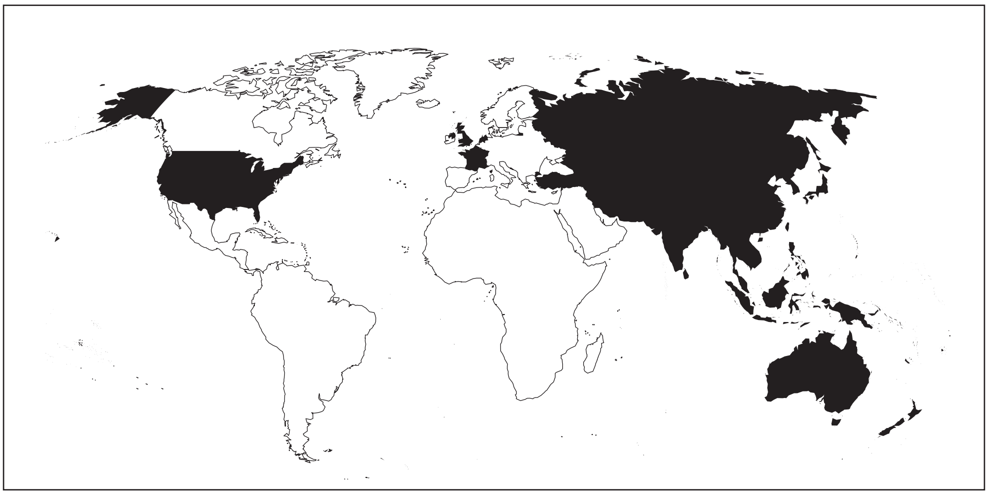
# Phasing-Down the Use of Coal in Pakistan

Economic and Social Commission for Asia and the Pacific



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# Table of Contents

# List of Figures



# List of Tables

# Executive Summary

Pakistan has an opportunity to hasten the switch from coal to clean energy sources thanks to the worldwide trend of falling costs for renewable technology. According to the International Renewable Energy Agency (IRENA), 62 per cent of renewable technologies that were put into operation globally in 2020 produced energy that was less expensive than from the least expensive coal-fired power plants.

This change is also noticeable in Pakistan, where the prices of producing solar and wind energy are now competitive with coal. Furthermore, Pakistan is facing the critical task of phasing down its coal power plants, necessitating a careful examination of various factors. These include energy security, environmental impacts, socio-economic impacts of just transition , feasibility of power generation alternatives (financial viability, depletion of gas reserves and feasibility of alternative technologies) Halting the construction of new coal-fired power plants and ramping up cost-effective deployment of low-carbon power are essential steps to align with global sustainability goals.

Technical options for the phase-down of existing coal plants include repurposing, retrofitting with carbon capture and storage technologies, or opting for early retirement and replacing them with renewable energy sources. Given that 9 out of a total of 11 of Pakistan's coal-fired power plants have come online under the China-Pakistan Economic Corridor (CPEC), China's announcement to stop investing in coal-fired power projects abroad post-2021 presents an invaluable opportunity for transitioning away from coal.

The transition to clean energy sources presents numerous opportunities for Pakistan. It can drive green job creation and stimulate economic growth in various sectors such as manufacturing, construction, and renewable energy operations. Shifting away from coal and adopting renewable energy alternatives can enhance energy security by reducing dependence on expensive fossil fuel imports. Moreover, rural electrification using decentralized renewable energy systems can uplift remote communities and spur socio-economic development. Additionally, transitioning from coal provides an opportunity to tackle the challenge of managing the circular debt in the energy sector. Exploring technical options for phasing out existing coal plants reveals three potential approaches: repurposing, retrofitting with carbon capture technologies, and early retirement. Each option presents its own set of opportunities and challenges, underscoring the need for a comprehensive approach tailored to Pakistan's unique energy landscape and environmental goals. While repurposing coal facilities to use natural gas is considered, the country's depleting gas reserves and volatile import prices make this solution less feasible.

Benchmarking criteria for coal phase-out highlight the trade-offs involved in this process. Balancing energy security with environmental concerns and socio-economic impacts is essential. Assessing the impact on job losses, particularly in the coal sector, underscores the need for careful planning and support mechanisms for affected workers and communities. Prioritizing investments in clean power sources like solar and wind is recommended as they offer competitive alternatives to coal power.

Pakistan's transition away from coal would offer substantial climate and environmental benefits as well, significantly reducing greenhouse gas emissions and improving air quality. The country possesses abundant renewable energy potential, particularly in solar and wind, making it well-suited for harnessing these resources. Moving away from coal will have positive health and social impacts, improving public well-being and creating cleaner living environments for communities near coal-fired power plants. Public awareness and support for this transition are also growing, setting the stage for favourable policy changes.

However, while Pakistan has abundant renewable energy resources, it faces challenges through its limited grid infrastructure to support the integration of renewables while maintaining grid stability. Significant investment and coordination among stakeholders are required to upgrade and expand the grid to accommodate variable renewable energy generation. Financing constraints for renewable energy projects, especially for smaller-scale initiatives, necessitate innovative financial models such as Just Energy Transition Partnerships (JETPs) and private sector involvement. Strengthening local technological capacity is also essential to foster expertise in renewable energy manufacturing, installation, and maintenance.

JETPs have emerged as a promising financing mechanism to support developing economies in their transition away from fossil fuels. JETPs aim to provide a relatively lower-cost finance, promote investment-grade policies, manage the phase-down of fossil fuels, and support affected communities Khalidi (2022). These partnerships combine public and private investments and utilize various financing instruments to invest in renewable energy infrastructure and support impacted communities. By aligning national climate goals with net-zero emissions targets and promoting sustainable development, JETPs offer a model that can be replicated globally. However, phasing down coal in Pakistan presents unique challenges due to the existing coal capacity and long-term agreements associated with coal projects, as well as global economic factors impacting energy prices. To successfully transition away from coal, Pakistan needs a comprehensive energy transition plan with clear targets, policies, and stakeholder engagement. Transparent data disclosures, a holistic policy framework, public awareness campaigns, and international collaborations are essential to build on the momentum on transitioning away from coal.

A just transition for affected workers and communities, enhanced institutional capacity, and accessible technology and data are also crucial aspects of the energy transition. Establishing tailored JETPs with actionable commitments, plans, and targets can incentivize renewable energy financing in Pakistan, accelerating the shift towards cleaner and sustainable energy sources.

A successful transition away from coal power in Pakistan requires a comprehensive energy transition plan with clear targets, timelines, and sector-specific strategies. This plan should be formulated through extensive stakeholder consultations, taking into account environmental, social, and economic considerations. To create a conducive environment for renewable energy investments, a medium to long-term policy and regulatory framework must be developed, providing certainty and support for public-private partnerships. Implementing well-designed and bankable remuneration schemes will attract investors and ensure a reasonable return on capital. Public awareness campaigns are also crucial to promote the benefits of a coal phase-out and renewable energy adoption. Furthermore, international collaborations and partnerships will facilitate knowledge sharing and access to funding opportunities. Robust monitoring and evaluation mechanisms will track the progress of the phase-out and renewable energy deployment, enabling necessary adjustments and effective policy implementation. Ensuring a just transition for affected workers and communities necessitates reskilling programs, job creation in alternative sectors, and social protection measures. To manage the energy transition effectively, enhancing the institutional capacity of energy-related government agencies and research institutions is essential.

Moreover, technology and data accessibility play a significant role in the energy transition process. Open data and tools for energy transition planning will facilitate stakeholder engagement and informed decision-making. Building local capacity and ownership in the design and implementation of JETPs are critical for their success, requiring closer coordination between stakeholders and active involvement of provinces and local communities. Establishing JETPs with focused commitments and targets will incentivize renewable energy financing, delink energy from politics, and provide stability and favorable environmental conditions for investors. Lastly, an inclusive platform for stakeholder participation and transparent dissemination of information will foster community engagement and compensation for communities adversely impacted by polluting assets. By implementing these recommendations, Pakistan can pave the way for a sustainable, low-carbon energy future.

CHAPTER 1

# The Role of Coal in Pakistan's Energy System

Pakistan is currently facing multiples headwinds as a result of the ongoing volatility in global energy markets and the impacts of climate change. In recent years, the country has faced surging costs for imported fuels, worsening local air pollution and water stress, deteriorating financial conditions, and challenges in delivering reliable electricity to a burgeoning population. Decision makers face acute questions over balancing energy security, affordability and environmental goals while enhancing societal welfare.

The Government has taken an approach of accelerating the build-up of coal power capacity, fuelled by domestic reserves of coal. However, it is essential to recognize the trade-offs as such a strategy risks undermining Pakistan's long-term climate goals and raises costs and uncertainties for local ecosystems and communities. While Pakistan has abundant renewable energy resources – which can offer affordability and socio-economic benefits – these lack supportive policy and integration frameworks to spur investment. Successful clean energy transitions require Pakistan to address its growing dependence on coal as well as the factors inhibiting the development of renewables.

This chapter aims to provide an overview of Pakistan's energy system and policy environment, with an emphasis on the factors behind the growing use of coal and its role in the power sector.

## 1.1 Clean Energy Transitions in Pakistan: Current Policy Settings and Net-Zero Ambitions

### 1.1.1 Overview of Energy Transition and Climate Goals

Pakistan, ranked 8th on the German Watch Long Term Climate Risk Index (2021), is highly vulnerable to climate change. This vulnerability was exemplified by the 2022 monsoon floods, which caused damages and losses amounting to USD 14.9 billion and USD 15.2 billion (2.2 per cent of GDP in fiscal year 2022), respectively (Government of Pakistan 2022). Moreover, approximately 33 million people have been adversely affected, with 8 million people displaced and an estimated 8.4 – 9.1 million people are expected to fall below the poverty line as a result of the disaster (ibid). The monsoon rainfall that afflicted vast swathes of Pakistan was 75 per cent heavier as a result of the climate warming up by 1.2°C (World Weather Attribution 2022). In addition, the monsoon rainfall was 7 times more intense than the average with the provinces of Sindh and Baluchistan receiving more rainfall (784 per cent and 500 per cent more, respectively) than the August average (The Express Tribune 2022).

Furthermore, both the frequency and the intensity of climate disasters is set to increase as per the current trajectory without any significant mitigation efforts. In Pakistan, median temperatures are expected to reach 28.5°C by the year 2100 in the best-case scenario and 33.5°C in the worst-case warming scenario as compared to 28.1°C in the reference year 2014 (World Bank 2022). Under these scenarios, Pakistan's GDP is projected to fall by 17.6 percentage points by 2050 in the best-case scenario and by 20.1 percentage points in the worst-case scenario relative to business-as-usual (BAU) (ibid).

Given the depth and wide front of challenges Pakistan faces, there is an urgent need to scale up the climate transition, with a focus on both mitigation and adaptation. Although it currently contributes less than 1 per cent of global greenhouse gas (GHG) emissions, Pakistan's GHG footprint is set to increase as per the current trajectory with $CO_2$ emissions from the use of coal, oil and natural gas doubling over the past couple of decades and emissions from coal increasing by over 500 per cent over the period (Global Energy Monitor 2021).

However, this seems to be a very short-term development strategy. Given that the use of coal-fired power was responsible for almost a fifth of Pakistan's total emissions in 2019 (ibid), it requires a dramatic transformation of energy systems, involving a massive scale-up of renewable energy and transition away from polluting fossil-fuel based power to avoid the worst impacts of climate change and limit global warming to 1.5 degrees Centigrade. Over the past decade, following the regional trend, Pakistan has dramatically increased its reliance on coal from 3.4 million tonnes of oil equivalent (Mtoe) to 12.6 Mtoe by 2020, almost a four-fold increase.

As in other Asia-Pacific countries, the ready availability of cheap coal in Pakistan has underpinned the economic and energy growth model, where coal has formed the central pillar for the expansion of power generation capacity. In 2015, coal-generated power was almost absent from the nation's electricity mix, but in Pakistan's latest Indicative Generation Capacity Expansion Plan (IGCEP 2022-31), it was expected to contribute 23 per cent of total power generation in 2023.

Current installed coal power capacity stands at about 8GW (IGCEP 2022-31), primarily from the construction of large-scale power plants developed as part of the China-Pakistan Economic Corridor (CPEC). From 2020, a Government-announced moratorium on building new coal-fired power plants has been in place. Nevertheless, some 3.6 GW worth of projects announced prior to the moratorium are in the development pipeline as of 2023 (CPEC Authority 2023).

In addition to their impact on the climate, these power plants emit a range of pollutants, including sulphur dioxide, nitrogen oxide, and particulate matter, and coal mining and transportation can have negative impacts on local ecosystems and communities. Coal-fired power plants can also cause problems for long-term capacity payments. There is a risk that these plants may become stranded assets, meaning they become obsolete or unprofitable. The plants are approved under "take or pay" contracts, therefore, these plants are subject to high capacity operation payments. This risk is made worse by the fact that climate change risks are not adequately considered in assessing their impact. Rapid phase-down of unabated coal is critical in the mitigation effort.

The use of coal in power generation accounts for the largest share of global energy-related $CO_2$ emissions, at nearly 30 per cent, with industrial use of coal for the manufacturing of steel, cement and other products comprising another 10 per cent (International Energy Agency 2021). There is a strong economic case of transitioning away from coal to cleaner and more sustainable energy sources, as the transition not only merits environmental benefits but also economic ones, such as promoting the development of new economic opportunities in the clean energy sector. This shift can create new jobs, reduce dependence on imported fossil fuels, and support sustainable economic growth and development in Pakistan.

Furthermore, decision-makers increasingly recognize the economic and environmental benefits of shifting away from coal. The Glasgow Climate Pact adopted at COP26 calls for "accelerating efforts towards the phasedown of unabated coal power". Nevertheless, for Pakistan, the policy landscape has been inconsistent. Although policymakers recognize the need for expediting the green transition, other considerations and economic challenges have hampered the transition effort. Some of the key policies that are guiding the energy and climate strategy of Pakistan include the Nationally Determined Contributions (NDCs) 2021, Alternative and Renewable Energy Policy 2019 (ARE Policy 2019), and the Indicative Generation Capacity Expansion Plan (IGCEP 2022-2031).

