0%	59.9%	57.2%	57.2%	54.9%
	Demand					
2021	58.2%	58.2%	58.2%	58.2%	58.2%	58.2%
2026	50.2%	49.7%	50.9%	50.5%	49.4%	49.0%
2031	54.0%	53.1%	55.3%	54.4%	52.7%	51.8%
2036	60.4%	59.1%	62.3%	60.9%	58.6%	57.3%
2041	64.1%	63.0%	64.7%	63.7%	63.4%	62.0%
2046	65.4%	64.0%	65.9%	64.6%	65.0%	63.4%

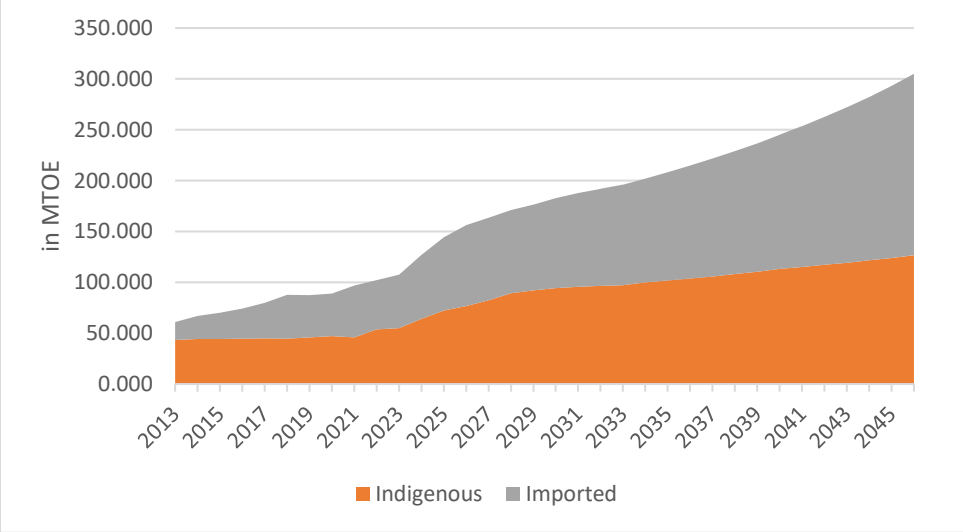

Figure 6: Primary Energy Supply by Indigenous and Imported (Baseline Scenario – S1)

Currently, share of energy indigenous sources is smaller as compared to imported energy. Overtime, for meeting energy demand, energy supply will be increasing. However, for minimizing import burden there will different initiatives will be taken for increasing renewable energy in overall energy mix. As reflected in the figure that indigenous energy sources will have higher share as compared to current energy supply mix.

4.6. Forecasted Energy Demand and Supply Mix

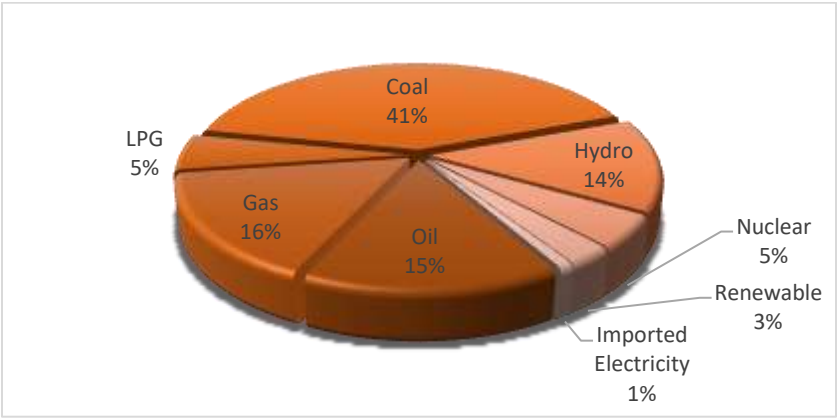

Figure 7: Primary Energy Supply Mix – 2046 (Baseline Scenario – S1)

The overall estimates of energy supply mix indicates that overtime dependence on oil for energy production will be reduced due to increase in environmental concerns, import burden and cost of energy. However, there is more inclination towards the usage of coal

and renewable energy sources for the production of energy. Installation of coal-based power plant will be applied due to availability of higher reserves of coals in southern region of Pakistan and even if it is imported then the cost of producing electricity will be significantly lower than other sources of energy.

