

Assessing the Energy Security, Just Energy Transition Partnership Potential under CPEC: A SWOT Analysis

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Abstract

The Just Energy Transition Partnership (JETP) under the China-Pakistan Economic Corridor (CPEC) can be the potential catalyst for Pakistan's efforts to reduce carbon emissions while receiving international support through climate finance and to accelerate the drive towards renewable energy. This research paper examines and explores the role of CPEC in facilitating Pakistan's transition to a low-carbon economy through JETPs, aligning with its commitments under the Paris Agreement. With the participation of key international stakeholders, including G7 members and China, the JETP enables global partners to showcase their political commitment to addressing global emissions. The partnership encompasses various elements, such as transforming the electricity sector, developing a hydrogen economy, and scaling up electric vehicles. Furthermore, it emphasizes the importance of a just transition, particularly in the coal mining sector, to ensure support for affected communities and workers. To gain a comprehensive understanding of the JETP's effectiveness and sustainability, a SWOT analysis is conducted using data gathered through interviews, discussions, and seminars. This analysis enables policymakers, stakeholders, and international partners to identify strengths, weaknesses, opportunities, and threats associated with the partnership. By leveraging strengths, addressing weaknesses, capitalizing on opportunities, and mitigating threats, the JETP under CPEC will aim to foster a just and sustainable energy transition in Pakistan.

Keywords: CPEC, Just Energy Transition Partnership, SWOT, Energy security.

1. Introduction

The Just Energy Transition Partnership (JETP) is an effort launched at COP26 in 2021 by international partners including the United States, the United Kingdom, France, Germany, and the European Union to give South Africa with energy transition finance (European Commission, 2021). The JETP intends to support large-scale energy transitions that will not only revolutionize South Africa's energy industry but will also deliver positive socioeconomic outcomes (Tyler & Mgoduso, 2022). Figure 1 shows that this collaboration aims to raise public and private funds to help South Africa transition to a low-carbon economy, especially through renewable energy, energy efficiency, and other clean energy technologies (Fakir, 2013). Based on this initiative, many countries are now seeking similar JETPs.

Pakistan, a rapidly developing nation in South Asia, is facing significant challenges in meeting its growing energy demands while transitioning towards a sustainable and just energy future. The China-Pakistan Economic Corridor (CPEC) has emerged as a prominent initiative to address these challenges by promoting infrastructure development, including a series of power plants throughout the country (Hussain, 2017). However, the implications of these power plants on energy security, their potential for fostering a just energy transition partnership, and the overall strengths, weaknesses, opportunities, and threats (SWOT) associated with their implementation remain crucial areas of investigation.

1.1 Projects under China-Pakistan Economic Corridor (CPEC)

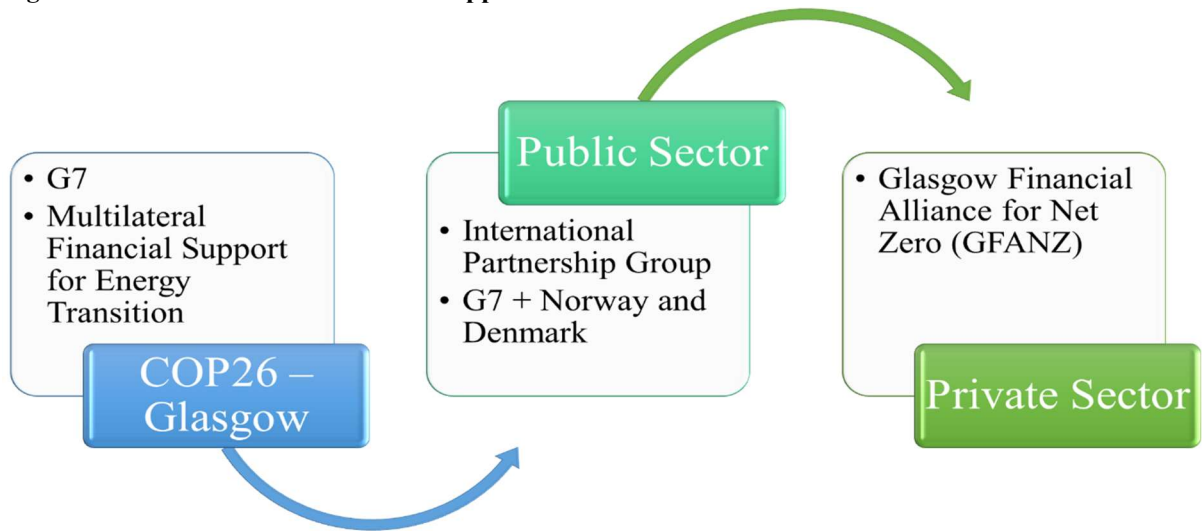
The China-Pakistan Economic Corridor (CPEC) represents a significant milestone in China's ambitious Belt and Road Initiative (BRI). Launched in 2013, this flagship project carries a staggering worth of \$62 billion. Spanning an extensive distance of approximately 3,000 kilometers, it stretches from the Gwadar Port on Pakistan's southwestern coast to the northwestern reaches of China (Ali, 2020). At its core, CPEC seeks to bolster connectivity and foster economic cooperation between these two nations through the development of robust infrastructure, energy projects, industrial collaboration, and trade facilitation. By

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virtue of its transformative potential, CPEC stands poised to reshape the economic landscape of both China and Pakistan, stimulating growth while fortifying bilateral ties (Khursheed et al., 2019).

Figure 1: Collaboration and Financial support under JETP



CPEC's central objectives are manifold, aiming to address pressing infrastructure gaps, enhance regional connectivity, fuel economic growth, and alleviate poverty (Ullah et al., 2021). Accomplishing these goals entails the creation of numerous job opportunities and attracting foreign direct investment to Pakistan. Key facets of the CPEC initiative include the development and modernization of critical highways, such as the renowned Karakoram Highway, the construction of railways, with emphasis on the Main Line-1 (ML-1) railway project, the establishment of strategically positioned Special Economic Zones (SEZs) to promote industrial cooperation and investment, and the expansion of energy projects designed to effectively tackle Pakistan's persistent energy crisis (Siddique & Shafqat, 2021).

