FAQEER MUHAMMAD, SARANJAM BAIG,
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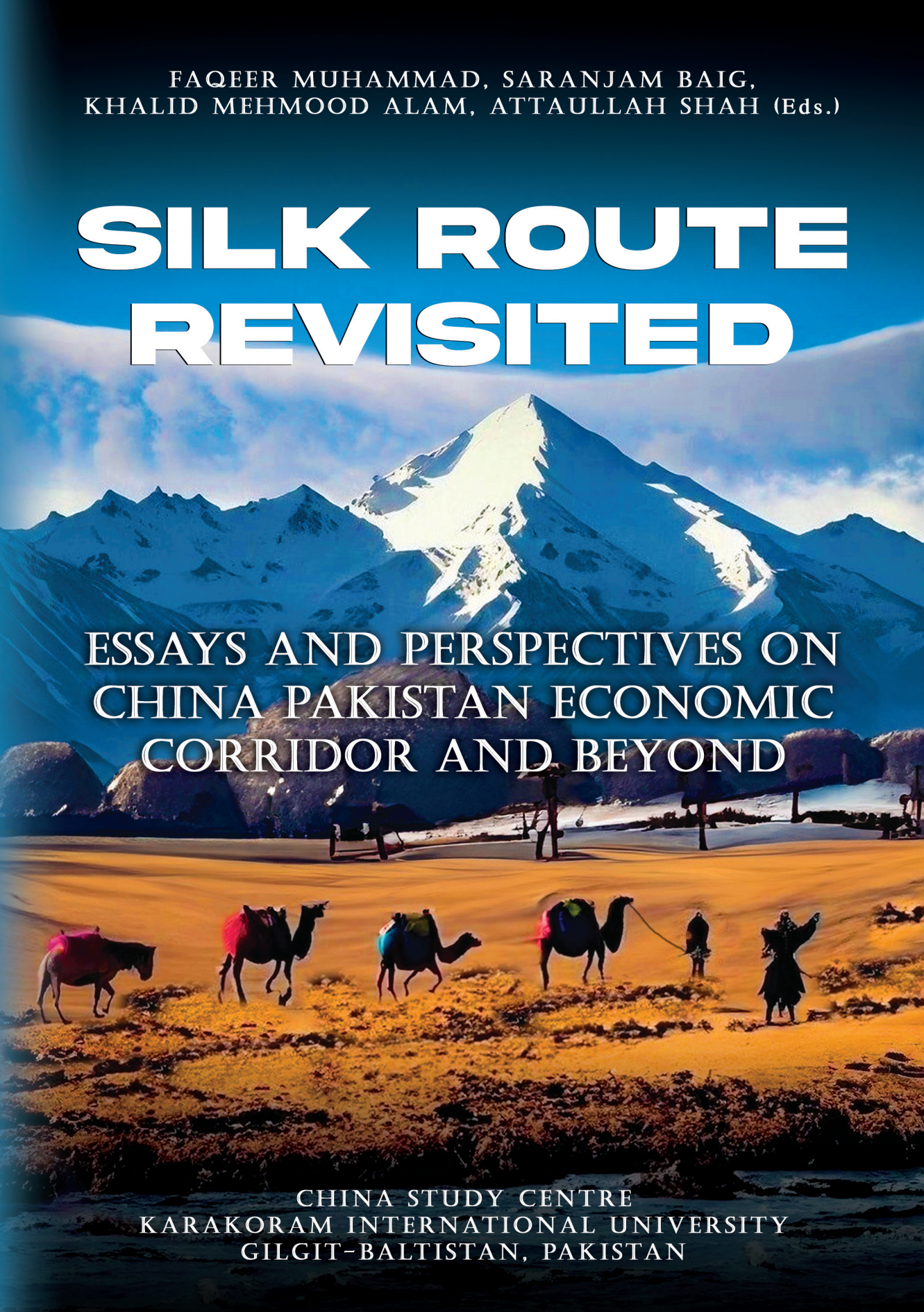
ESSAYS AND PERSPECTIVES ON CHINA PAKISTAN ECONOMIC CORRIDOR AND BEYOND