### 1.1.2 Updated Nationally Determined Contributions (NDCs) – 2021

Pakistan, in its submission to the United Nations Framework Convention on Climate Change (UNFCCC) in October 2021, has demonstrated its commitment to reducing greenhouse gas (GHG) emissions by 50 per cent below business-as-usual levels by 2030, relative to the baseline year of 2015. Of this target, 15 per cent is deemed unconditional, while the remaining 35 per cent is conditional on international funding and support. To achieve these ambitious objectives, Pakistan's updated Nationally Determined Contributions (NDCs) encompass a comprehensive set of measures.

The NDCs prioritize several strategies to reach the emissions reduction target. These include enhancing energy efficiency, increasing the proportion of renewable energy sources, and promoting the adoption of electric vehicles. Notably, Pakistan has set a goal to elevate the share of renewable energy in its power mix to 60 per cent by 2030, with a specific emphasis on solar and wind energy, alongside a significant contribution from hydropower. Complementary initiatives outlined in the NDCs comprise the promotion of afforestation and reforestation, the adoption of climate-smart agricultural practices, and the implementation of a national electric vehicle policy. Additionally, Pakistan plans to establish a climate-resilient infrastructure system, encompassing the construction of coastal protection infrastructure and the enhancement of flood forecasting and warning systems.

The NDCs also shed light on Pakistan's vulnerability to climate change and the imperative need for international support to achieve its mitigation and adaptation targets. The energy transition alone necessitates an estimated USD 101 billion of investment by 2030. The NDCs further estimate that accelerating the phase-down of relatively new coal power projects including the local Thar coal mines would involve an estimated cost of USD 18 billion. It is worth noting that the fleet of coal power plants in Pakistan is relatively young, therefore, the estimated phase-down cost is higher compared to Indonesia, South Africa and Viet Nam. Moreover, the capacity building will be required to shift labor to the green jobs. Therefore, the NDCs underscore the importance of financial and technological assistance, along with capacity-building support, to effectively implement the outlined measures.

By submitting its updated NDCs, Pakistan has demonstrated its commitment to tackling climate change and transitioning towards a sustainable and low-carbon future. The ambitious targets, comprehensive strategies, and recognition of the need for international collaboration underline Pakistan's determination to address the challenges posed by climate change.

### 1.1.3 Alternative and Renewable Energy Policy 2019

The Alternative and Renewable Energy (ARE) Policy 2019 aims to facilitate the adoption of alternative and renewable energy technologies (ARET) for both grid generation and consumer-driven applications. This policy encourages private sector investment by providing incentives and seeks to achieve multiple objectives, including environmental protection, cost-effective power generation, transparent and expedited development of ARET projects, utilization of indigenous resources, and attracting private sector investment with competitive returns.

To ensure progress, the policy sets specific targets for renewable energy generation, aiming for a minimum of 20 per cent by 2025 and 30 per cent by 2030. By displacing more expensive fossil energy with cheaper renewable sources, the policy aims to reduce the average cost of power generation. It encompasses all projects utilizing ARET for power production, whether for sale to public utilities or private consumers. The policy covers a wide range of technologies, including conventional renewable energy sources such as solar, wind, geothermal, and biomass, as well as alternative technologies like biogas, syngas, waste-to-energy (WTE), energy storage systems, and ocean/tidal waves, along with hybrid technologies.

However, the implementation of the ARE 2019 Policy faces challenges due to political instability and policy inconsistency. Despite these obstacles, the Alternative Energy Development Board (AEDB) remains committed to exploring policy options for renewable energy development in the country, demonstrating a sustained effort to overcoming

**Table 1. Pakistan's renewable energy policies and targets**

| Pakistan's Renewable Energy Policies and Targets | |
|---|---|
| **Policy** | **Targets** |
| Updated Nationally Determined Contributions | • Reduce GHG emissions by 50% below business-as-usual levels by 2030 |
| | • 15% unconditional reduction |
| | • 35% conditional reduction dependent on international funding and support |
| | • Increase share of renewable energy in power mix to 60% by 2030 |
| | • Promote energy efficiency, electric vehicles, afforestation, climate-smart agriculture |
| | • Establish climate-resilient infrastructure system, including coastal protection |
| Alternative and Renewable Energy Policy 2019 | • Achieve 20% renewable energy generation by 2025 |
| | • Achieve 30% renewable energy generation by 2030 |
| | • Displace expensive fossil energy with cheaper renewable energy |
| Indicative Generation Capacity Expansion Plan (IGCEP) 2022-31 | • Increase share of renewable energy in energy mix to 30% by 2030 |
| | • Increase share of hydropower to 30% by 2030 |
| | • Achieve 60% non-fossil fuel-based generation |
| | • Reduce carbon dioxide ($CO_2$) emissions from 398g/kWh in 2022 to 190g/kWh by 2030 |
| | • Introduce 10GW of solar projects and 5GW of wind projects by 2031 |
| | • Install 9.27 GW of coal capacity by 2031, with 4.68 GW of imported coal and 4.59 GW of local coal |
| | • Subject to annual review and adjustment based on infrastructure development |

barriers and promoting the growth of renewable energy in Pakistan.

### 1.1.4 Indicative Generation Capacity Expansion Plan (IGCEP) 2022-31

The IGCEP 2022-31 is an iterative plan launched by the Government to guide investment decisions in the power sector and provide an indication of the expected growth in the country's generation capacity. The plan aims to increase the share of renewable energy in the energy mix to 30 per cent by 2031, in addition to a 31 per cent share of hydropower, to take the overall share of non-fossil fuel-based generation to 61 per cent.

As of June 2022, Pakistan had 36 wind power projects with a capacity of about 1,845 MW, seven solar projects of 600 MW, and 9 bagasse projects of 364 MW. Under the IGCEP, the Government plans to introduce 10GW of solar projects and 5GW of wind projects by 2031, reducing the overall carbon dioxide ($CO_2$) emissions in the country from 398g/kWh in 2022 to 190g/kWh by 2030. However, the IGCEP envisages the installed capacity of coal to be around 9.27 GW by 2031, with 4.68 GW of imported coal and 4.59 GW of local coal. 1.98 GW of coal fired power plants are coming online in 2022-2023 with the addition of 330 MW Thal Nova power project, 330 MW Thar TEL project and the 1.32 GW Thar-I (SSRL) project.

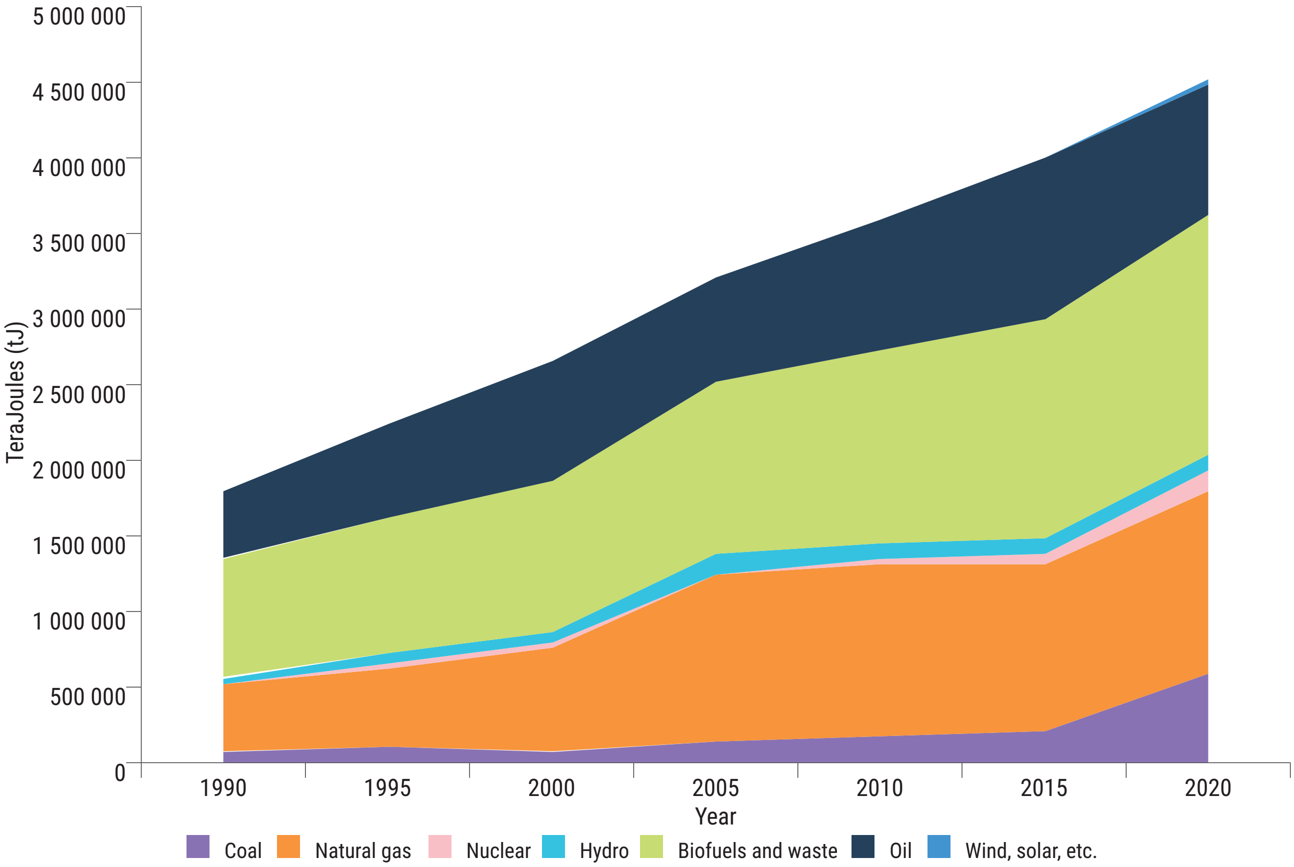
The IGCEP 2022-31 has 6 scenarios including the low demand, high demand, Dhiamer Bhasha scenario, Chashma Nuclear, local coal inclusion, and unconstrained VRE scenarios. It was established on the least-cost principle (lowest tariff basis), and the targets are subject to annual review and subsequent adjustment based on dynamic parameters such as whether Pakistan has added enough transmission lines and suitable infrastructure to meet the targets laid out in the earlier iterations of the IGCEP. The plan aims to ensure sustainable and affordable electricity for all, while reducing the overall carbon footprint of the country.

## 1.2 The role of coal in total primary energy supply (TPES), emissions, trade, and compatibility with energy security and sustainability goals

### 1.2.1 Pakistan's TPES Profile and Role of Coal: Trends and Composition

Pakistan's TPES increased from 43.1 Mtoe in 1990 to 107.8 Mtoe by 2020, at an annual growth

Figure 1. **Pakistan total energy supply by source (1990-2020)**




*Source: Data taken from IEA.*

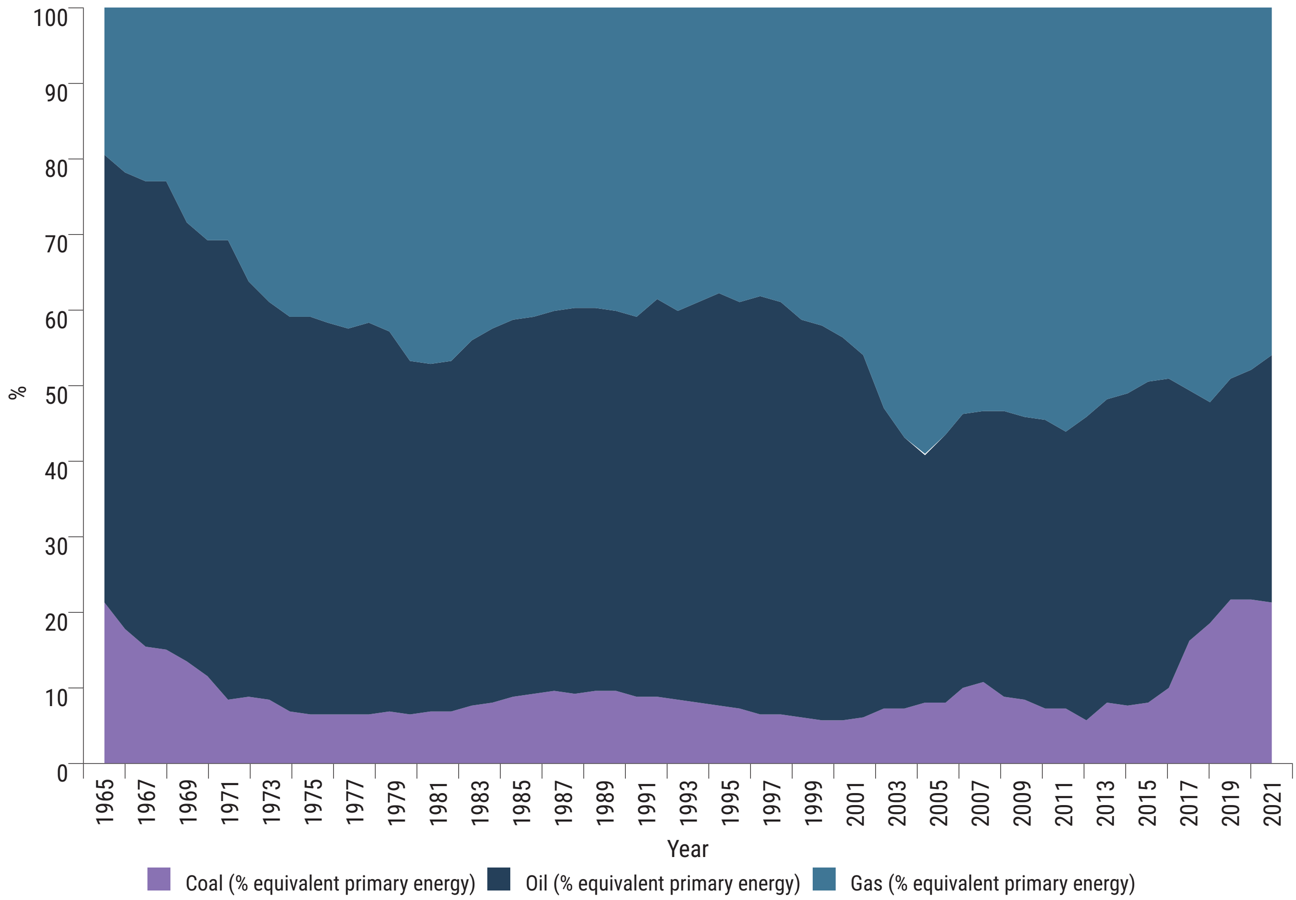
rate of 3.1 per cent over the period (Figure 1). The share of coal in Pakistan's TPES increased from 83,799 terajoules (4.6 per cent) in 1990 to 584,876 terajoules (13 per cent) in 2020 at an annual growth rate of 6.7 per cent. Biofuels have traditionally dominated Pakistan's TPES mix with the share of biofuels standing at 43.6 per cent (785,890 terajoules) in 1990, which slightly declined to 34.9 per cent (1,575,667 terajoules) in 2020. Other major sources of energy include oil and natural gas, with the supply of natural gas increasing at an annual growth rate of 3.6 per cent from 422,032 terajoules (23.4 per cent of TPES) in 1990 to 1,216,022 terajoules by 2020 (26.9 per cent of TPES), and the supply of oil increasing at an annual growth rate of 2.3 per cent from 447,217 terajoules (24.8 per cent of TPES) in 1990 to 875,619 terajoules by 2020 (19.4 per cent of TPES).