After a decade of the China-Pakistan Economic Corridor (CPEC), Pakistan finds itself grappling with a severe energy crisis, operating at a deficit of 7,440 MW in the electricity industry (Ullah et al., 2021). Load shedding and power outages have become commonplace as the country struggles to meet the demand for electricity, with a shortfall of approximately 25,000 MW as compared to the generation capacity of 17,560 MW (Rasheed et al., 2022). Despite completing over half of the energy projects under CPEC, Pakistan continues to face persistent electricity shortages and is burdened by massive borrowing in the power sector.

The energy infrastructure, falling within the ambit of CPEC, has witnessed some progress, but the timely completion of energy projects prior to the commencement of CPEC phase II was crucial. Historically, Pakistan has faced energy shortages due to the challenges in attracting adequate investments for power generation. However, since the initiation of CPEC in 2014, new power plants have been constructed, significantly augmenting the country's energy production capacity (. Pakistan now possesses the potential to generate more energy than it actually requires. The structural deficiencies in the power industry have been effectively addressed through the CPEC energy framework.

Notwithstanding the COVID epidemic, the energy sector of Pakistan under the corridor has achieved excellent progress in terms of timely execution of power-producing plants launched under the purview of CPEC phase I, leading to the start of Phase II of CPEC. The primary objective of phase II is enhancing industrial collaboration by creating SEZs that have sufficient energy supply (Hussain, Khan & Ayaz, 2021). Therefore, the conclusion of the energy projects anterior to the start of CPEC phase II was unavoidable. Pakistan was one of the nations that had severe energy issues. 2011 saw a spike in electricity shortages that surpassed 7,000 MW. Pakistan's scarcity of capacity for electricity generation contributed to

the energy shortage. The energy shortage arose primarily due to the inability to engage investments at the levels required for maintaining and expanding power output in tandem with the escalating demand.

The China-Pakistan Economic Corridor (CPEC) has ushered in a remarkable surge in Pakistan's power generation capacity. By 2022, the overall installed capacity of CPEC projects, which included hydropower, coal-fired, and solar power facilities, had reached an impressive 6,570 MW. These strategically developed power facilities have not only mitigated Pakistan's dependence on imported energy but are poised to effectively address the escalating energy demands of the nation.

Within the ambit of the China-Pakistan Economic Corridor (CPEC), there are currently 21 energy projects underway, encompassing the construction of new power plants and the modernization of transmission lines. These projects use a variety of energy sources, including coal, hydropower, solar, and wind, and supply a significant 13,000 MW of electricity to Pakistan's national grid. Notwithstanding, that majority of these projects are centered around coal-based energy, with nine such initiatives accounting for an estimated capacity of 6,900 MW. In contrast, only five hydropower projects have been initiated, with a combined capacity of approximately 3,478 MW. Similarly, while various renewable energy projects are being planned, their overall potential remains limited, with the exception of the Quaid-e-Azam Solar Park in Bahawalpur, boasting a capacity of about 1,000 MW.

While coal-based energy projects have indeed contributed to the overall generation capacity, their environmental implications are significant, despite their cost-effectiveness as a source of energy production. Therefore, recognizing the environmental consequences, China embarked on a greener trajectory for the country a decade ago, making substantial progress in ecological and environmental conservation by translating stringent measures into tangible achievements.

1.2 Objectives of the Study

The objective of this research paper is to provide a comprehensive and actionable policy road map for Just Energy Transition Partnership potential under CPEC for the energy security implications, to analyze the potential for fostering a just energy transition partnership and conduct a SWOT analysis to evaluate their overall effectiveness and sustainability. By examining these dimensions, we aim to shed light on the critical factors influencing the success and long-term impact of the CPEC power plants on Pakistan's energy landscape and the broader socio-economic development of the country.

Energy security is of paramount importance for Pakistan, given its growing population, industrialization, and economic aspirations. With their considerable capacity increases to the national grid, the CPEC power plants have the potential to improve energy security by lowering reliance on fossil fuel imports and increasing local power output. However, it is critical to assess how much these power plants help to diversifying Pakistan's energy mix and limiting supply-side risks, such as reliance on a single energy source or geopolitical vulnerabilities.

This research paper explores the potential of the CPEC power plants in fostering a just energy transition partnership. A just energy transition involves the equitable distribution of the costs and benefits of transitioning to cleaner and more sustainable energy sources, ensuring social inclusivity, and addressing the needs and aspirations of marginalized communities (Hege et al., 2022). The assessment of social, economic, and environmental dimensions of the CPEC power plants helps to identify the potential for creating partnerships that promote a just energy transition in Pakistan.

Lastly, doing a SWOT analysis will allow us to assess the overall strengths, weaknesses, opportunities, and threats related with the CPEC JETP implementation. This analysis will provide a comprehensive understanding of the internal and external factors that may impact the success and sustainability of power plants, allowing policymakers, investors, and stakeholders to make informed decisions and develop strategies to maximize benefits while addressing potential challenges.

By critically assessing the energy security implications, just energy transition partnership potential, and conducting a SWOT analysis of the CPEC power plants in Pakistan, this research paper seeks to contribute to the ongoing dialogue on sustainable and inclusive energy transitions in developing countries. The findings and recommendations derived from this study can inform policy formulation,

enhance energy planning, and promote effective collaborations between Pakistan and its international partners to achieve a resilient, low-carbon, and equitable energy future.

1.3 Significance of the Study

This research is pivotal as it aims to develop a policy roadmap for a Just Energy Transition Partnership under the China-Pakistan Economic Corridor (CPEC), focusing on enhancing Pakistan's energy security. By examining the role of CPEC power plants in reducing reliance on fossil fuels and diversifying energy sources, the study addresses Pakistan's growing energy needs amidst its expanding population and industrial growth. Crucially, it explores the potential for a just energy transition, emphasizing equitable distribution and social inclusivity. The inclusion of a SWOT analysis further enriches the study, offering insights for policymakers and stakeholders to navigate challenges and capitalize on opportunities. Overall, this research contributes to the broader goal of achieving a sustainable, inclusive, and resilient energy future in Pakistan.