CHINA STUDY CENTRE
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GILGIT-BALTISTAN, PAKISTAN

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Urbanization And Energy Security in Pakistan: Lessons from Chinese Experiences

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Introduction

This chapter highlights the importance of rapid urbanization and energy security in Pakistan. Energy security is the energy supply available to meet the energy demand. This indicates energy insecurity when demand/consumption exceeds supply/production. Here, electricity consumption and generation gap are used as proxies for energy security. Rapid urbanization and economic growth are the main causes of energy insecurity in developing countries. According to research by (Cherp & Jewell, 2014), urbanization is the population growth in urban areas brought on by natural growth and migration from rural areas. Unplanned urbanization may compromise the nation's energy security. A 2017 population census reveals that of many communities have relocated from rural to urban locations. In the 2017 census, 75.58 million people were living in urban areas, or around 37% of the total population. In the 1998 census, this percentage was 33%. Therefore, 37% or so of Pakistan's population lives in metropolitan areas. Pakistan's urban population is overgrowing because of communities moving there in pursuit of services, amenities, and employment. Urban regeneration could make cities growth-oriented and livable, but this urban regeneration requires energy security to sustain economic growth.

Figure 1 shows that urban population, population density, and population living in large cities are increasing rapidly where economic growth, and employment in industrial and employment services sectors is volatile. Therefore, urbanization and economic growth do not go together in the case of Pakistan.

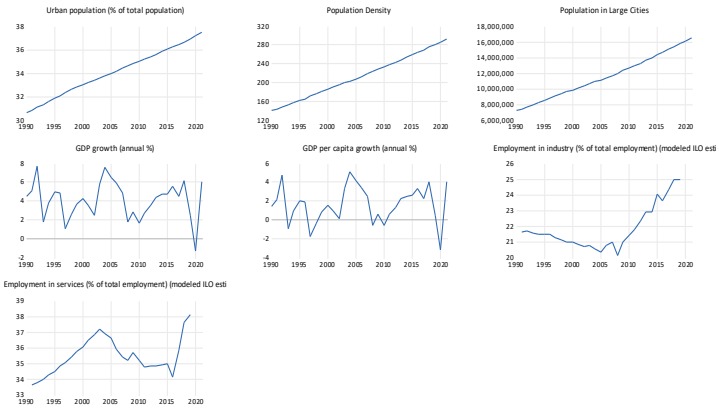

Figure 1: share of the urban population, population density, the population living in large cities and economic growth, employment in the industrial sector and employment in the services sector Source Author's calculation based on WDI

China, on the other hand, is seeing tremendous urbanization and economic expansion. Millions of individuals have been freed from poverty thanks to this composition. China has successfully developed institutions and programs that may promote urbanization and long-term economic growth. Another study by (Bai, Chen, & Shi, 2012) asserted that the critical driver of overall economic success and growth in China was urbanization's spillover impact on other areas. The study also discovered that more significant, wealthier cities generate more income than smaller, poorer ones. The detrimental externalities of China's rapid urbanization were emphasized in research by (J. Chen, 2007). Figure 2 demonstrates the favorable correlation between employment in the industry and services sectors and urbanization.