Figure 2 shows Pakistan's primary energy mix from different sources; coal, oil and gas, and the cumulative share of fossil fuels in the primary energy mix from 1965 to 2021. Traditionally, the share of fossil fuels in the primary energy mix has been near the 90 per cent mark (excluding biofuels), with fossil fuels contributing 85.9 per cent of the total share of the primary energy mix on average over the period. Out of this, oil was the greatest contributor with the average share of oil in the primary energy mix being 40.6 per cent over the whole period. However, the share of oil fell from a peak of 56.4 per cent in 1968. By comparison, coal was a significant part of the energy mix in the late 1960s before picking up again post-2015 after the induction of coal-fired power under CPEC. The average share of coal in the energy mix over the period from 1965-2021 was 8.1 per cent. However, the peak share of coal in the energy mix was 19.5 per cent in 1965, after which the share of coal fell to 4.9 per cent by 2000. Coal contributed 17.4 per cent of the primary energy supply in 2021.

### 1.2.2 Pakistan's Emissions Profile by Sector and Source

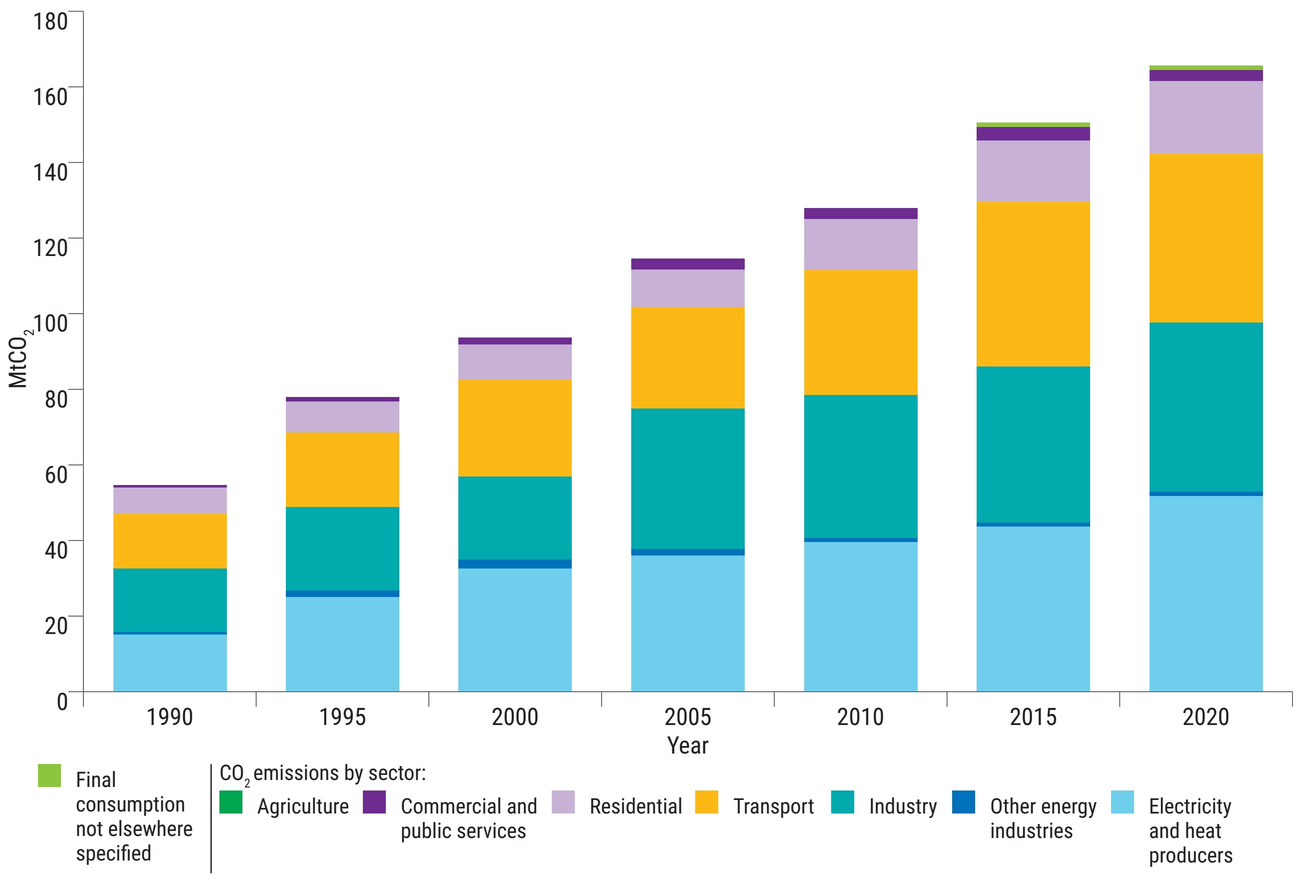
Pakistan's overall emissions expanded from 56 $MtCO_2$ equivalent in 1990 to 166$MtCO_2$ equivalent by 2020, an almost three-fold increase over the period. Overall, the industrial sector contributed the most

Figure 2. **Pakistan primary energy (% equivalent) from 1965 to 2021**



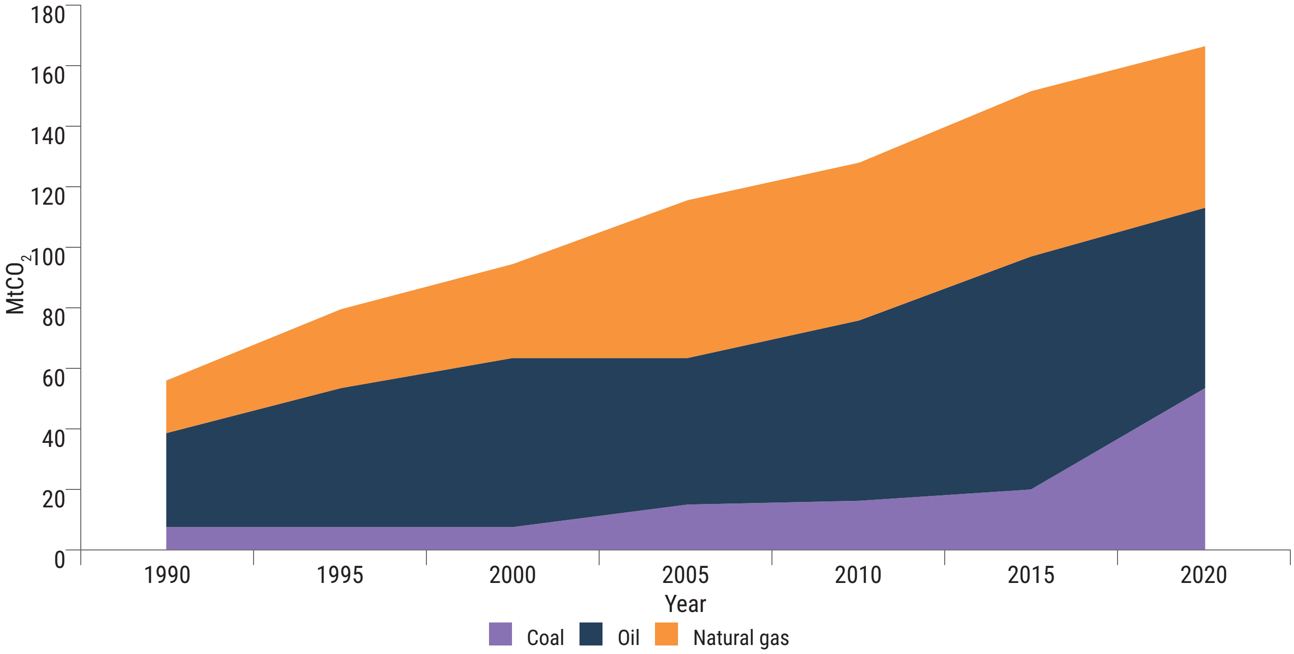

*Source: Data taken from Our World in Data (2022).*

Figure 3. **Pakistan $CO_2$ emissions by sector (1990-2020)**



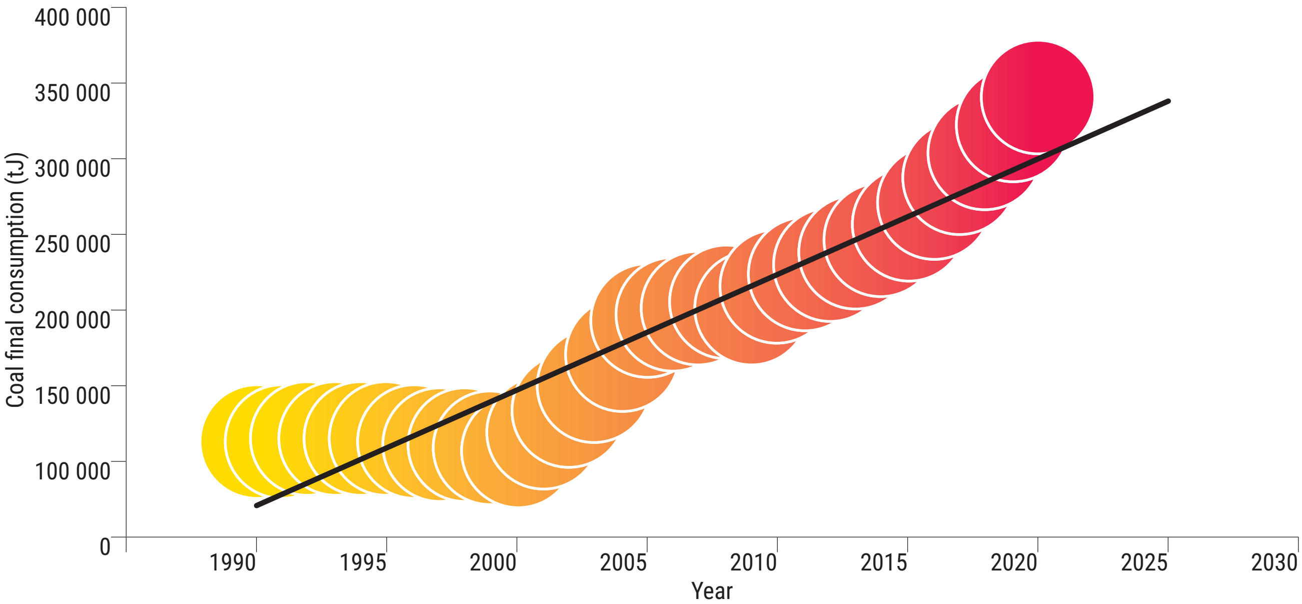

*Source: Data taken from IEA.*

Figure 4. **Pakistan $CO_2$ emissions by energy source (1990-2020)**




*Source: Data taken from IEA*

Figure 5. **Bubble chart showing high correlation (trend line) between coal $CO_2$ emissions and gross final consumption from coal in terajoules over time (1990-2020)**

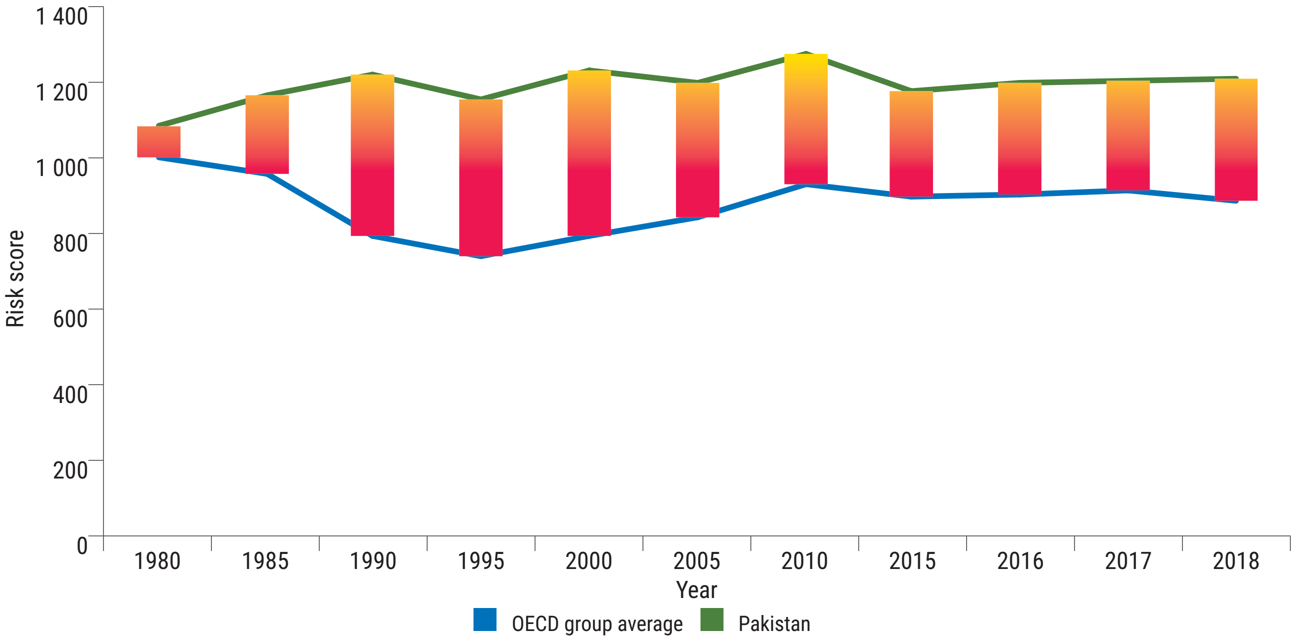



*Source: Data taken from IEA*

to emissions in 1990 at 30.4 per cent (17 MtCO2e) followed by electricity at 26.8 per cent (15 MtCO2e) and the transport sector at 25 per cent of the total (14 MtCO2e). However, the sectoral emissions contributions had changed by 2020 (Figure 3 and 4), with electricity contributing the greatest share at 31.3 per cent (52 $MtCO_{2e}$) followed by the industrial and transport sectors at 27.8 per cent each (45 $MtCO_{2e}$).