2. Conceptual Framework and Methodology

The Just Energy Transition Partnership (JETP) under the China-Pakistan Economic Corridor (CPEC) holds significant potential for Pakistan's efforts to achieve greater carbon emission reductions while receiving international support through climate finance (Houston & Ruppel, 2022). The JETP aims to provide Pakistan with low-cost concessional loans and grants to catalyze its transition to a low-carbon economy, aligning with the country's National Determined Contribution (NDC) commitments under the Paris Agreement (von Lüpke, Aebischer & Bolaños, 2023).

Figure 2: Conceptual Framework for Just Energy Transition (JETPs)



(Source: Project 90 by 2030)

Pakistan's NDC necessitates substantial climate finance support from global partners and funds to support its journey towards a low-carbon future. The JETP, with its ambitious scale and involvement of key international stakeholders, particularly the G7 members and China, allows these partners to demonstrate their ongoing political commitment to addressing global emissions (Kramer, 2022; Hao et al., 2020).

The JETP encompasses five key elements, each contributing to Pakistan's energy transition.

1. It focuses on transforming Pakistan's carbon-intensive and coal-dependent electricity sector over the next two decades by promoting cleaner energy sources.
2. It provisions are made for the development of a hydrogen economy, tapping into the potential of this emerging clean energy source.
3. The JETP aims to scale up the production of electric vehicles, fostering the adoption of sustainable transportation alternatives.

4. The partnership emphasizes the need for a just transition, particularly in the coal mining sector, ensuring that affected communities and workers are supported throughout the energy transition process.

Given the significance of the JETP under CPEC for Pakistan's sustainable development goals, conducting a SWOT analysis can provide valuable insights into the strengths, weaknesses, opportunities, and threats associated with the partnership (Seiler, Brown & Matthews, 2023). Evaluating the internal and external factors related to the JETP will help identify potential areas of advantage, areas that require improvement, opportunities for further collaboration, and potential challenges that need to be addressed (Gurl, 2017). The SWOT analysis is based on the technical focused-group discussion of 15 policy experts. These experts also highlighted the factors and dimensions of SWOT analysis and provided their answer to the questions asked. The data for SWOT analysis has been gathered through key informant interviews and focused group discussions and series of seminars conducted by Sustainable Development Policy Institute (SDPI).

By conducting a thorough SWOT analysis, policymakers, stakeholders, and international partners can gain a comprehensive understanding of the JETP's effectiveness and sustainability (Sarsby, 2016). This analysis will enable them to leverage strengths, address weaknesses, capitalize on opportunities, and mitigate threats, ensuring that the JETP under CPEC achieves its intended objectives of fostering a just and sustainable energy transition in Pakistan (Rasheed, Kanwal & Abbas, 2022).

3. Results and Discussion

3.1 CPEC and Just Energy Transition Partnership

Energy transition is imperative to mitigate climate change and ensure long-term energy security. The CPEC power plants in Pakistan could bring a significant opportunity to examine how transition from conventional to sustainable energy sources can be achieved in a just and equitable manner as CPEC power plants affect the social, economic as well as environmental dimensions of the region, particularly Pakistan (Awais et al., 2019). This section critically evaluates the potential of CPEC in fostering JETP in a sustainable manner.

3.1.1 Social Dimensions

3.1.1.1. Access and Affordability

Access to affordable and reliable energy is critical for improving living conditions and fostering social fairness. When assessing the ability of CPEC power plants to facilitate a JETP, it is critical to consider how they would improve access to electricity for all segments of society, particularly vulnerable communities. Literature provide insight into Pakistan's energy access concerns and the role of renewable energy projects in addressing these issues (Sher et al., 2019). The analysis revealed that CPEC has the potential to strengthen the infrastructure in electricity generation, transmission, and distribution network, expand grid connectivity, and the affordability of renewable energy sources (Niazi, He & Ullah, 2019).

3.1.1.2. Job Creation and Skills Development

JETP should prioritize job creation and skills development which will ensure that the workforce is prepared for the shift to sustainable energy sources (Nazneen, Xu & Din, 2019). In this regard, evaluating the potential of CPEC power plants entails investigating their role in creating job opportunities and encouraging skill development programs. Literature emphasizes the necessity of investing in renewable energy technology to create new employment and improve worker capacity (Niazi, He & Ullah, 2019). Under CPEC Phase II various skill training and capacity building are planned to be initiated which further improved the capacity building for the renewable energy sector (Saad et al., 2020).

3.1.1.3. Community Engagement

A just energy transition requires community engagement and participation. Evaluating the ability of CPEC power plants to facilitate a fair energy transition partnership necessitates examining how much local people are involved in decision-making processes and how their concerns are handled. Literature revealed the relevance of community participation in renewable energy projects (Saad, Xinping & Ijaz,

2019). The benefits of encouraging community ownership, cooperative models, and inclusive governance structures also confirm the significant potential of CPEC in fostering sustainable energy transitions (Aman et al., 2022).

Policymakers and stakeholders may use these social elements to ensure that the shift to sustainable energy sources driven by CPEC power plants adheres to values of social justice, inclusion, and equitable access to opportunities.

3.1.2. Economic Dimensions

3.1.2.1. Economic Diversification

A critical aspect of JET is economic diversification, which entails minimizing reliance on a single energy source and broadening the variety of sectors and economic activities. Analysis of the potential of CPEC power to facilitate a JETP necessitates to consider the contribution of these projects in Pakistan's economic diversification. Literature highlights various economic implications of renewable energy projects, such as job creation, revenue production, and the growth of related sectors (Bhattacharyya et al., 2016).