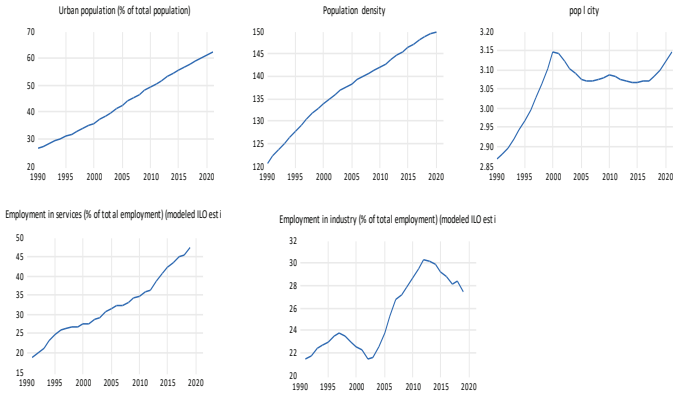

Figure 2: share of urban population, population density, population living in large cities, and employment in industry and services sectors Author's calculation based on WDI

Externalities of unplanned urbanization are detrimental. Rapid urbanization has an impact on the economy and the environment. The low growth trap, unemployment, pollution, and the energy problem are a few of its externalities. Most of the

population of the area lacks adequate access to adequate sanitation, electricity, water, and energy due to this unplanned urbanization (Drakakis-Smith, 2000). Urbanization without a strategy may compromise current energy security. As a result, the relationship between fast urbanization and energy security is highlighted in the following portion of this chapter, where energy security is defined as the inconsistencies in power supply and demand.

Energy Security in Pakistan

The reliable and adequate energy supply at fair rates is referred to as energy security (Bielecki, 2002). Reliability and appropriateness, where the energy supply entails a steady flow of fuel to fulfill the energy demand. This is a significant issue regarding energy security. Following the oil price shock of the 1970s, these worries surfaced. Some energy economists think there is no need to worry about energy security because the market mechanism has overcome problems with energy security problems. However, other analyses indicate that the period of high oil prices has returned, and the equilibrium between energy supply and demand has been upset. As a result, energy security is receiving more attention (Cherp & Jewell, 2014). Many energy economists and governments believe that the problem of energy security has not been solved without demand management (Banks, 2000). In the last two decades energy demand in urban areas has been around 4 times higher than in rural areas.

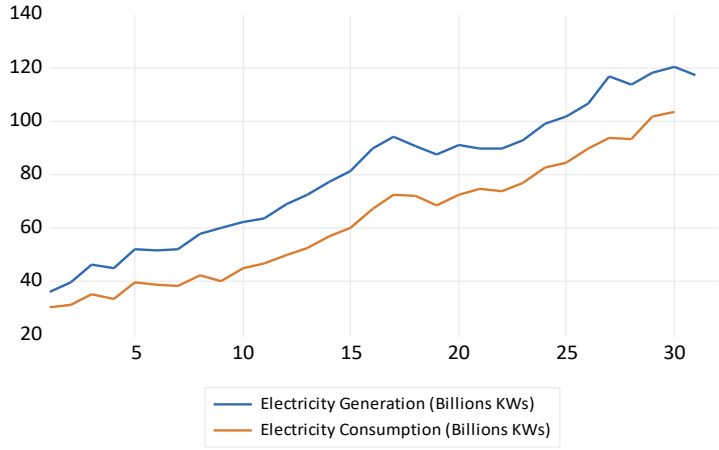

Figure 3: Electricity Production/Generation and Consumption

Energy infrastructure in Pakistan is in a transitional face; it is not well managed yet. Pakistan is facing an energy crisis due to weak infrastructure and poor management. Growth-led energy demand has been rising since the last two decades, but no progress has been made to overcome growth-led energy crisis. Another area that is still needed to improve is a reduction in transmission and distribution losses. These losses of result from aging power infrastructure, power theft, and seasonal reductions in hydropower availability have exacerbated the situation. Therefore, the demand exceeds per person. The amount the energy consumed

is equivalent to 0.53 tons of oil. Since 2014, the annual growth in total energy usage has been 4%. However, the availability of energy has decreased during the past few decades. Transmission and distribution capacity is around 22,000 MW, with an installed power generating capacity of 41,557 MW and a total demand of 31,000 MW. There is a 9,000 MW shortage as a result. Even though the nation's peak demand is significantly lower than the installed capacity of 41,557 MW, the additional 9,000 MW needed cannot be transported. One of the critical causes of unsustainable economic expansion is a lack of electricity.