When it comes to emissions by energy source, oil has traditionally dominated the fossil fuel mix for Pakistan and therefore, it is the largest contributor to $CO_2$ emissions. However, the contribution of coal to

Figure 6. **Pakistan vs. OECD Energy Security Risk Score (1980-2020)**




*Source: Data taken from the Global Energy Institute (2020) - (OECD=1000 base year 1980).*

overall $CO_2$ emissions has picked up as the share of coal in TPES has increased post-2015. On average, oil contributed 54.1 $MtCO_2$ annually to $CO_2$ emissions, while natural gas contributed 41 $MtCO_2$ annually to $CO_2$ emissions and coal contributed 18$MtCO_2$ annually to $CO_2$ emissions over the period (Figure 5).

### 1.2.3 Energy Security Profile: Short Run vs. Long run Sustainability Perspective

Figure 6 shows a comparison between the energy security risk index[1] for Pakistan and the Organization for Economic Cooperation and Development (OECD) for the time period 1980-2018. The data shows that Pakistan's energy security risk index has gradually edged upwards over time while the OECD's risk security index has decreased over the period. Pakistan's energy security risk score reached a peak of 1,276 in 2010, compared with the OECD's energy security risk score of 1,000 in the base period of 1980 (this was also the OECD's peak energy security risk score). OECD's energy security risk declined to 739 in 1995 before rebounding to 884 by 2018. Pakistan's energy security risk was at the lowest point in 1980 with a score of 1,084. Pakistan's average energy security risk over the period was 1,192 points, more than 300 points higher than the OECD's average score of 878.

These risk scores showcase the risk arising out of a combination of factors such as a country's overall fuel consumption, dependency on imported fuels, energy expenditures as a percentage of total expenditures, reserves, production, intensity and susceptibility to price shocks. In Pakistan's case, these scores are a product of factors such as energy expenditure intensity, energy intensity, crude oil prices, $CO_2$ emissions trend, energy expenditure volatility, transport expenditure intensity, electricity capacity diversity etc. For example, the 2010 peak coincides with Pakistan's energy crisis, with energy expenditure intensity, crude oil prices, $CO_2$ emissions trend, and energy expenditure volatility contributing the most to the energy security in that period (Nawaz and Alvi 2018).

Pakistan's energy security profile is characterized by a short-term reliance on imported energy sources, which is not sustainable in the long run. To ensure energy security and socio-economic and

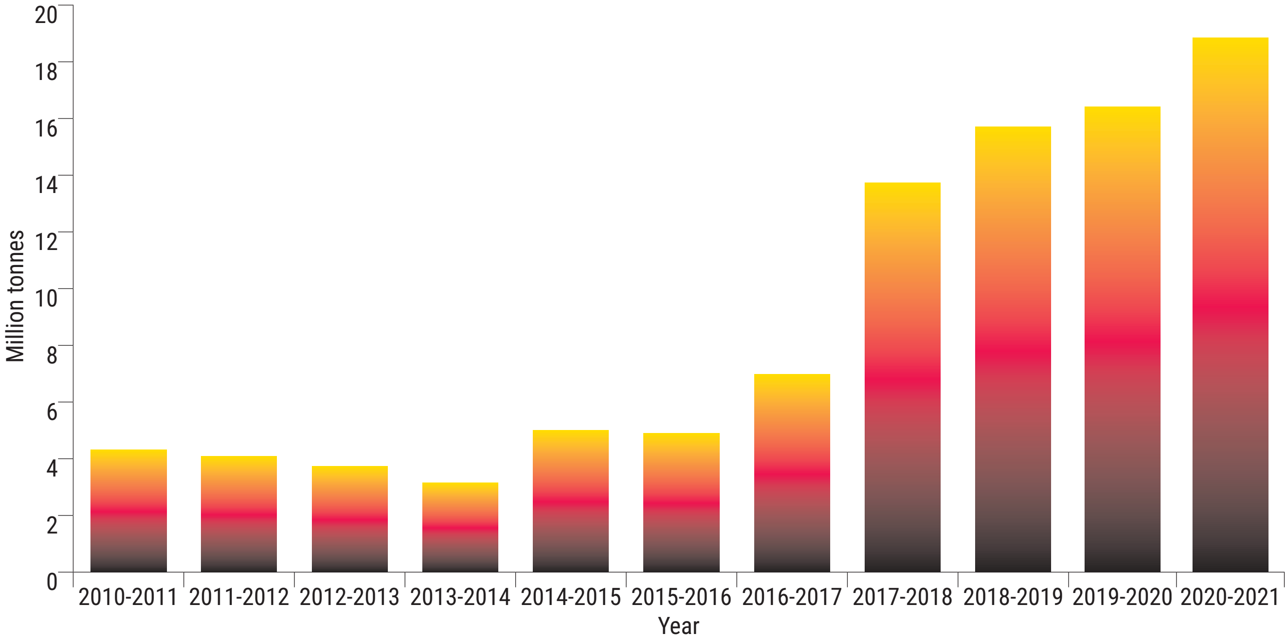
1 The Index is made up of 37 different measures of energy security risk in nine categories: global fuels; fuel imports; energy expenditures; price and market volatility; energy use intensity; electric power sector; transportation sector; environmental; and basic science and energy research & development. The Index covers the historical period from 1970 to 2019 and a forecast period out to 2040.

environmental sustainability, policy makers should focus on minimizing reliance on imported energy and promoting energy efficiency (ibid). This will help to reduce the country's dependence on imported energy sources and ensure long-term energy security.

### 1.2.4 Indigenous coal bringing energy security but climate insecurity

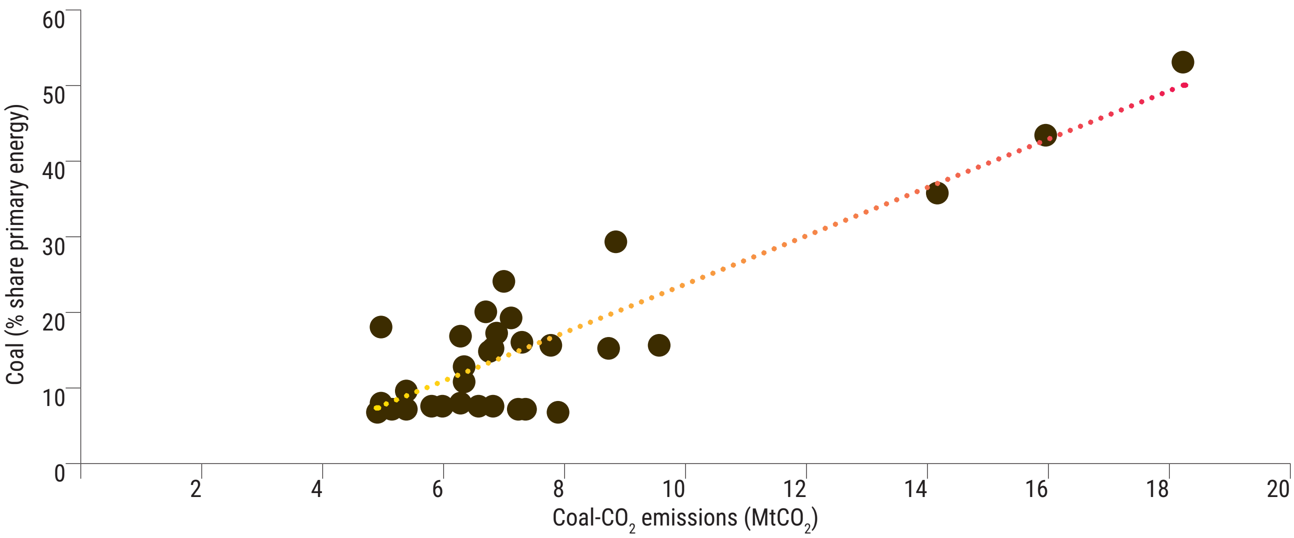
Pakistan has been suffering from persistent energy crises since the start of the 21st century, with peak electricity shortfalls reaching 8.5 GW by mid-2012, and 7.5 GW in April 2022. Additionally, the country is reliant on a costly fuel mix with a high percentage of imported fuels. Facing a shortage of foreign exchange, the Government has emphasized the use of indigenous coal as a viable option to shift away from costly fuel imports while ensuring system adequacy. Plants that run on imported coal constitute 12 per cent of total installed capacity (including the K-Electric system's installed capacity) as of 2022 (IGCEP 2022-31).

Figure 7. **Pakistan coal imports in megatonnes**




*Source: Data taken from Economic Survey Statistical Supplement 2021-22.*

Figure 8. **Scatter plot showing correlation between Pakistan's coal share (% of TPES) and $CO_2$ emissions from coal (1990-2020)**




*Sources: Data taken from the IEA and Our World in Data (2022).*

Pakistan's reliance on coal gradually increased over the years with coal imports worth 24,790 terajoules in 1990 and 26,168 terajoules in 2000. Post-2000, coal imports increased to 451,863 terajoules by 2020, at a growth rate of 10.2 per cent. In tonnes, coal imports have increased from 4.27 million tonnes in 2010-11 to 18.85 million tonnes by 2020-21, at an average annual growth rate of 2.78 per cent (Figure 7).

Pakistan imported coal worth USD2.3 billion in 2021 (Workman 2022). The average annual rate of growth for primary coal imports was 17.2 per cent, from 1.74 million tonnes in 2002 to 21.6 million tonnes in 2021 (Knoema 2022). The average volume of annual coal imports for Pakistan during the 1980s to 2020 was 3.7 million tonnes (Global Economy 2021).

Figure 8 shows the correlation between $CO_2$ emissions from coal usage in Pakistan and the share of coal in TPES, showing that a 1 per cent increase in coal usage over the period concerned is associated with an emissions increase of 0.81 per cent. Although the Government's stance on utilizing indigenous coal is primarily driven by considerations of energy security and a desire to reduce the trade deficit, however, from a long-term sustainability perspective, the use of indigenous coal presents a significant challenge to climate security. The trade-off between energy security and climate insecurity should be comprehensively assessed, taking into account the interconnected aspects of energy, economy, and environment.

While indigenous coal may appear to be a more economically viable option in the short term, its long-term implications extend beyond emissions and encompass potential environmental hazards, particularly with regards to water contamination. Thus, it is imperative to carefully evaluate the multifaceted consequences associated with the utilization of indigenous coal, considering its impact on both the economy and the environment in order to make informed decisions that align with long-term sustainability goals.

Additionally, it should be noted that the majority of domestic coal in the mentioned context is lignite, which is particularly detrimental from an environmental perspective. Therefore, it is crucial to acknowledge the broader potential environmental costs associated with domestic coal production and utilization, encompassing not only the $CO_2$ emissions but also other significant impacts such as water contamination and various environmental hazards. By considering these multifaceted aspects, a comprehensive evaluation of the environmental consequences of domestic coal can be achieved, leading to informed decision-making and a more holistic understanding of its potential environmental risks.

## 1.3 Drivers for coal, including domestic mining, employment, incumbents, subsidies and barriers to renewables

### 1.3.1 Financial Drivers

Market interventions provided to artificially reduce the cost of fossil fuels, known as fossil fuel subsidies, present a significant financial obstacle to the transition towards renewable energy sources. Globally, governments allocate approximately USD 500 billion annually towards such subsidies (Carbon Brief 2017). Subsidies are one of the primary drivers of coal consumption in Pakistan. Although the Government of Pakistan has been trying to reduce subsidies given to coal-power plants, the total value of subsidies given has nevertheless increased significantly in recent years with the figure reaching PKR 100 billion for FY 2021-22 (The Express Tribune, June 11 2022). This is due to a number of factors, including the rising cost of imported coal and the increasing number of coal-power plants being built in Pakistan.

### 1.3.2 Socioeconomic Drivers

Socio-economic drivers of coal in Pakistan include domestic mining and employment. Coal mines contribute to local economies, resulting in jobs and enhanced economic activity in the region as a whole (World Bank 2022). For example, the presence of the Thar coal mine has not only given job opportunities to locals, but has also contributed to social equity as a significant number of truck drivers in the region are women. Besides mine workers, coal mines also lead to job opportunities in transportation, equipment manufacturing, maintenance, and support services.

The loss of these jobs can create challenges for workers and their families who rely on the coal industry for employment. This can have a broader impact on the overall economic health of the region. Moreover, there might also be various education and healthcare opportunities available, as can be seen in Thar where the Sindh Engro Coal Mining Company (SECMC) has established schools/vocation centres as well as basic health units, thereby contributing to the socio-economic development of the Thar region.