3.1.2.2. Economic Sustainability

Economic theory emphasizes resource efficiency and equitable distribution. Two changes have happened as a result of the realization of the importance of the environment in economy. To begin, the efficiency and resource distribution criterion must be complemented by a new scale norm. Second, when natural resources are threatened, markets as a distribution mechanism become constrained. Economic capital should be steady, and a third scale constraint should be introduced, limiting the movement of energy and materials from sources to sinks. In economic terms, environmental products such as natural capital and intangible resources face value issues. As a result, economists must address risk, uncertainty, and the use of protective measures (Naz, Ali & Fatima, 2018).

The China-Pakistan Economic Corridor (CPEC) incorporates plans for energy transportation, infrastructural development, and industrial expansion. CPEC's completion is intended to minimize commerce delivery times and costs while avoiding contested routes. The Karakoram Highway (KKH) extension is a critical component of the CPEC since it serves as the principal land route between Pakistan and Kashgar (Ali et al., 2018). The CPEC is expected to improve trade efficiency, boost company competitiveness, and create economic prospects for industries including agriculture. Pakistan, like many other countries, has had energy crises that have harmed many industries and contributed to poverty.

It provides a potential for Pakistan to become a regional economic centre, contributing to infrastructure development, job creation, and energy-related initiatives. The CPEC also opens the door for China and Pakistan to collaborate in a variety of industries, including mineral exploration and tourism. Pakistan may become a profitable tourism destination by investing in infrastructure, protecting the environment, and boosting marketing and branding (Ali et al., 2018).

Several economic zones have been developed in Khyber Pakhtunkhwa (KP), Punjab, Balochistan, Sindh and Gilgit Baltishtan (Ali et al., 2015). Through the formation of economic zones, the CPEC is projected to address Pakistan's economic issues, unlock new growth opportunities, and boost economic development. Furthermore, it has the potential to offer economic possibilities for neighbouring nations like as Afghanistan, Iran, and India, therefore boosting regional cooperation and trust-building (Butt & Butt, 2015).

3.1.3. Environmental Dimensions

3.1.3.1. Climate Change Mitigation

The CPEC's emphasis on renewable energy projects provides Pakistan with a chance to reduce greenhouse gas emissions and contribute to global climate change mitigation efforts. However, a larger share of CPEC in Phase I relied on coals power plants which had raised the emission level in the country. Reynolds, Stout and Wang (2018) showed that CPEC emissions were estimated to reach 51 million metric tons of CO₂ per year. However, in response to the global criticism on CEPEC related emissions, China has

changed its policy and ensured the investment in renewable energy projects in 2020 (Aslam, Nazir & Zia, 2021).

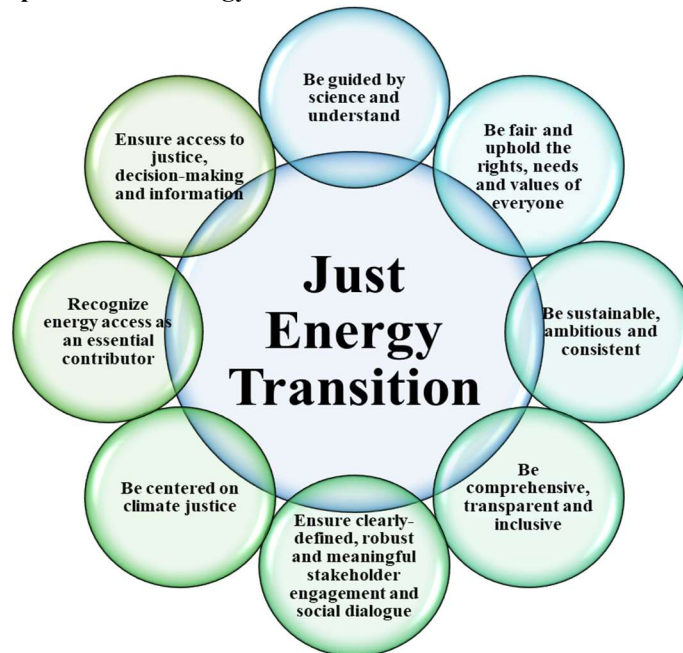
China has stated a commitment to cleaner energy and a shift away from coal in BRI projects in its most current Five-Year Plan, which was issued in 2020 (Ullah et al., 2023). As a major BRI project, the China-Pakistan Economic Corridor (CPEC) can demonstrate China's commitment to these larger goals through supporting greener practices. While there are still reservations and skepticism about coal-power projects in the BRI, there are signs of development towards renewable energy sources. Both China and Pakistan have verbally agreed to suspend new coal-power projects.

Furthermore, reports indicate that the CPEC is investing less in fossil fuels and more in renewable energy, notably hydropower (Reynolds, Stout & Wang, 2018). China's position as the world's leading producer of wind and solar energy opens further opportunities for supporting renewable energy development and projects. Though problems persist, these improvements point to a greener CPEC that is in line with China's larger renewable energy aspirations. In contrast the investment in solar and wind projects, can replace fossil fuel-based energy sources and minimize carbon emissions by ensuring just energy transition in Pakistan (Ali, Khan, & Aftab, 2021).

3.1.3.2. Renewable Energy Integration

Integrating renewable energy sources into the existing energy grid is essential for a just energy transition. The potential of CPEC power plants show their compatibility with the existing infrastructure and the potential challenges and opportunities associated with renewable energy integration.

Figure 3: Core Principles for Just Energy Transition



(Source: UNDP and WWF, 2023)

The China-Pakistan Economic Corridor (CPEC) has 399 MW of wind capacity and 1000 MW of solar capacity (Reynolds, Stout & Wang, 2018). Pakistan has a significant potential for solar and wind energy generation due to its geographical location. Literature have done analyses and mapping of Pakistan's renewable resource potential. Long, bright days with eight to ten hours of sunlight each day, strong solar radiation, and insulation help the country. According to one estimate, Pakistan's yearly solar potential is 1600 GW. Similarly, estimates for the country's technical wind potential range from 346 to 360 GW, which is much larger than the country's overall generation capacity in 2016. These findings emphasize Pakistan's large untapped renewable energy resources, notably solar and wind energy, which can be harnessed.