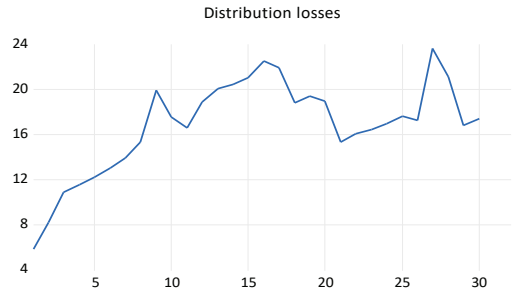

Figure 4: Distribution Losses during last three decades

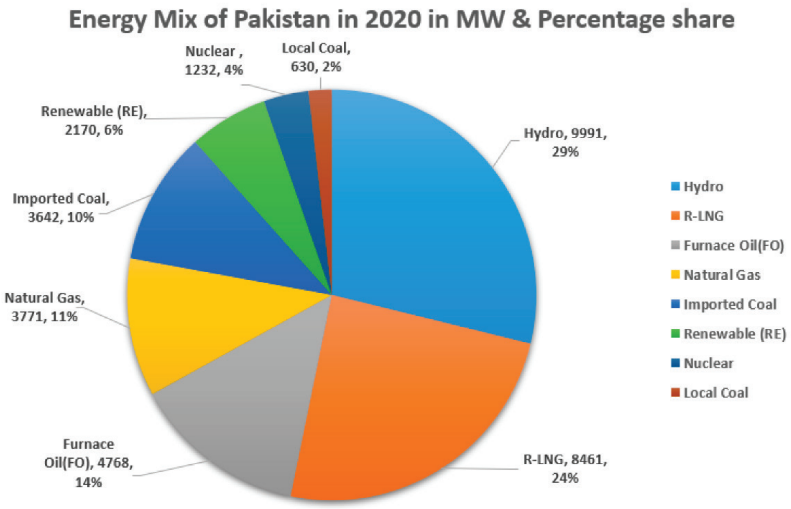

Figure 5: Share of Energy Mix in Pakistan

Pie chart showing Pakistan's energy mix. Share of hydro is highest and share of local coal is lowest due to its substandard conversion techniques. Share of renewable energy and local coal are needed to increase.

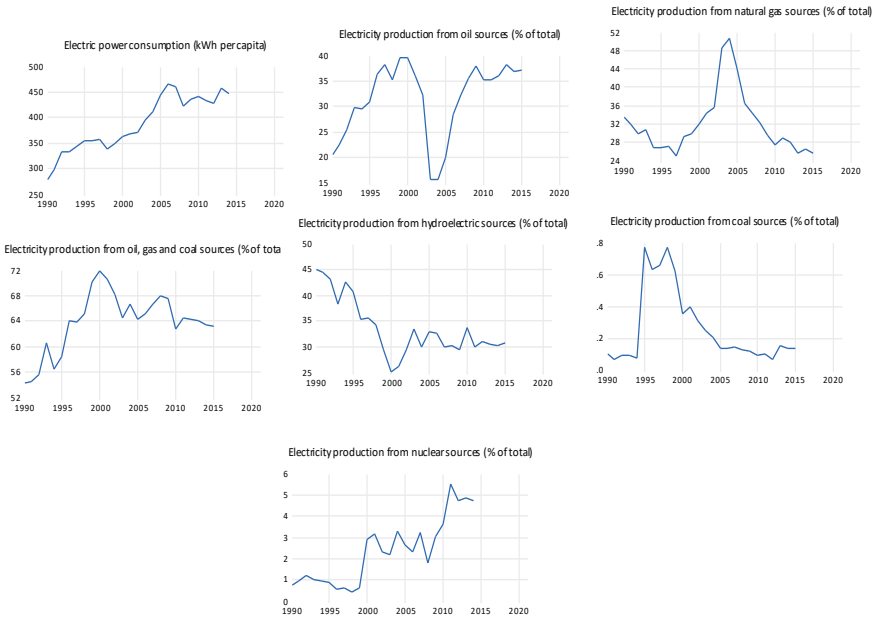

Figure 6: Electricity Production from different Sources in Pakistan from 1990-2020