Table 2: Primary Energy Supply Mix (Baseline Scenario – S1)

Year	Oil	Gas	LPG	Coal	Hydro	Nuclear	Renewable	Imported Electricity	Total
2021	23.3%	38.8%	1.4%	24.8%	8.3%	2.3%	1.1%	0.1%	100.0%
2026	13.0%	38.1%	1.5%	24.1%	14.3%	6.8%	1.3%	1.0%	100.0%
2031	12.1%	29.9%	2.0%	28.4%	16.7%	7.8%	1.8%	1.2%	100.0%
2036	13.2%	24.8%	2.8%	32.4%	16.0%	6.8%	2.6%	1.2%	100.0%
2041	14.2%	20.0%	3.9%	36.6%	15.1%	5.8%	3.3%	1.0%	100.0%
2046	15.2%	16.0%	5.3%	41.2%	13.9%	4.8%	2.7%	0.9%	100.0%

Table 3: Primary Energy Demand Mix (Baseline Scenario – S1)

Year	Oil	Gas	LPG	Coal	Hydro	Nuclear	Renewable	Imported Electricity	Total
2021	21.2%	47.6%	1.2%	19.3%	7.5%	2.1%	1.0%	0.1%	100.0%
2026	13.5%	36.7%	1.6%	25.2%	14.9%	7.1%	0.0%	1.0%	100.0%
2031	11.3%	36.0%	1.9%	26.6%	15.7%	7.3%	0.0%	1.1%	100.0%
2036	11.4%	37.0%	2.4%	28.1%	13.9%	5.9%	0.0%	1.1%	100.0%
2041	11.2%	36.8%	3.1%	28.9%	11.9%	4.6%	2.7%	0.8%	100.0%
2046	10.7%	35.5%	3.7%	28.9%	9.8%	3.4%	7.3%	0.6%	100.0%

Comparatively, the demand side of energy shows some differences due to the fact that other than some industry, most of the sector's demand for electricity rather than relying on the source of energy. Similar to the supply side of energy, demand for the oil will decline from 21.2% in 2021 to 10.7% in 2046. On the other hand, renewable energy sources demand increases from 1.0% in 2021 to 7.3% in 2046.

4.7. Energy Intensity

Energy intensity referred as the level of energy used for per unit of economic activity, it is the ratio between energy supply and gross domestic product which is measured at purchasing power parity of specific time. Higher energy intensity ratio specified that more energy used for producing one unit of output (Mirza, & Fatima, 2016). Energy efficiency reflecting technological advancement and defined as more units can be produced with the same unit of energy. Globally, energy intensity has been improved in different countries with application various measures along with structural changes. with consideration of demand and supply side aspect of energy intensity for next five year it has been observed that it will increase for the short-term period. However, long term forecasting for energy intensity (primary supply) indicates that it will decline significant from 11% in 2026 to less than 0.08 in 2046. On the contrary, energy intensity (primary demand) will be 11% in 2046. Developing countries are 30 percent more intensive than developed countries.