### 1.3.3 Other Drivers

As renewables represent a key alternative to coal for the expansion of power generation capacity, it is important to understand the barriers to the integration of renewable energy sources. These barriers play a crucial role in the decision to opt for coal consumption and usage in Pakistan. Nevertheless, it is important to address these barriers separately, as they extend beyond socio-economic factors. Similarly, it is also necessary to differentiate between variable and dispatchable renewables when discussing integration issues. Moreover, it is worth highlighting that many countries worldwide have effectively accelerated the deployment of renewables while addressing these challenges in a cost-effective manner.

The barriers preventing the rapid uptake of renewables include:

**Dispatchability:** One key barrier is the perceived inability of renewable energy technologies to meet the dispatchability demands of electricity systems. Although availability of renewables such as solar and wind for dispatch purposes can be predicted in advance, however as penetrations increase, they require more flexible generation from other power sources supplying the grid. Thus, it is important to distinguish between variable (such as solar and wind) and dispatchable (hydro, biomass) renewables, to more accurately assess the integration challenges associated with each.

**Up-front Costs:** The initial capital investment required for building and installing wind and solar farms presents a significant financial barrier as compared to coal fired power plants, requiring greater levels of financing and making them more sensitive to financing costs than fossil fuels, where costs are spread out over fuel costs as well as capital costs. These up-front costs are hindering the widespread adoption of renewable energy sources in Pakistan. The total share of VRE is still less than 5 per cent in the total electricity mix. Therefore, the up-front costs coupled with frequent curtailing of wind plants is a major barrier to the widespread adoption of wind plants.

**Lack of Holistic Policy Framework for Indigenization:** The absence of an effective policy framework for indigenization of renewable energy technologies in Pakistan limits the availability and affordability of these solutions, hindering their broader implementation. Although the framework is also limited for indigenization of coal-related manufacturing, there is a need to shift the policy focus towards fostering indigenization of renewable technologies for long term sustainability. Perhaps the most crucial factor leading to the slow uptake of renewables is the prevalent political uncertainty and policy inconsistency in Pakistan. The lack of a clear and stable policy framework for renewable energy discourages significant investments and hampers the transition towards renewable energy sources.

**Land-Use Concerns:** Another obstacle to renewable energy expansion is the need for suitable land for the construction of wind and solar farms. The availability and allocation of appropriate land resources and managing competing land uses can pose challenges and slow down the progress of renewable energy projects. The construction of large-scale power plants particularly for private sector wind and solar has caused many land use settlement issues, which causes delays in projects.

It is important to note that these barriers have contributed to the economic feasibility of coal consumption and usage, but they do not reflect inherent limitations of renewable energy technologies themselves. By effectively managing system planning and modernizing operations, the challenges associated with integrating renewables can be successfully overcome. The crux of the problem lies in addressing the issue of policy uncertainty and inconsistency, which poses a significant obstacle to the wider adoption of renewable energy in Pakistan.

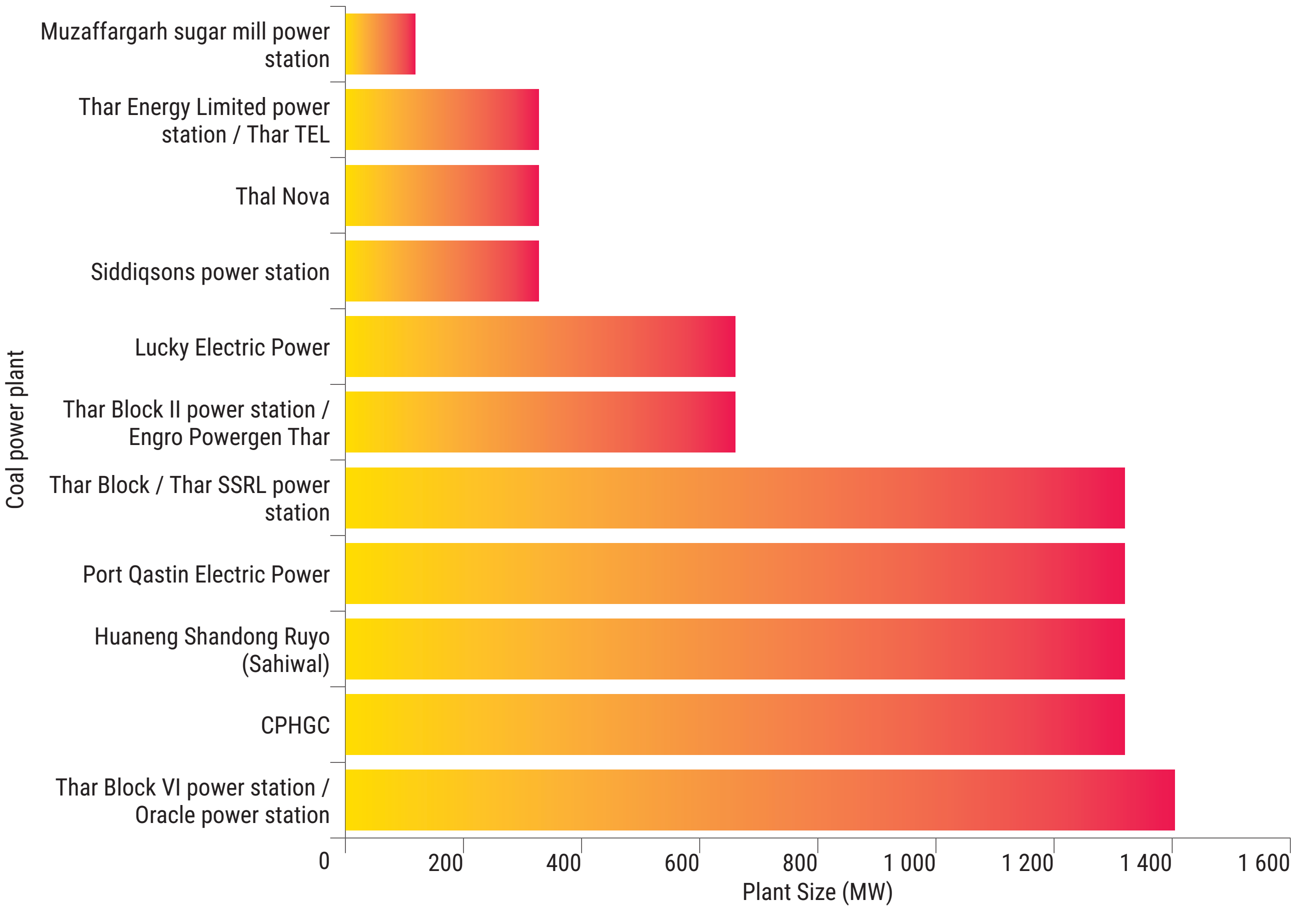
### 1.3.4 Role of CPEC in Coal Power Plants

CPEC is a flagship project of the Belt and Road Initiative (BRI) that is aimed at boosting economic cooperation between China and Pakistan. Since its inception, Pakistan has received about USD 23.1 billion in energy investments (including transmission line, coal, wind, solar and hydro power plants) and USD 17.1 billion in transport investments under CPEC with an overall cumulative investment pledge of USD 62 billion (CPEC Authority 2023). The total investment includes the projects planned in the long term and those already in the pipeline.

One of the key components of CPEC is the development of coal-fired power plants in Pakistan. Investment in coal-fired power plants (including projects that have been completed and those that are under development) is around USD 12.1 billion (ibid). As of 2023, there are 9 coal-fired power plants either complete or under construction as part of CPEC. These plants will have a total capacity of 8,220 megawatts (MW) (ibid). All of the plants are expected to be completed by 2025 at the latest, with the 300 MW Gwadar coal-fired plant and the 1320 MW Thar Mine Mouth Oracle Power Plant and surface mine expected to come online by 2025 (ibid).

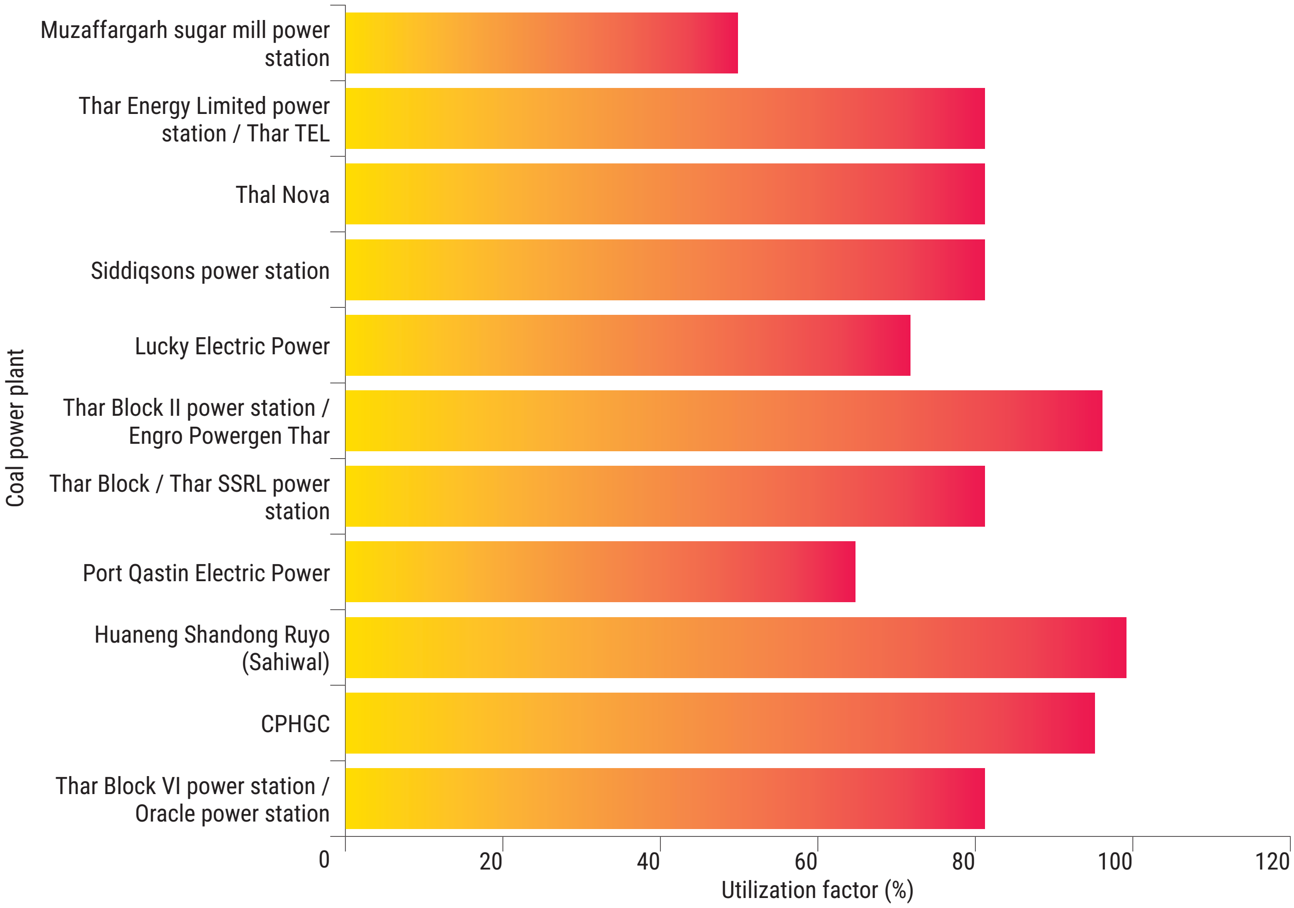
There are a number of reasons why coal-fired power plants are being developed under CPEC. First, coal is a relatively abundant and affordable source of energy in Pakistan. Moreover, coal-fired power plants can handle the base-load requirements and generate a large amount of electricity. The Government believes that coal-fired power plants will help to meet the growing demand for electricity in Pakistan and will boost economic growth. Thus, CPEC also remains a significant driver of coal-power in Pakistan.

Figure 9. **Size of coal fired plants in Pakista**




*Source: Data taken from IEA.*

Figure 10. **Utilization factors of coal fired plants in Pakistan**




*Source: Data taken from IEA.*

## 1.4 Trends in coal power generation and capacity, including utilization rates, ages, capacity under construction and FIDs

### 1.4.1 Generation, Capacity and Utilization trends of Coal Plants in Pakistan

- There are a total of 11 coal-powered plants currently operational or under development in Pakistan (excluding the 300MW Gwadar coal-fired power plant which is also under consideration but not yet under construction) with a maximum capacity (at 100 per cent utilization rates) of 9.11 GW. Nine plants are currently operational, with the 330 MW Siddiqsons power station at Tharparkar, Sindh under construction and the 1,400 MW Thar Block VI / Oracle power station in the pre-permit stage (Figure 9).

- Utilization trends generally vary from 50 per cent to 99 per cent, with plants such as the Sahiwal coal power plant operating at almost full capacity while the 120 MW Fatima Energy power plant, which is a Combined Cycle Plant operating on bagasse and coal, in Muzaffargarh, Punjab is being utilized at 50 per cent capacity. The dispersion is mostly owing to the higher dispatch of coal-fired plants in the merit order as compared to the 120 MW Fatima Energy Combined Cycle Plant (Power Systems Statistics 2022). The average utilization rate stands at 80 per cent. Nevertheless, actual installed capacity as of FY2022 for coal stood at 5.33 GW with coal accounting for almost 18 per cent of total power generation (27,700 GWh) (IGCEP 2022-31). However, the share of coal in power generation is expected to rise to 21 per cent by 2031 (approximately 48,000 GWh) with 13 per cent local and 8 per cent imported coal (ibid). With an average age of roughly 1.9 years, 4 of the plants that are currently operational are under a year old. By comparison, Sahiwal coal fired power plant is the oldest plant and has been operating for over 5 years. Figure 10 shows the high utilization factors of newer coal-fired power plants under CPEC. Most of these plants are large plants with a capacity of over 1,000 MW and utilization rates of over 80 per cent.