Literature revealed that grid integration strategies, energy storage technologies, and grid management systems under CPEC could help to ensure a stable and reliable energy supply from renewable sources (Reynolds, Stout & Wang, 2018).

3.2. Technical SWOT Analysis for Pakistan

3.2.1. Strengths

1. Pakistan's renewable energy potential is immense, with abundant resources such as solar, wind, and hydropower. The country's geographical location and climate make it ideal for harnessing solar energy, as it receives ample sunlight throughout the year. Along with this, the coastal areas suffer high winds, which may be used to generate wind power. Furthermore, Pakistan is endowed with a large number of rivers, which offer enormous potential for hydropower projects. Pakistan may diversify its energy mix, lessen its dependency on fossil fuels, and alleviate the negative environmental repercussions associated with traditional energy generation by tapping into these renewable energy sources. This shift to renewables will help to provide a more sustainable energy sector, as well as a cleaner and greener future for the country (Aslam et al., 2021).
2. The strategic geographical location of Pakistan gives a unique advantage in terms of energy trade and connectivity. The nation shares borders with China, Iran, and other Central Asian countries, making it a vital hub for regional energy cooperation (Khan et al., 2020). Pakistan may use its geographic location to enable cross-border energy projects like the China-Pakistan Economic Corridor (CPEC), which involves the development of energy infrastructure and the construction of power plants. Furthermore, Pakistan's closeness to resource-rich Central Asian nations allows for energy imports and transportation (Khetrane, 2016). Pakistan can increase its energy relations with neighboring countries, improve regional energy security, and develop economic cooperation through energy trade by capitalizing on its strategic location.
3. In recent years, Pakistan has made significant investment in energy infrastructure development. This involves expanding transmission and distribution networks, building new power plants, and establishing liquefied natural gas (LNG) ports. Improving energy infrastructure is critical for supporting a developing country's expanding energy demands, such as Pakistan (Rafique & Rehman, 2017). The government can assure efficient and dependable power supply while minimizing transmission losses and boosting overall energy availability for its inhabitants by strengthening transmission and distribution networks. Furthermore, the construction of new power plants, both conventional and renewable, increases energy producing capacity, answering the increasing energy demands of various sectors such as residential, commercial, and industrial (Khetran & Khalid, 2019). The development of LNG terminals promotes the import of natural gas which will fill a gap in domestic gas production and ensuring a continuous supply for power generation and other businesses. Pakistan's developing energy infrastructure indicates the government's commitment to improving energy access, promoting economic growth, and meeting the country's growing population's energy demands.

3.2.2. Weaknesses

1. Pakistan's energy sector is plagued by a significant gap between energy supply and demand. In terms of renewable energy generation, the country's present generation capacity is insufficient to fulfil the rising energy demands of its people and economy (Khatri et al., 2022). This mismatch causes frequent power outages and electrical shortages, affecting a variety of industries and stifling economic progress. Furthermore, inefficiencies in the distribution system cause transmission losses, worsening the supply-demand mismatch. To address this difficulty, significant investments in increasing generation capacity and updating distribution infrastructure are required to assure a sustainable and steady energy supply for everybody (Shakeel, Takala, & Shakeel, 2016).

2. The energy mix in Pakistan is strongly biased towards fossil fuels, especially natural gas and oil (Wakeel, Chen, & Jahangir, 2016). While these resources have been critical in satisfying the country's energy demands, their overreliance offers several difficulties. Firstly, it raises worries about Pakistan's energy security, as the country significantly relies on imports to fulfil its fossil fuel consumption. Because of this reliance, the country is vulnerable to price volatility and geopolitical threats. Second, using fossil fuels adds to environmental damage, such as air pollution and greenhouse gas emissions. Pakistan must reduce its dependency on fossil fuels and diversify its energy mix by boosting the percentage of renewable energy sources to achieve a more sustainable energy sector.
3. The energy sector in Pakistan faces a significant gap in technology transfer and innovation (Lin & Raza, 2020). The sector's efficiency and modernization are hampered by the sector's slow adoption of innovative technology. Furthermore, a lack of innovation hinders the development of residential clean energy solutions as well as the integration of renewable energy into the grid (Akber et al., 2017). To address this dilemma, Pakistan must prioritize technology transfer, research and development, and create an environment that encourages innovation. This includes partnerships with international organizations, engaging with technologically advanced nations, and the building of research and development centers to encourage the adoption of cutting-edge technology and the development of indigenous solutions. Pakistan can improve its efficiency, sustainability, and resilience by embracing technology transfer and promoting innovation.

3.2.3. Opportunities

1. Pakistan owns significant untapped renewable energy potential, including solar, wind, and hydropower. Expansion of renewable energy project capacity is a significant potential for the country (Shakeel, Takala, & Shakeel, 2016). Solar energy can be harnessed effectively throughout the year due to Pakistan's geographical location, receiving ample sunlight. Wind resources are abundant in coastal areas, making them ideal for wind power generation. Furthermore, the country's rivers provide a lot of potential for hydroelectric projects. Pakistan can diversify its energy mix, reduce its dependency on fossil fuels, and contribute to global efforts to mitigate climate change by increasing renewable energy capacity. The construction of renewable energy infrastructure will not only generate jobs, but will also attract local and foreign investment, therefore promoting economic growth. Furthermore, the growth of renewable energy projects would help to reduce greenhouse gas emissions and enhance the country's overall environmental sustainability.
2. Implementing energy efficiency measures is crucial for reducing energy demand and promoting sustainability. Pakistan has the potential to apply energy-saving technology and practices in a variety of industries (Shahid et al., 2015). For example, boosting industrial processes, improving building insulation and encouraging energy-efficient transportation can reduce energy use. Pakistan can improve its energy security by lowering its dependency on imported fuels, increase affordability for consumers and businesses, and reduce the environmental effect associated with energy production and consumption (Ahamed, Guo, & Tanino, 2019). Energy efficiency methods can also reduce energy expenses for households and enterprises, freeing up resources for other developmental goals.
3. Pakistan's strategic location provides an opportunity for regional energy cooperation and connectivity. The country can use its geographical location to participate in energy initiatives and collaborate with neighboring countries. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) gas pipeline project, for example, seeks to carry natural gas from Turkmenistan to South Asia via Afghanistan and Pakistan (Ali et al., 2021). This initiative encourages energy trade, increases energy security, and promotes regional economic integration. In addition, Pakistan can explore electricity trade with neighbouring nations, allowing for the exchange of surplus energy and optimizing resource use (Saira & Javed, 2022). Regional energy cooperation not only improves

energy security, but it also helps the economy through greater cross-border trade and shared infrastructure. Pakistan can boost its energy sector and contribute to regional stability and prosperity by actively engaging in regional energy cooperation projects.