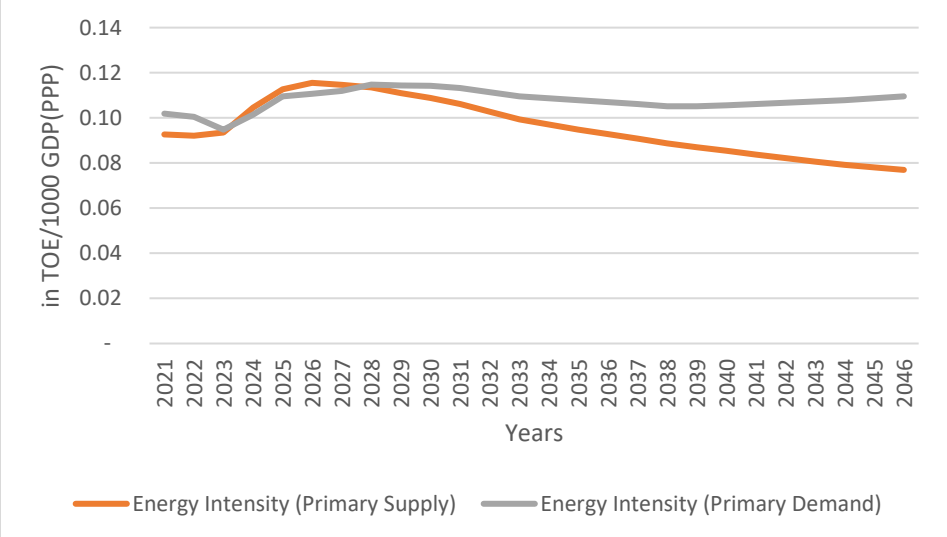

Figure 8: Energy Intensity Primary Demand vs Supply (Baseline Scenario – S1)

5. Conclusion

With application of ARMAX model for forecasting, the research identifies energy demand and supply for the next 25 years. This forecasting will contribute for cost-effective energy generation plan and developed several opportunities. This energy forecasting result in attaining demand supply balance. From the analysis, it has been found that estimated energy indicates that energy demand and supply gap will minimize in next 25 years. The core finding of the research suggest that energy deficit will decline with effective implement government energy supply plan that result in elimination of energy deficit in next seven years.

Additionally, the analysis of indigenous and imported energy reveals that due to higher dependence on imported energy import bill is on continuous rise which burdened the economy with higher debt. However, by shifting it to renewable sources of energy this can be minimized and made the energy affordable and accessible. The energy estimates for the supply suggest that dependence on oil will decline due to higher environmental concern. However, there will be more inclination toward the sustainable sources for the energy production.

According to the government's plan for energy supply, the deficit is expected to reduce gradually and will be close to zero in next three to five years. As per the projections of energy demand and supply in future, there is a need to add natural gas from the year 2027 and renewable sources from the year 2040. Lack of supply for post 2026 may result in significant shortage of natural Gas in the country.

Moreover, realization of the National Electric Vehicle Policy targets 2019 are very likely to result in significant reduction in oil demand. It is estimated to be 10% lower demand of oil by 2030 and more than 35% reduction in the oil demand by 2046. The Primary Energy Supply in Pakistan is clearly inclined towards fossil fuels, around 88% of the energy consumption is attributed to oil, gas, and coal. This situation is expected to be better to some extent, but the inclination will remain towards fossil fuel in future

Even with the improvements like reduced T&D losses, off-grid power generation, and implementation of electric vehicle policy, the imported contents in energy supply is expected to increase in future. Currently, 53% of the energy supply is imported which is expected to gradually reduce to 48% by 2030 but increase afterwards

Higher growth rates in consumption are found in the residential sector followed by industrial sector. These higher growth rates are expected to continue in future and will make the residential sector as the second largest energy consumer. These higher growth rates are due to the lower access to energy by residential sector but side by side reflect the inefficient consumption by the sector. This inefficient consumption of energy is also reflected by the expected positive slope of energy intensity for primary energy demand.

5.1. Recommendations

The above analysis and conclusions lead to the following recommendations for the government of Pakistan and other policymakers and stakeholders' institutions.

- The energy outlook of the country does not suggest required sustainability in the sector. There is a need to reduce the use of fossil fuels, lower import bill, increase efficiency in energy consumption, and making the energy affordable for the consumers.
- The sustainability will also be hampered if the national electric vehicle policy is not implemented in letter and spirit.
- The reliance on the imported energy is a major issues major contribution of energy import bill is attributed to the oil and gas import. Multi-pronged strategy is needed in which energy conservation, energy efficiency, alternative energy sources, energy exploration must be considered. If definite measures are not taken in the present it will lead towards a deeper energy and resulting economic crisis in future.

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