## 1.5 Market Structure, Contractual Arrangements and Pricing for Coal Power Plants

### 1.5.1 Market Structure of Coal in Pakistan

There are a small number of players in the coal market in Pakistan. Most of the players on the generation side are Independent Power Producers (IPPs), with 10 out of the 11 power plants being operated by IPPs while Fatima Energy's 120 MW project is a co-generation project operating on an independent generation company (IGC) basis with bagasse and coal being used as the fuels. The coal market in Pakistan is subject to government regulations and policies governing mining, pricing, and environmental standards with regulatory bodies such as the Ministry of Energy, Private Power and Infrastructure Board (PPIB) and the National Electric Power Regulatory Authority (NEPRA) being responsible for issuing Letters of Intent (LoIs), to the procurement and pricing of electricity for IPPs. However, the ownership of coal and leasing of mining rights is currently a provincial subject with provincial authorities such as the Sindh Coal Authority being responsible for the provincial reserves of coal. Thus, provinces have the authority to manage and regulate the exploration, extraction, and sale of coal and minerals (National Electric Power Regulatory Authority 2004).

State-owned enterprises have historically dominated the coal mining sector, with the Pakistan Mineral Development Corporation (PMDC) serving as one the country's largest coal producers, currently operating multiple coal mines and being responsible for 17 per cent of the total coal production in Pakistan (Pakistan Mineral Development Corporation 2022). PMDC is responsible for the exploration, development, mining, marketing and utilization of coal in Pakistan (ibid).

On the private side, Sindh Engro Coal Mining Company (SECMC) has become one of the leading coal producers in Pakistan, operating the first open-pit lignite mine in Block II of Tharparkar area in Sindh province (Sindh Engro Coal Mining Company 2022). To meet its energy needs, Pakistan also relies on coal imports, which is primarily utilized in power generation and industrial processes. Given the huge investments required in the construction of coal-fired power plants, the coal market in Pakistan remains relatively closed, although the government has provided significant financial support for the development of coal-fired power plants, making the market more attractive to investors.

### 1.5.2 Pricing Mechanism for Coal in Pakistan

Coal prices in Pakistan are based on a number of factors, including the type, quality, location, and the cost of transportation of the coal. The main types of coal used in Pakistan are bituminous, sub-bituminous and lignite. Bituminous coal is the most common type of coal in Pakistan, used to generate electricity and to produce steel, while sub-bituminous coal is a lower-quality type of coal used to generate electricity and to produce heat. Lignite coal is the lowest-quality type of coal used in Pakistan, which is primarily used to generate electricity.

Bituminous and sub-bituminous coal is primarily imported from South Africa and Indonesia, while lignite coal is indigenous coal from the Thar region. The greatest concentration of coal reserves in Pakistan lies in the Thar region of Sindh, which is estimated to have 175 billion tonnes of reserves (ibid). Given that a third of all the coal power plants are located in Thar region, local cost of coal for power plants running on indigenous coal is relatively low (see section 1.6.).

However, the local price of coal is also affected by the global market prices. When the global market price of coal is high, the price of coal in Pakistan also rises. Imported coal prices in Pakistan are influenced by global coal market dynamics, including international supply and demand, geopolitical factors, shipping costs, and quality specifications. Local traders/importers negotiate contracts with international suppliers and determine the prices at which imported coal is sold in the domestic market.

Moreover, state-owned enterprises, such as the PMDC which is a major coal producer, may set prices based on production and operational costs and the government may intervene in coal pricing through regulations and policies. This can include setting price benchmarks, regulating profit margins, and providing subsidies or incentives to specific coal projects or consumers.

In the context of coal-based power generation, prices are determined through long-term power purchase agreements (PPAs) between coal power plant operators (IPPs) and the government. Such PPAs often specify the pricing structure, which can be based on various factors such as capacity charges, fixed or variable energy charges, and fuel pass-through mechanisms.

### 1.5.3 Circular Debt and Affordable Electricity

Circular debt has been a persistent issue in Pakistan's energy sector, resulting from grid inefficiencies, subsidies and tariff differentials, fixed capacity payments, and power theft and revenue losses in the distribution sector. Circular debt refers to the accumulated unpaid bills and outstanding payments within the energy supply chain, primarily between power generation companies, distribution companies, and the government.

The issue of circular debt, affordable electricity, and coal-fired power plants in Pakistan is interconnected and has significant implications for the country's energy sector. The Government's move towards coal as an energy source is driven by the need to diversify the energy mix, reduce dependence on expensive imported fuels, and meet the growing demand for electricity. However, the increasing circular debt poses challenges to the affordability of electricity and the sustainability of the power sector especially with regards to the increasing dependence on coal-based production.

Pakistan's energy sector circular debt grew from PKR 450 billion in FY 2013 to PKR 1.148 trillion by FY 2018, at an average growth rate of 9.2 per cent. Over the next 5 years, the circular debt further increased to PKR 2.467 trillion in FY 2022 at a growth rate of 3.5 per cent. Overall, the energy sector's circular debt is increasing by PKR 129 billion annually (The Express Tribune 2022, December 14).

A number of factors have contributed to the circular debt issue in Pakistan. Firstly, the high losses and thefts of electricity, which stand at over 17 per cent, mean that the power sector is unable to generate enough revenue to cover its costs, while the cost of fuel for power generation remains high owing to the fact that Pakistan imports most of its fuel. Inefficiencies due to corruption, mismanagement, and technical problems have also contributed to the spiralling circular debt.

Capacity payments also play a significant role in the circular debt issue and the increasing reliance on coal can further exacerbate this problem. Capacity payments are fixed payments made to power generation companies to ensure their availability to meet the electricity demand, regardless of whether they generate electricity or not. These payments are necessary to secure reliable power supply, especially during peak demand periods.

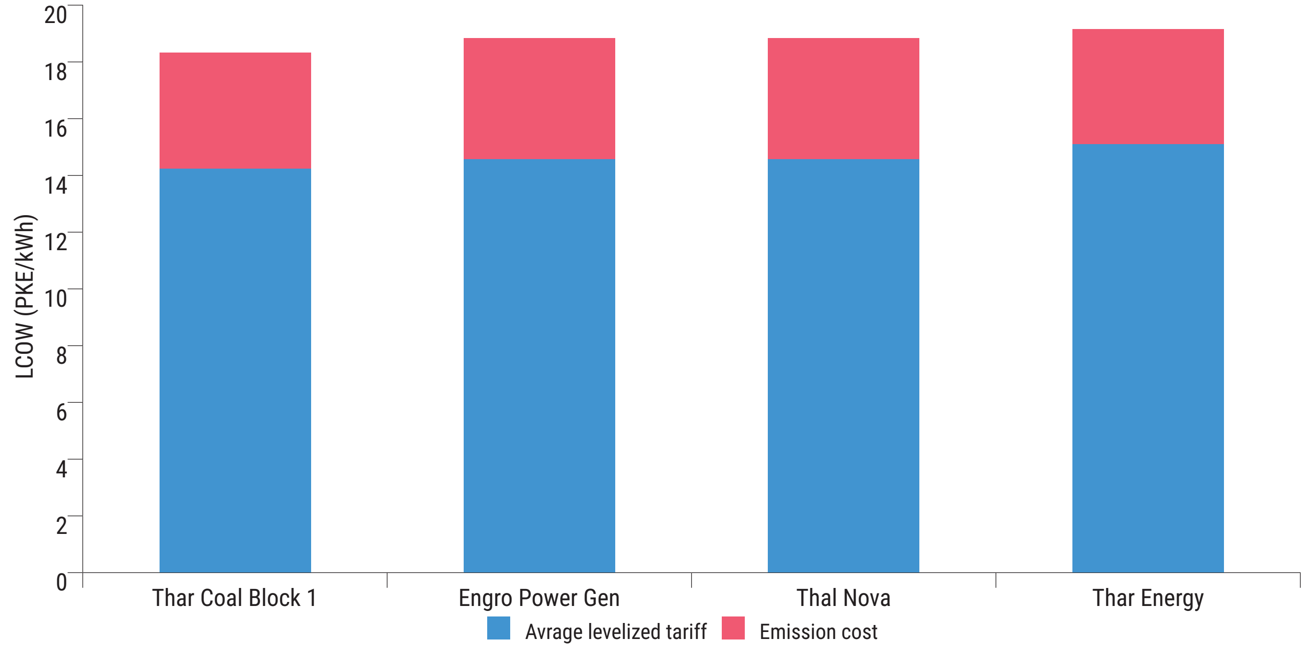
However, as the country's reliance on coal-fired power plants increases, so do the capacity payments associated with them. Coal-fired power plants typically have higher capital costs and longer payback periods compared to other forms of electricity generation. The construction and operation of these plants requires substantial investment, resulting in higher fixed costs and consequently larger capacity payments.

The larger capacity payments for coal-based power generation contribute to the circular debt issue in two ways. Firstly, the increased capacity payments add to the financial burden of the power sector, straining the liquidity of distribution companies and increasing their outstanding payments. This, in turn, exacerbates the circular debt problem as the unpaid bills accumulate within the energy supply chain.

Additionally, the higher capacity payments for coal-fired power plants can lead to higher electricity tariffs for consumers. This puts additional pressure on the affordability of electricity, particularly for households and industries, and can contribute to a higher level of non-payments and losses within the distribution sector. Ultimately, this can further widen the revenue collection gap and exacerbate the circular debt issue.

To ensure affordable electricity, the Government has been providing subsidies to various sectors, including coal-fired power plants. These subsidies

Figure 11. **LCOE of 4 coal projects under CPEC**




*Source: Graph taken from Zia et. al. 2021, p.37.*

aim to offset the higher costs of imported coal-based electricity generation and make it more affordable for consumers. However, while subsidies on coal can temporarily reduce the cost of electricity, they can contribute to the circular debt issue in the long run as the Government struggles to cover the growing expenses and outstanding payments to coal-fired power plants. The increasing circular debt is placing additional burden on power generation companies, and increases their risk of plants becoming stranded assets, especially when it comes to the coal-fired power plants coming online under CPEC. For instance, the 1,320 MW PQEPC plant declared a technical default over outstanding financial liabilities worth almost USD 1.9 billion and served a formal notice of payment default on the Central Power Purchasing Agency (CPPA) in May 2023 (Alam 2023, May 31).

## 1.6 Prices and costs of different technology options (coal, gas, renewables) in power and industry

### 1.6.1 Comparison cost of alternative technologies

Globally, 62 per cent of renewable technologies that were commissioned in 2020 were cheaper than the cheapest coal-fired power plants (International Renewable Energy Agency (IRENA) 2021). Thus, the cost of such technologies has significantly fallen over the years. Coal-fired power plants exhibited a lower Levelized Cost of Electricity (LCOE) as compared to renewable energy technologies up to 2017 but this is accompanied by the additional cost associated with emissions (Zia et. al. 2021, Figure 11).

However, there has been a significant shift in levelized costs for solar and wind power generation since 2018. The global trend in recent years has been towards a declining LCOE for renewable plants, which is now effectively lower than fossil-fuel based plants (Lazard 2021; IEA 2023). According to LAZARD's unsubsidized estimates of LCOE, solar (utility scale) costs a maximum of 96 USD/MWh, and wind (onshore) costs 75 USD/MWh while coal costs around 166 USD/MWh. The average LCOE for coal power plants in Pakistan is approximately PKR 12,5005/MWh (approximately 42 USD/MWh) when considering an operational capacity factor of 85 per cent. However, when the average emissions cost is factored in, the LCOE exceeds PKR 16,500/MWh (approximately 56 USD/MWh) (ibid).

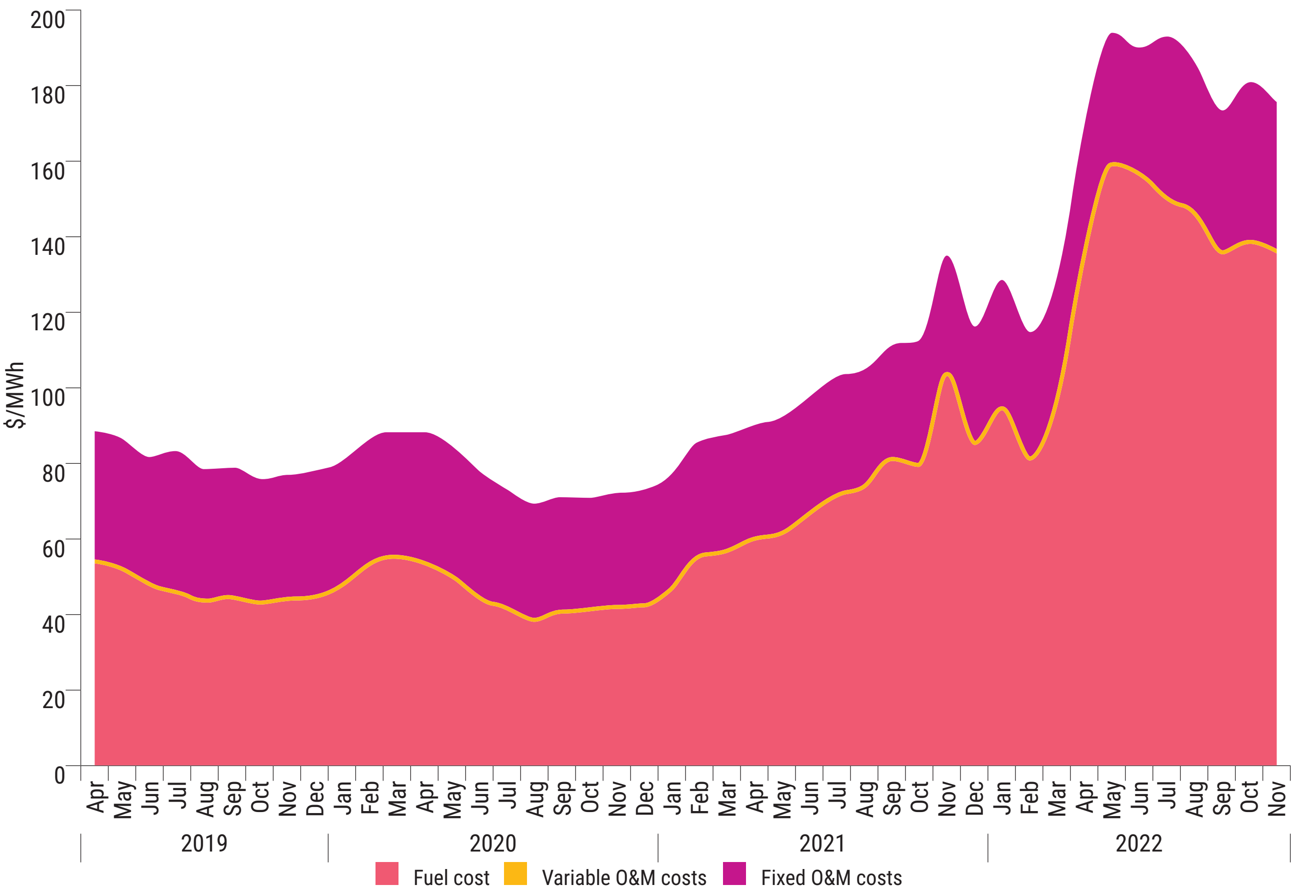
### 1.6.2 Comparison of coal tariffs versus alternatives