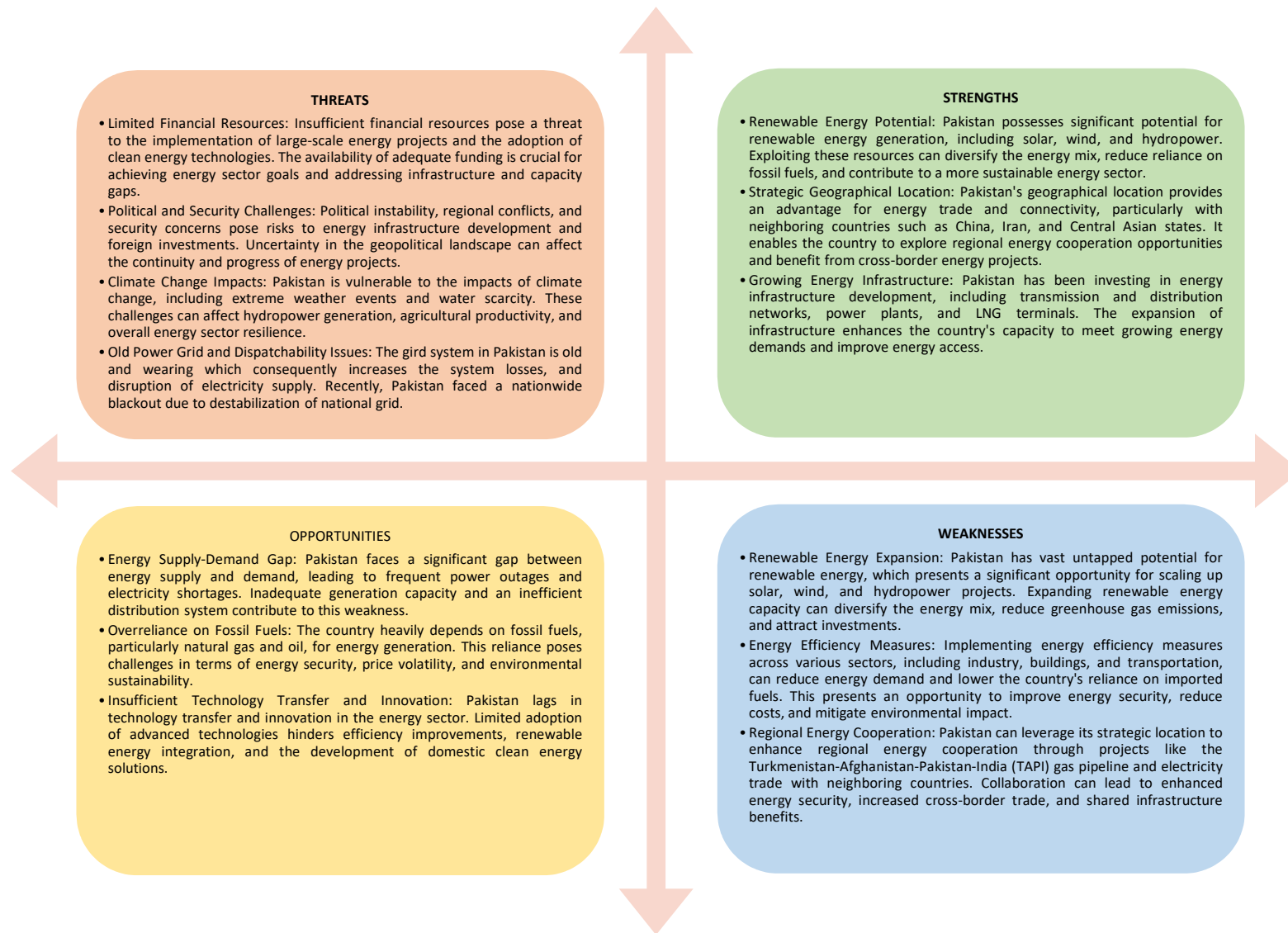
3.2.4. Threats

1. Limited financial resources present a serious barrier to Pakistan's energy sector (Komal & Abbas, 2015). Large-scale energy initiatives, such as the creation of renewable energy infrastructure and the modernization of existing systems, need significant investment. However, restricted access to capital and budget limitations might stymie energy industry advancement. To overcome the financing deficit and speed the growth of the energy industry, Pakistan must explore possibilities for attracting local and foreign investments, promoting public-private partnerships, and obtaining financial help from international organizations (Usman et al., 2022).
2. Political instability, regional conflicts, and security issues pose threats to Pakistan's energy infrastructure development and international investment. Uncertainty in the political environment might result in policy inconsistencies and decision-making delays, threatening the continuity and advancement of energy projects (Khan et al., 2022). Furthermore, security concerns might discourage international investment and jeopardize the integrity of energy supply systems. It is critical for the government to prioritize political stability, improve security measures for energy infrastructure, and create an investment-friendly climate to ensure the energy sector's long-term profitability and sustainability.
3. Pakistan is extremely vulnerable to the effects of climate change, posing considerable difficulties to the energy industry (Perwez et al., 2015). Extreme weather events, such as floods and heat waves, can damage energy infrastructure and reduce power generating dependability. Water shortage, caused by shifting rainfall patterns and glacier melting, can have an influence on hydropower generation, a critical component of Pakistan's energy balance. Furthermore, climate change has the potential to have a domino impact on agricultural output, which has ramifications for bioenergy production and food security. It is imperative for the country to incorporate climate change adaptation and mitigation techniques into its energy planning which include robust infrastructure construction, diverse energy sources, and effective water management practices, must be incorporated into Pakistan's energy planning.
4. Pakistan's power grid faces challenges due to aging infrastructure and dispatchability issues. The inefficient and ageing power infrastructure causes substantial transmission and distribution losses, resulting in an unreliable electricity supply and increasing prices (Ul-Haq et al., 2021). The recent countrywide outage in Pakistan showed the grid system's weaknesses. The government must spend in updating and modernizing the electrical grid, as well as deploying smart grid technology and enhancing system efficiency. Addressing dispatchability concerns, such as integrating energy storage technologies and improving grid flexibility, can ensure stable and reliable power supply, reducing the likelihood of blackouts and interruptions.