The share of hydroelectricity in electricity production decreased from 2020 to 2021. Pakistan has abundant energy resources in the field of hydropower; however, only 29% of total electricity production comes from hydropower. Now we have 6555 MW with a potential of 41000-45000 MW.

Table 1: Capacity and Potential of different Hydropower in Pakistan

Hydropower Station		**Potential Hydropower Stations**	
Tarbella Dam:	3,478 MW	Diamer-Bhasha Dam:	4500 MW
Ghazi Brotha:	1450 MW	Munda Dam:	740 MW
Mangla:	1,000 MW	Kalabagh Dam:	2400-3600 MW
Warsak:	240 MW	Bunji Dam:	5400 MW
Chashma:	184 MW	Dasu Dam:	13800 MW

Whereas share of thermal increased, and now thermal has most significant shares. The use of RLNG became standard to produce electricity, it also helped to sustain supply to different power. Petroleum is another primary source of electricity generation in Pakistan, which counts 3rd and most significant sources of electricity generation. Estimated crude oil reserves in Pakistan are 303.63 million barrels, and about 24 million barrels of crude oil are produced annually. If we do not drill new wells in 12-13 years, we will exhaust our current oil reserves.

Natural gas is also a significant source of electricity generation. The aver-

age natural gas production is 4,048.76 million cubic feet per day. Natural gas is used in almost all industries and electricity generation. Shares of local coal in electricity generation are 2 %. Pakistan has over 185 billion tons of coal reserves, including 175 billion tons. Energy intensity in China is seven times higher than in Japan and 3.7 times higher than US. These basic statistics suggest that China needs to start conserving resources better manner to overcome potential energy insecurity in the future. However, electricity production from renewable energy resources is expanding rapidly in China. These green growth energy sources for electricity production could be one of the main reasons for China's economic growth.

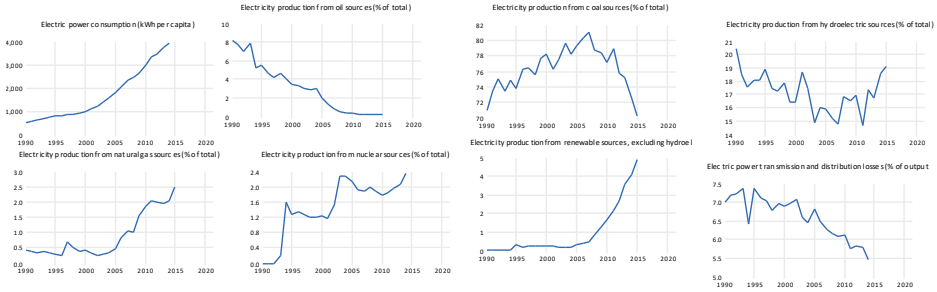

Figure 7: Electricity Production from different Sources in China from 1990-2020

Potential of Renewable Energy in Pakistan and Collaboration with China

The term "renewable energy" refers to energy sources that naturally replenish themselves. Examples include water, sunlight, wind, rain, tides, and geothermal heat. Electricity generators are used to harness the energy of moving water to produce hydropower. Hydropower, which produced 45% of the country's electricity in 1991, served as the nation's initial power source. However, this ratio has since decreased to around 29% because of preferences for short-term planning. According to Pakistan's Water and Power Development Authority (WAPDA), just 7,320 MW of its 60,000 MW hydropower potential has been reached. The hydropower is a type of energy that is tied to the force of moving water and can provide electricity (Wagner & Mathur, 2011). Around 20% of the total electricity produced worldwide is produced using hydropower (Asif, 2009; Peake, 2018). Pakistan's total water resources—including its rivers, glaciers, snow melt, etc.—are projected to cover 400,000 Km2 (Sheikh, 2009).