The cost of producing renewable energy has experienced a significant decline within a relatively short timeframe. Tariffs associated with solar photovoltaic (PV) projects have become increasingly competitive when compared to conventional fossil fuel-based power generation. For instance, in 2011-12, solar tariffs were around 17 cents/kWh (National Electric Power Regulatory Authority 2012). By 2013-14, they came down to 11 cents/kWh (NEPRA 2014). However, with the remarkable progress in the sector, a notable example being the 100 MW Zhenfa solar project in the Layyah district of Punjab, completed in April 2022, the tariffs have significantly decreased reaching as low as 3.74 cents/kWh. This demonstrates the substantial cost reductions achieved in solar power generation over the years. In other projects as well, the range of solar tariffs is between 2.6-3.2 cents/kWh as of 2022 (NEPRA 2022) (Aslam et. al. 2022).

Additionally, the cost of biomass has also been falling over the years. For biomass, NEPRA had an upfront tariff in 2013 of around PKR 10.4/kWh (NEPRA 2013). Later, in 2017, this was revised to around PKR 7/kWh (NEPRA 2017). This is mainly owing to factors such as greater feedstock availability, lower transportation costs, technological efficiency, and improved conversion processes. Moreover, the LCOE for wind power has also become increasingly competitive, especially in the Gharo and Jhimphir areas of Sindh, which have been significantly endowed with wind resources.

By comparison, the average tariff for coal-fired power plants in Pakistan is PKR 8.38/kWh with the lowest tariff being PKR 0.93/kWh for the Thar Energy Limited plant in Tharparker, Sindh, and the highest being PKR 11.1/kWh for the China Power Hub Generation Company (CPHGC) plant in Lasbela which is running on imported coal. Thus, tariffs for renewable energy technologies are at a par with tariffs for coal-fired power plants.

Figure 12. **Running costs for the import-fuelled 1.3 GW Huaneng Shandong Ruyi Sahiwal coal plant ($/MWh)**




Source: *Transition Zero, 17 March 2023.*

It is pertinent to mention that Pakistan pays a premium for coal power as can be seen with the stratospheric running costs for the 1,320 MW Sahiwal coal fired power plant over the past year, with fuel costs soaring post-Ukraine Russia war (Figure 12).

#### 1.6.3 Economic Challenges in Power Generation via Imported Gas

As a result of the increasing demand for electricity, coupled with the fact that Pakistan's gas reserves are limited and the country is facing a gas shortage, the Government is considering other alternatives such as importing natural gas to generate electricity. However, importing natural gas presents a number of economic challenges. Since the onset of the Russia-Ukraine war, liquefied natural gas (LNG) prices have soared given that Russia is a major exporter of LNG, especially as demand from Europe has outstripped the supply of natural gas globally. In addition, the war has also led to a decrease in the availability of LNG globally as sanctions have led to a disruption in Russian exports, making it more difficult for Pakistan to find LNG to import. The combination of higher prices and lower availability makes importing gas economically infeasible as compared to coal-based power generation.

### 1.7 Investments and sources of finance for coal power plants

#### 1.7.1 Asian Development Bank (ADB)

ADB has traditionally financed a number of coal-fired power plants in the past. In Pakistan, the ADB provided USD 900 million for the Jamshoro Power Plant in Sindh province in 2013 (Asian Development Bank 2014, 12 February). In 2021, ADB announced that it would no longer finance new coal-fired power plants (Pardikar 2021, June 17), and has launched the Energy Transition Mechanism (ETM) to blend private investment funds and public finance to buy up or refinance coal power plants in Southeast Asia to retire them early and expedite the shift to renewable energy sources (Ha-Duong 2023). The ETM, which is still in its pre-feasibility stage for Pakistan, will use public and private investments to retire coal power assets on an earlier schedule than if they remained with their current owners (ADB 2022).

#### 1.7.2 China-Pakistan Economic Corridor (CPEC) /Belt and Road Initiative (BRI)

For Pakistan, a majority of funding for coal-based power plants has come under CPEC. There are 9 coal-fired power projects either under construction or operational under CPEC with a cumulative investment of almost USD 12.1 billion and a total capacity of 8.22 GW. Four of the projects are currently operational at a total cost of USD 6.7 billion while the rest are in various phases of development. However, in 2021, China announced a moratorium on overseas investments in coal fired power projects post-2021. This is an important step as a green CPEC would act as a role model for making other BRI investments sustainable and would further help in achieving sustainability goals related to climate change and environmental conservation.

Nevertheless, the Government announced that the 300 MW Gwadar coal-fired power plant, initially slated for being converted to solar, would proceed (Mustafa, 2022, 25 July).

In 2021, China announced that it would stop investing in coal fired power projects post-2021. Furthermore, following the release of the "Green Development Guidelines for Overseas Investment and Cooperation" in July 2020, and the "Guidelines for Ecological Environmental Protection of Foreign Investment Cooperation and Construction Projects" in January 2022 by the Ministry of Commerce and the Ministry of Ecology and Environment of the People's Republic of China, there is an expectation of greater green overseas investments by China from 2022 onwards (Wang et al. 2021; Wang et al. 2022).

#### 1.7.3 Other sources

Since the beginning of the COVID-19 pandemic in early 2020, global investments/commitments for coal have reached almost USD 80 billion (Energy Policy Tracker 2022). This financing has come from countries such as Australia, China, India, Turkey, and Ukraine. Multilateral development partners like the World Bank, European Investment Bank (EIB), European Bank for Reconstruction and Development (EBRD), Islamic Development Bank (IDB), Asian Infrastructure Investment Bank (AIIB), and African Development Bank (AfDB)) have also traditionally financed coal-based projects abroad.

Although the World Bank stopped direct financing of coal-power projects globally in 2013, it has played a significant role in supporting Pakistan's Thar coal field development by providing valuable technical assistance and guidance. Since 2013, the World Bank has actively assisted Pakistan in implementing a strategic plan focused on the utilization of coal resources. As part of broader energy sector reforms aimed at reducing subsidies, the World Bank's efforts to increase energy tariffs created highly profitable conditions for new coal power investments in Pakistan, making them among the most financially lucrative in the world (Mainhardt 2021).


# Pathways for Coal Power Phase Down in Pakistan

The phase-down of coal power plants in Pakistan requires careful consideration of various factors. These include the impact on energy security, environmental concerns, the need for a just transition, power generation alternatives (financial viability, depletion of gas reserves and feasibility of alternative technologies). Additionally, the Government's decision to halt the construction of new coal-fired power plants is expected to play a crucial role in transitioning to low-carbon alternatives.

## 2.1 Outlook for power systems under potential coal phase-down scenarios

Using the SDG-7 roadmap for Pakistan developed by UNESCAP, we assessed the different pathways for coal including a business-as-usual scenario, an accelerated coal phase-out scenario by 2030, and a scenario based on the IGCEP 2022-31.

Figure 13 illustrates a business-as-usual scenario, wherein the coal generation capacity continues to increase in line with historical growth rates. Conversely, Figures 14 and 15 provide a comparative analysis of two scenarios: the SDG scenario (representing the baseline scenario of IGCEP) and the Decarbonization scenario, which entails phasing out coal by 2030. These scenarios are based on the SDG7 roadmap developed by UNESCAP specifically for Pakistan. Achieving decarbonization in Pakistan necessitates significant investment and financing.

Figure 13. **Electricity Generation Capacity by Source in Pakistan, 2021-2030, BAU Scenario**

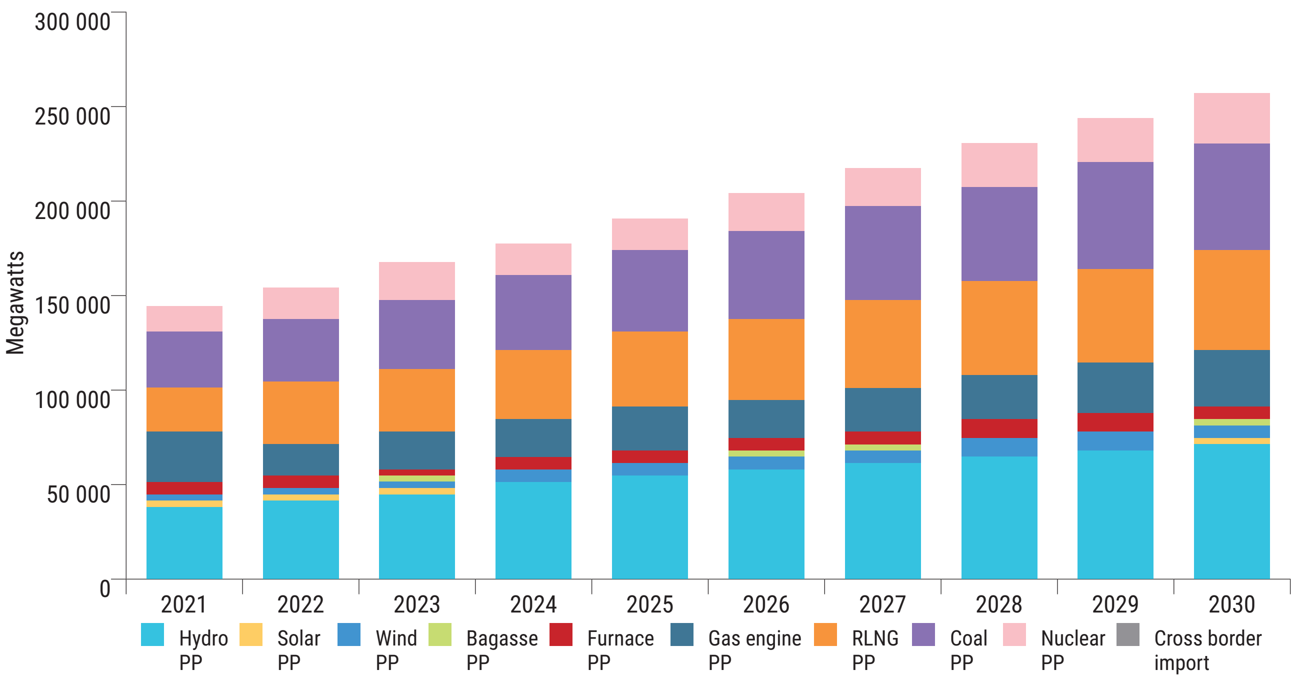


Figure 14. **Electricity Generation Capacity by Source in Pakistan, 2021-2030, DPS Scenario**