By considering these strengths, weaknesses, opportunities, and threats, Pakistan can develop strategies and policies to overcome challenges, capitalize on opportunities, and drive the sustainable development of its energy sector.

4. Technical and Actionable Policy Recommendations

The transition to renewable energy sources has gained significant importance worldwide as nations strive to mitigate climate change and achieve sustainable development. In its pursuit of a renewable energy transition, Pakistan, as a developing country, confronts problems and possibilities. This paper proposes a series of policy proposals to help Pakistan execute a comprehensive renewable energy strategy. The following are the ministry specific recommendations for the effective establishment of Just Energy Transition Partnerships (JETPs) under the umbrella of CPEC are as follows:

Figure 4: SWOT Analysis for Potential of JETP under CPEC in Pakistan

4.1. Ministry of Energy

The recommendations include setting clear targets and timelines, providing policy incentives for private investment, improving energy efficiency, strengthening grid infrastructure, updating the Integrated Generation Capacity Expansion Plan (IGCEP), developing distributed generation plans, and developing an actionable roadmap for Just Energy Transition Partnerships (JETPs). Pakistan may expedite its transition to a greener and more sustainable energy mix by following these policy initiatives.

1. **Creating a Comprehensive Renewable Energy plan:** A well-defined plan with clear objectives and timeline is essential for guiding Pakistan's transition to renewable energy sources. Specific targets for increasing the share of renewables in the energy mix, such as the percentage of electricity generated by solar, wind, and hydropower, should be outlined in the roadmap. The objectives should be ambitious yet achievable, taking into account the country's renewable energy capacity as well as socioeconomic concerns.
2. **Putting Policy Incentives in Place:** To encourage private investment in renewable energy projects, the government should put policy incentives in place such as feed-in tariffs and tax exemptions. Feed-in tariffs ensure long-term contracts and favorable rates for renewable energy producers, ensuring financial viability and predictability. Tax breaks and other financial incentives can help to stimulate private investment in clean energy technologies.
3. **Improving Energy Efficiency Programs and Regulations:** Energy efficiency measures are critical in lowering energy demand and increasing total energy production (Oyedepo, 2012). The government should improve energy efficiency programs and regulations in a variety of industries, including manufacturing, construction, and transportation. Energy audits, energy-efficient building rules, and incentives for adopting energy-efficient technologies are examples of such approaches.
4. **Grid Infrastructure Strengthening:** Grid infrastructure strengthening is critical to supporting the integration of renewable energy sources into the electricity system (Yoldaş et al., 2017). The government should prioritize system expansion and upgrading to ensure that growing renewable energy generation can be accommodated. This will increase the electrical system's stability and dependability, allowing for a smooth transition to a renewable energy-based grid.
5. **Integrated Generation Capacity Expansion Plan (IGCEP) Update:** The Integrated Generation Capacity Expansion Plan (IGCEP) should be revised to include expected demand for developing technologies such as electric vehicles, electric stoves, and industrial decarbonization. This will ensure that the increase of renewable energy capacity corresponds to future energy requirements and projected changes in energy consumption patterns.
6. **Developing Distributed Generation and Community-Based Grids:** To enable energy generation closer to the point of consumption, a strategy for distributed generation, including small-scale renewable energy installations, should be developed. Community-based networks can improve energy access, particularly in rural regions and encourage local energy generation and resilience.
7. **Developing an Actionable plan for Just Energy Transition Partnerships:** Pakistan should create an actionable plan for Just Energy Transition Partnerships (JETPs) to ensure a just and inclusive energy transition. This plan should include initiatives for promoting fair benefit sharing and addressing social and economic difficulties connected with the transition. Collaboration with foreign partners can help in mobilizing financial resources, transferring technology, and exchanging knowledge to strengthen JETPs.

4.2. Ministry of Foreign Affairs

International engagement and partnerships are critical in promoting sustainable energy development, particularly in developing nations like Pakistan. This article highlights key policy recommendations to promote international collaborations in the energy sector, with a focus on attracting FDI, technology transfer, regional energy cooperation, climate finance advocacy, and active participation in international climate negotiations. By implementing these recommendations, Pakistan will be able to

leverage international expertise, financial resources, and technical capabilities to improve its energy sector, promote cross-border energy trade, align with global energy transition goals, and accelerate the deployment of sustainable energy projects.