Under the umbrella of CEPEC energy projects, China and Pakistan are working together on 21 renewable energy projects (Alam et al., 2019; Baig et al., 2020). Twenty-one projects total, five of which are hydroelectric projects. The Karot Hydropower Project is in Punjab/AJK. This project is being carried out by China

Three Gorges (CTG) and Karot Power Company Ltd (KPCL). This project has an 884 MW capacity, and it is finished in 2021. This project is currently running. The Suki Kinari Hydropower Project is in KP and is being carried out by China Gezhouba Group Company Ltd. and Suki Kinari Hydro Ltd. The project is 70% complete (720 MW) and will be finished in a few years. CTG/CWEI (China Three Gorges) / (CWE Investment Crop) are going to undertake the Kohala Hydropower Project in AJK (Baig & Zehra, 2020; Ghanem et al., 2021). This project has a 1124 MW capacity. It has begun the process of acquiring land. In June 2020, TPPA and Gop-IA were inked. The Financial Closer is being worked on. Another hydropower project is Azad Pattan Hydropower Project, AK/Punjab, which has a capacity of 700.7 MW and is operated by Laraib Energy/China Gezhouba Group Company. It has begun the process of acquiring land. In June 2020, TPPA and Gop-IA were inked. A financial closer is being worked on.

The coastline region of Pakistan stretches 1,050 km from the Iranian border in the west to the Indian border in the east (250 km in Sindh and 800 km in Balochistan) (Bhutto, Bazmi, & Zahedi, 2013). According to estimates, the wind speed along Pakistan's coastlines is between 5 and 7 m/s. As a result, wind power plants have been installed in coastal areas of Sindh and Balochistan, including Karachi, Ormara, Jivani, Pasni, Baburband, Kati Bandar, and Gharo (M. A. Ahmed, Ahmed, & Akhtar, 2006; D. Li, Wu, Liu, Zhang, & Arıcı, 2018; Sheikh, 2009). Wind power is the process of using the wind's force to propel wind turbine blades. By causing magnets to spin, these turbines produce power. Despite Pakistan's 10,000 MW to 50,000 MW of potential wind energy, the nation is still in the early phases of generating wind power. In Jhampir, 6 MW have already been installed by a Turkish company as part of a first phase, and 50 MW will follow soon.

There will be new wind energy facilities constructed in Jhampir, Gharo, Keti Bandar, and Bin Qasim Karachi. Through CEPEC, China and Pakistan are collaborating on six wind power projects. The UEP wind farm is situated at Jhimpur, Thatta. UEP Wind Power Pvt Limited (UEPL), which has a 100 MW capacity, is executing this project. It is now in use and was completed in 2017. The Hydro China Dawood Wind Farm is a piece of land close to Gharo, Thatta, that is run by Hydro China Dawood Power Pvt. Limited (HDPPL). It was completed in 2017 and is currently operational; it has a 50 MW capacity. The Hydro China Dawood Wind Farm, which is also close to Gharo, Thatta, is run by Hydrochina Dawood Power Pvt. Limited (HDPPL). It was completed in 2017 and is currently operational; it has a 50 MW capacity. Operating the 50 MW capacity Sachal Wind Farm, Jhimpir, Thatta, which was finished in 2017, is Sachal Energy Development Pvt. Limited (SEDPL). The organizations in charge of completing the Three Gorges Second and Third Wind Power Projects are Three Gorges and Three Gorges Second Wind Farm Pakistan Ltd. (TGSWF). Finished in 2018, the Third Wind Farm Pakistan Pvt. Ltd. (TGTWF) is now functioning. This project has a 100 MW capacity. Cacho Wind Energy Pvt. Ltd. is considering and implementing the Cacho Wind Power Project. It has a 50 MW capacity and is currently

in the LOI stage. The wind power project is being carried out by Western Energy (Pvt.) Ltd and is now at the LOI stage.