1. **Encourage International Collaborations for Foreign Direct Investment and Technology Transfer:** Pakistan should aggressively participate in international collaborations and partnerships to attract FDI and technology transfer. This may be accomplished by creating platforms, forums, and collaborative projects that encourage information exchange, networking, and commercial prospects. Encouraging foreign investment in Pakistan's energy industry would not only bring in funds but will also give access to sophisticated technology and best practices, expediting the adoption of sustainable energy solutions.
2. **Participate in Regional Energy Cooperation Initiatives:** Regional energy cooperation offers Pakistan considerable opportunity to boost cross-border energy commerce and build gas and power transmission networks. Participating actively in regional forums such as the South Asian Association for Regional Cooperation (SAARC), the Central Asia Regional Economic Cooperation (CAREC), and the Economic Cooperation Organization (ECO) will allow Pakistan to collaborate on energy projects with neighboring countries (Kumar & George, 2020). These projects have the potential to improve energy security, diversify energy sources, and foster regional stability and economic integration.
3. **Advocate for Climate funding and assistance:** Pakistan should advocate for climate funding and international partner assistance in order to fund sustainable energy initiatives. This entails working with international financial institutions, bilateral donors, and climate funds to get the required money for renewable energy installations, energy efficiency programs, and the adoption of clean technologies (Kagan & Dodge, 2023). Pakistan can position itself as an attractive beneficiary of climate finance and utilize this help to meet its energy transition goals by demonstrating a commitment to sustainable energy development.
4. **Actively Participate in International Climate discussions:** Active involvement in international climate discussions and agreements is critical to ensuring that Pakistan's energy transition goals are in line with global efforts. Pakistan may contribute to formulating international climate policy, advocate for its national interests, and access climate funding mechanisms by actively participating in forums such as the United Nations Framework Convention on Climate Change (UNFCCC) (Namahoro et al., 2021). This involvement will also allow for information sharing, capacity building, and partnership with other nations confronted with comparable issues and possibilities.

4.3. Ministry of Climate Change

1. Sustainable energy practices should be promoted in Pakistan in order to solve environmental concerns, reduce emissions, and secure a resilient energy future. This article provides policy ideas to help guide the creation of successful policies in a number of critical areas. To begin, strict laws and standards in the industrial and transportation sectors must be developed and enforced in order to minimize emissions. These policies should prioritize pollution monitoring, technical advancements, and the use of cleaner fuels. Second, encouraging the use of clean and renewable energy in public buildings and infrastructure would not only lower carbon footprints, but will also serve as a model for the private sector and the broader public (Elavarasan et al., 2022). This can be achieved through incentives, mandatory renewable energy installations, and energy performance standards.
2. Implementing climate change adaptation techniques is critical for mitigating the hazards presented by extreme weather occurrences. This involves assessing and strengthening energy infrastructure to resist extreme weather events including floods, storms, and heatwaves. Furthermore, the establishment of contingency planning and early warning systems can aid in the reduction of interruptions to the energy industry. Finally, it is critical to promote public awareness campaigns

and capacity-building programs to educate the public about energy saving and sustainable practices. This may be accomplished through media campaigns, instructional programs in schools, and industry professional training activities. Individuals and organizations may adopt energy-saving practices such as good insulation, efficient equipment, and responsible energy usage through raising awareness.

4.4. Private Sector

1. Private sector is critical for promoting sustainable energy transition and meeting environmental goals in Pakistan (Cantarero, 2020). This article makes policy proposals for the business sector to actively engage in the country's efforts to achieve a sustainable energy transition. To begin, through leveraging regulatory incentives and favorable financing structures, the private sector should be encouraged to participate in renewable energy projects and technology. Tax breaks, feed-in tariffs, and renewable energy certificates can all provide financial rewards while lowering investment risks. Access to inexpensive financing alternatives can help the private sector participate in renewable energy development.
2. Secondly, it is critical to develop collaboration among the corporate sector, research institutes, and academia in order to stimulate innovation in clean energy solutions. Joint R&D endeavors can lead to the progress of technology such as solar panels, wind turbines, and energy storage systems. Public-private partnerships may be formed to offer a platform for information sharing, technology transfer, and the commercialization of research discoveries, hence speeding up the implementation of sustainable energy solutions.
3. Thirdly, the business sector should incorporate energy-saving techniques into its operations and supply networks. Energy consumption and expenses may be considerably reduced by implementing energy-saving practices such as efficient lighting, heating, and cooling systems, and optimizing energy use in industrial processes. Engaging suppliers and promoting energy-efficient practices throughout the supply chain can also help to achieve sustainability goals.
4. Lastly, public-private collaborations are critical in developing sustainable energy infrastructure and initiatives. Collaboration between the corporate sector and government agencies has the potential to result in the construction of renewable energy parks, grid expansion projects, and smart city initiatives. These collaborations can benefit from government assistance and policy frameworks while using private sector experience, innovation, and resources.

4.5. CPEC Authority

1. Ensure that energy projects under CPEC prioritize the development of renewable energy sources and promote energy diversification (Baker & Benoit, 2022). The CPEC Authority should prioritize the inclusion of renewable energy projects within the CPEC portfolio. By placing emphasis on renewable energy sources, such as solar, wind, and hydropower, the Authority can contribute to reducing reliance on fossil fuels and promote energy diversification in Pakistan.
2. Strengthen monitoring and evaluation mechanisms to ensure timely completion and quality of CPEC energy infrastructure projects. The CPEC Authority should establish robust monitoring and evaluation mechanisms to ensure that energy infrastructure projects under CPEC are completed within specified timelines and meet the required quality standards. Effective project management and oversight will contribute to the successful implementation of sustainable energy projects.
3. Promote knowledge exchange and technology transfer between Chinese and Pakistani businesses in order to promote sustainable energy development. The CPEC Authority should actively encourage knowledge exchange and technology transfer between Chinese and Pakistani energy enterprises. This may be accomplished through collaborative research and development efforts, training programs, and partnerships that promote collaboration and the sharing of best practices in sustainable energy development.

4. Develop an integrated strategy to bring all stakeholders together in a holistic way to discuss the potential of Just Energy Transition collaborations (JETPs) and climate funding via CPEC and other regional partners. The CPEC Authority should take the lead in creating an integrated strategy that includes all essential stakeholders, including government bodies, financial institutions, commercial sector players, academia, and civil society organizations. Through inclusive dialogue, the Authority may enable the research and design of JETPs, as well as the mobilization of climate funds, by leveraging CPEC and other regional partners to promote sustainable energy transitions in Pakistan.

These recommendations aim to guide policy efforts across multiple sectors and stakeholders in Pakistan to facilitate the transition to a low-carbon energy future. Coordination and collaboration among ministries, private sector groups, academics, and financial institutions will be essential to promote the transition to cleaner and more resilient energy systems.

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