Solar energy entails using solar thermal panels to heat water or the atmosphere and turning sunlight through solar cells into electricity. More than 100,000 MW of solar energy capacity exists in Pakistan. Baluchistan, Kashmir, Punjab, and Sindh are currently constructing solar power facilities. Independent vendors are importing solar panels and water heaters to suit market demand. The Alternative Energy Development Board (AEDB) is attempting to build 20,000 solar water heaters in Gilgit Baltistan. The use of solar energy panels rather than petroleum to power mobile firms' transmission towers has been mandated by the government. Additionally, Pakistan and China are working together on various solar energy projects. Bahawalpur is where Quaid-e-Azam Solar Park is located. The project's overall capacity is 1000 MW. While a 600 MW project is being implemented, a 400 MW project was finished in August 2016 and is now operating. The Quaid-e-Azam Solar Power Park (QASP), named after Pakistan's founding father, is a complex of 400,000 solar panels over 200 hectares of level desert in Punjab. This is the first energy project under the US$46 billion China-Pakistan Economic Corridor, a crucial component of China's "new silk roads," which connects Kashgar in China's western region of Xinjiang with the port at Gwadar in southern Pakistan.

Biomass production refers to the use of trash or other renewable resources like corn, sugarcane, or other vegetation to generate power. Waste decomposes into methane, which is then trapped in pipelines and finally burned to provide electricity. Like fossil fuels, plants and wood can be directly burned to produce energy or processed to produce alcohols. One of the biggest biomass/biodiesel-based renewable energy projects in the world is in Brazil, followed by the United States. By using municipal waste, Pakistan's Alternative Energy Development Board (AEDB) plans to generate 10 MW of electricity in Karachi, with follow-up projects in 20 other cities around the country. In China, biomass is a substantial source of energy. Modern biomass technologies are being used in China to raise the standard of living in rural areas and encourage industrialization. Additionally, these technologies can deliver affordable, clean fuels for power and heating. According to Vice Chancellor of the University of Agriculture Faisalabad (UAF), Professor Dr. Iqrar Ahmad Khan, Pakistan produces enormous amounts of biomass and crop leftovers each year that might be turned into electricity to help the nation's energy shortage. He said during the inauguration of an energy plant built at the Punjab Bio Energy Institute, Postgraduate Research Station UAF, in partnership with China, that the UAF had installed a 100-KW biomass gasification power plant intended to promote alternative energy to address a power shortage of up to 5,000 MW.

Another clean, sustainable energy source derived from the earth's internal heat source is geothermal energy. Geothermal energy comes from a variety of plac-

es, including hot springs, volcanoes, fumaroles, and geysers. Geothermal energy offers enormous potential for producing electricity in Pakistan. In the areas of Balochistan, Sindh, Karachi, Azad Kashmir, and KPK, there are several hot springs with temperatures ranging from 30 to 170 °C that can be used to produce geothermal energy. Despite Pakistan's abundance of geothermal resources, little has been done or is planned to use them to generate useable electricity (Awan & Rashid, 2012; S. N. Malik & Sukhera, 2012).

The Moon's gravity can be used to generate power by submerging a water turbine in a tide stream. Energy can be stored until it is required by the electrical generator or gas compressor that the turbine drives. Coastal tides provide clean, limitless, renewable, and sustainable energy. Tidal energy utilization is currently planned in Pakistan, although nothing has been put into action yet. The current capacity of Pakistan's nuclear power programme is 425 MW, while there are plans to significantly increase it. Pakistan's attempts to produce civil nuclear energy are hampered by the Nuclear Non-Proliferation Treaty, which forbids the country from dealing in nuclear items. The management of solid waste, prevention of chain reactions, and uranium enrichment from U235 to U238 remain difficult tasks in the advancement of nuclear energy. Pakistan is working to boost the share of nuclear energy and other renewable energy sources in its overall energy mix to combat the worsening energy crisis and its ensuing economic problems. Pakistan wants to produce 8,800 MWe of nuclear energy by 2030, which would make nuclear energy responsible for 20% of Pakistan's total energy. China and Pakistan agreed in November 2017 to construct a fifth nuclear power station at Chashma (C-5) to achieve this. Even though C-5 hasn't started being built yet, once it does, the new reactor will be able to supply the national grid with an extra 1,000 megawatts of electricity. Even though nuclear energy only accounts for a small portion of Pakistan's overall energy mix at the moment, increasing Pakistan's nuclear energy generation capacity and combining it with other renewable energy sources could not only help Pakistan resolve its energy crisis but also have a positive impact on the climate**.**

Conclusion and Policy Recommendations

Urbanization is uneven across countries because of disparities in socioeconomic development (Elmqvist et al., 2013). Urban growth in the developed world is due to well-planned urban infrastructures, including water and electricity supply (Giles-Corti et al., 2005). On the other hand, in the developing world, national economic growth and development are not enough to sustain the unplanned urban population. Pakistan's urban population is increasing. This high growth rate of urbanization should be a matter of concern. Growth-led energy demand puts pressure on energy infrastructure and creating energy security in Pakistan.

Electricity is essential for the operation of machines in factories and industrial plants. As a result of urbanization and population growth, there is a huge in-

crease in demand for electricity compared to the increase in electricity production. Therefore, the electricity supply is much less than the actual demand due to losses in electricity distribution and the increase in the cost of generating electricity from non-renewable sources, resulting in a crisis in Pakistan. An energy crisis can be defined as any significant bottleneck in the economy's supply of energy resources. Therefore, Pakistan should learn from China and invest in renewable energy sources, the contribution of renewable energy sources other than hydro is vertically increasing in China, whereas the contribution of renewable sources other than hydro is negligible in Pakistan. For example, the Potential of electricity generation from wind power is high. Pakistan has the potential to generate electricity from wind power between 10000 MW to 50000 MW but currently has negligible shares in the electricity mix. Another source of renewable energy is solar power. Pakistan has the potential generating generate electricity through solar energy is around 100,000 MW. Pakistan needs foreign investment, and China could be a potential investor. The alternative Energy Development Board of Pakistan works on solar water heaters in Gilgit Baltistan. Nuclear energy is used in the generation of electricity in many countries. Pakistan generates 425 MW from nuclear energy, which is not enough and needed to increase capacity with the help of China.

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The China Study Centre (CSC) at Karakoram International University (KIU) is funded by the Higher Education Commission (HEC), Government of Pakistan, which frames the core objectives to value the foreseeable consequences of the establishment of this Center with special reference to the benefits that will achieve from creating a social space, which facilitates to study and research on diverse arts, culture, history and polity of China, GB-Pakistan and surrounding mountainous region. Hence, there is a deep understanding that the study or promotion of culture, history, society and polity is a shared objective of proposed China Study Centre at KIU and other partner institutions.

The establishment of centre aims to provide a base to learn not only Chinese society, but a window of opportunity to take advantage of this platform via developing research collaborations in Xinjiang and mainland China. These collaborations are key to conduct research with high relevance to GB. As referred above that, historically the GB (Pakistan) and Xinjiang (China) offer much in common to share, which includes languages, heritage sites, oral and documented traditions, religious traditions, socio-political and economic pacts, ethnography mapping of mountain communities, cultural diplomacy, etc. The commonalities of these wide range areas are significantly important to consider as an opportunity for collaboration between KIU, Chinese Universities and beyond.

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