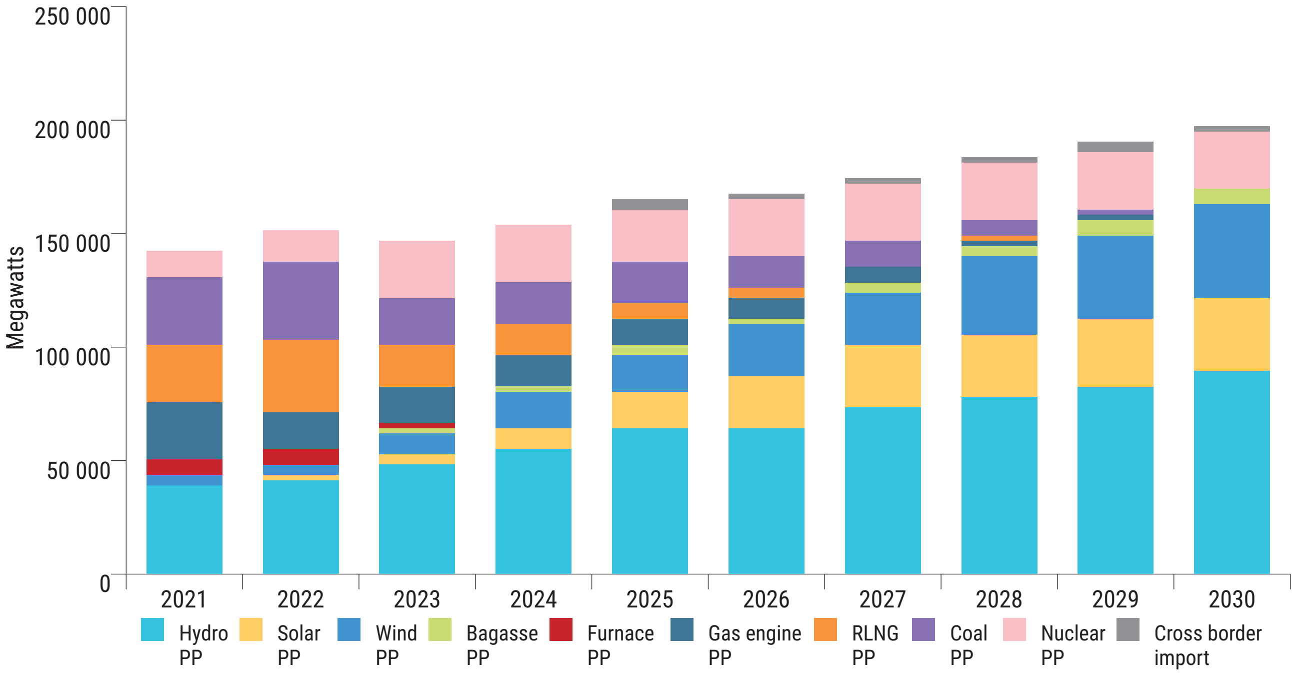
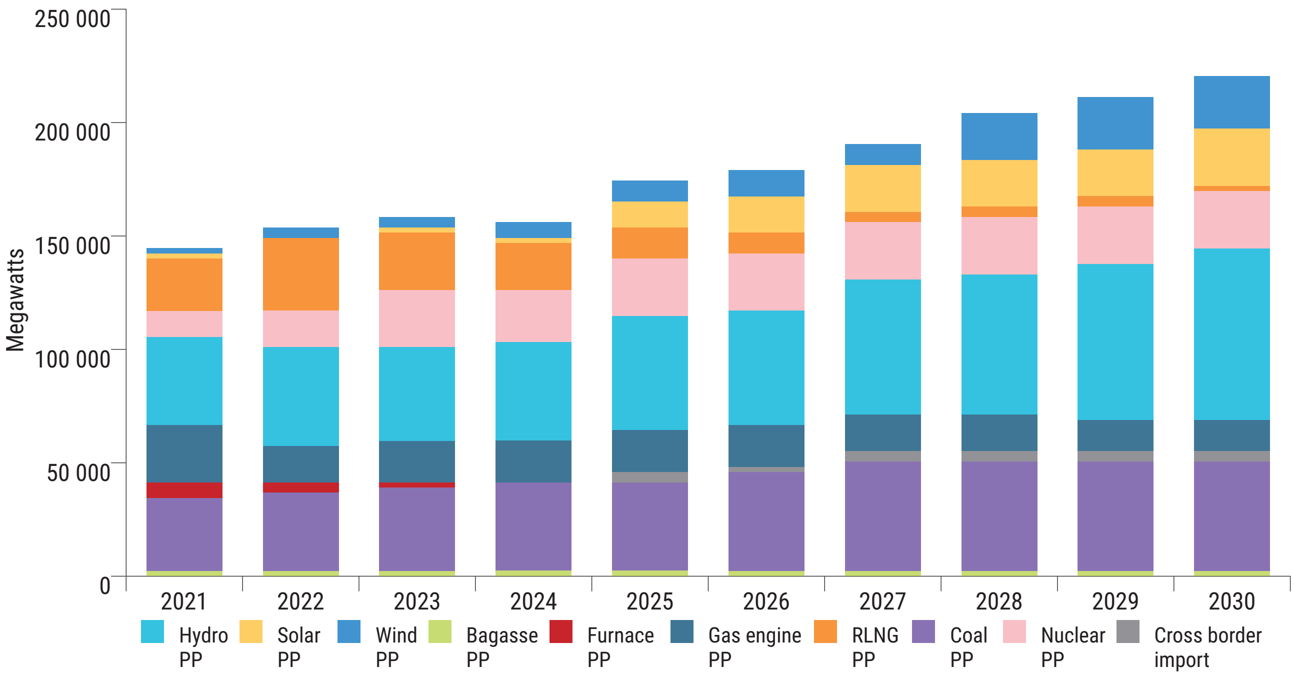



Figure 15. **Electricity Generation Capacity by Source in Pakistan, 2021-2030, SDG Scenario**




## 2.2 Halting construction of new plants; in parallel, ramping up cost-effective deployment of low carbon power

In 2021, the Government of Pakistan announced that it was halting construction of any new coal-fired power plants. Consequently, the 300 MW Gwadar coal-fired power plant was initially set for being reconverted to a 300 MW solar park (Mustafa 2022, July 25). However, the idea of converting the coal-fired plant into a solar plant of the same capacity was later scrapped and the 300 MW coal fired plant at Gwadar will come online by 2025.

Given that the moratorium focuses on not entertaining any new proposals for coal-fired power plants as opposed to scrapping the plants that had not yet begun construction but were in the pipeline before the moratorium was announced, therefore, the Gwadar coal-fired plant is technically not a violation of the moratorium as the plant was initially in the picture since the early days of CPEC and before the government announced moratorium on new coal-fired power came in place at the end of 2020.

Nevertheless, it is essential that new plant construction is halted if Pakistan is to meet its NDC targets of reducing unconditional emissions by 15 per cent by 2030 as compared to 2015 levels. Continuing with the construction of the 300 MW coal-fired power plant at Gwadar not only undermines Pakistan's pledge to reduce GHG emissions but also goes against the global trend of transitioning towards renewable energy. Moreover, given the threats that Pakistan is facing on both the climate and the economic fronts, it is imperative to address how it can redirect investments from the earlier coal based, fossil fuel investments to green, sustainable and decarbonized alternatives.

The integration of renewable energy sources and development of energy storage infrastructure are crucial to meet electricity demand during the transition. This would require significant investments to the current grid infrastructure as well as large scale investment and deployment of renewables. For instance, Zonergy's 1,000 MW solar park at Bahawalpur testifies to the solar potential of Pakistan, which can be expedited under CPEC or under different 'Just Energy Transition Partnerships' (JETPs) as per the country's needs. The Government recently announced the National Solar Energy Initiative, a 10,000 MW solar policy which aims to shift government buildings from diesel to solar solutions, thereby providing cheaper energy (Business Recorder 2022, September 2). In addition, cheap residential rooftop solar solutions widely accessible to the public can help ramp up access to low-carbon power and such incentives/policies can be opened up to investments from abroad in order to accelerate the deployment of cost-effective renewable energy solutions.

## 2.3 Technical options for phase-out of existing coal plants: repurpose, retrofit, and retire

There are various options that exist for phasing-out coal plants in Pakistan, including repurposing existing plants, retro-fitting plants with carbon capture, utilization, and storage (CCUS) technologies or opting for early retirement of plants and replacing them with an equivalent amount of renewable energy.

Repurposing involves converting the existing coal facility to another source or fuel that can sustain operations using the existing infrastructure at a reduced cost compared to retiring the plant. One potential repurposing option is to shift the plant's fuel source to natural gas. However, as discussed earlier, given the shortage and cost of natural gas in Pakistan, this might not be the best solution.

Another option that is under consideration globally is the repurposing of coal power plants using small modular reactors (SMRs) (World Nuclear News 2023). SMRs are smaller sized nuclear plants which can practically replace existing coal facilities by replacing their coal-fired boilers with clean steam generated by nuclear power without the need to retire the full plant. Other repurposing options include ammonia co-firing in coal power generation, and coal-to-biomass. Nevertheless, in Pakistan's context, repurposing options might not be as economical as in the case of other countries. This primarily due to the fact that the fleet of coal power plants in Pakistan is relatively young in Pakistan, therefore, repurposing might not present a viable economic case.

Retrofitting involves upgrading coal-fired power plants with technologies such as CCUS or High-Efficiency, Low-Emissions (HELE) technologies to reduce emissions without changing the primary fuel source. An advantage of this approach is that it can significantly reduce GHG emissions by capturing and storing $CO_2$ without the need for repurposing the entire plant to fit another source/fuel.

Thus, it allows utilization of existing assets and infrastructure including power generation units, transmission systems, and workforce. However, such an approach also has various challenges associated with it such as cost and viability as retrofitting existing coal plants with CCUS or HELE technologies can be capital-intensive and would require significant investments and technical know-how for operation and maintenance.

There might also be technical limitations especially in older coal plants that lack the necessary infrastructure for integrating CCUS or HELE technologies. Compatibility issues and plant-specific constraints may require customized solutions for each facility. It should also be noted that while retrofitting reduces emissions, it does not eliminate them entirely.

Retirement involves the complete closure and decommissioning of coal-fired power plants. This option prioritizes a swifter transition to cleaner energy sources as compared to retrofitting and repurposing. Post-retirement, direct emissions associated with coal combustion, as well as air pollution and groundwater contamination can be effectively reduced as compared to the previous scenarios where there might be some air pollution or emissions as coal use is modified instead of being eliminated. So, retiring these plants can improve air quality and public health outcomes, particularly in regions affected by coal-related pollution.

While this may be the most advantageous in the long-run given the exponential costs that might accrue as a result of climate-induced disasters, prematurely retiring coal-fired power plants may result in significant economic costs, including the loss of jobs and potential stranded assets. Additionally, the retirement of coal plants must be accompanied by adequate replacement capacity to ensure energy security and reliability.

Furthermore, while retiring coal plants may reduce emissions in the long run, the process of decommissioning the plant may lead to high emissions in the short run. Nonetheless, each technical option for phasing out existing coal plants; repurposing, retrofitting, and retiring offers its own set of opportunities and challenges. For Pakistan, a comprehensive approach that considers its unique energy landscape, economic feasibility, and environmental goals is crucial.

Whatever technical option is chosen, the ultimate goal should be to transition away from unabated coal and to scale up clean power sources in a manner aligned with long-term sustainability pathways, reduced emissions, and improved public health outcomes.

## 2.4 Benchmarking criteria for coal phase out

There are many aspects to be considered when it comes to phasing-out coal power in Pakistan. These aspects include impacts on energy security, socio-economic impacts of just transition, environmental concerns related to the phase-out, as well as power generation alternatives (financial viability, depletion of gas reserves and feasibility of alternative technologies). As such, there is a need for a more detailed analysis, including asset-level system modelling to better assess the interplay of factors and various trade-offs.

### 2.4.1 Impact on Energy Security

With frequent power outages and an increasing reliance on imported fossil fuels, an expedited coal phase-out would be expected to have a significant impact on Pakistan's energy security. A couple of factors would be at play here. Firstly, transitioning from coal to cleaner energy sources could help improve Pakistan's energy security by diversifying its energy mix and helping the country reduce its dependence on imported coal. This would not only save foreign exchange reserves but also make the country less vulnerable to global price fluctuations and supply chain disruptions.

However, compared to renewable energy sources such as solar and wind, coal provides more stable electricity generation. To manage potential adequacy and reliability issues, a shift away from coal towards higher levels of variable renewable energy (VRE) would need to be accompanied by measures to transform Pakistan's power system over time. This would involve prioritizing operations and planning that promotes system flexibility, including through dispatchable generation, grids, storage, and demand side measures.

While the impacts of a transition from coal to renewables would vary according to the level of deployment and context of the power system, potential energy security issues arising out of an expedited transition provide a lens through which coal retirements may be assessed. A priori, coal fired power plants with high utilization rates, and which contribute to grid stability should be lower down the retirement order.

With utilization rates varying from 50 per cent to 99 per cent and an average utilization rate of 80 per cent (median utilization rate of 81 per cent), plants with utilization rates of less than the average can be considered for early retirement. Furthermore, plants that are larger (and therefore) contribute more to grid stability, should be lower down the retirement order as discussed earlier. With an average (median) plant size of 660 MW, plants that are below this size can be considered for early retirement as they contribute relatively little to grid stability.

Thirdly, based on external security considerations, plants that are reliant on local coal should be lower down the retirement order as compared to plants that are reliant on imported fuel. 4 out of the 11 plants are reliant on imported fuel, and thus, can be considered for an early retirement. There is a need to consider the criteria holistically in order to gauge which plants are suitable for an early retirement.

### 2.4.2 Climate Change and Environmental Concerns

Coal-fired power plants are a major source of air and water pollution, and emit greenhouse gases, thereby contributing to climate change. Plants that have a greater carbon intensity, and do not have mitigating technologies such as air pollution control equipment should be prioritized for early retirement. Furthermore, plants that are operating in locations with high concentrations of groundwater contamination should ideally be retired early.

Apart from the 120 MW Fatima Energy plant, all the coal plants operating in Pakistan have installed air pollution control technologies. When it comes to carbon intensity, the average carbon intensity of coal-fired power plants in Pakistan is 0.985 $tCO_2$/MWh (with a median of 0.93 $tCO_2$/MWh). Two out of the 11 plants have a carbon intensity greater than the mean value while 8 out of the 11 plants have a carbon intensity greater than the median value, and thus, plants with a higher than average carbon intensity are suitable for an early phase-out.

### 2.4.3 Just Transition

A just transition ensures that the process of phasing out coal is carried out in a socially responsible manner, considering the needs of workers, communities, and other stakeholders affected by the shift. In Pakistan, this would entail providing support for coal-dependent workers and communities to transition to new jobs and industries, including retraining and reskilling programs, education initiatives, and social protection measures.

An early coal phase-out may lead to job losses in the coal sector, although this would be somewhat mitigated by the green jobs that would be created in the renewables sector. Another mitigating factor is that the retirement process might create direct jobs for the workers employed in the coal fired power plant. Nevertheless, the jobs lost in the coal sector might create greater GDP losses as compared to the gains from the green jobs created, and the new jobs might not necessarily accrue to those who lose their jobs given the different skills required. Transitioning workers to new industries requires careful planning including reskilling and adjustment packages.

Overall, wind and solar have higher job creation per million USD invested as compared to coal-based projects with wind projects creating 7.52 new jobs per million USD invested, solar projects creating 7.24 new jobs per million USD invested and coal projects creating 3.1 jobs per million USD invested (Garrett-Peletier 2017). Thus, the larger the plant the greater the net jobs that can be created by transitioning to an equivalent number of renewables (although job losses would also be higher in such a case).

Assuming that job losses entail higher corresponding economic losses as compared to equivalent employment gains, therefore, the benchmark rate for a socially just transition can be set as one which causes the least disruption to economic activity and employment status quo, under which plants should be considered for an accelerated phase-out. This is especially true given the community-wide disruption resulting from an expedited coal phase-out, new job search process for whole families previously in the coal sector and the social protection measures that would be needed to mitigate the lost earnings potential. Note that for just criteria, least disruption can be defined as a shift in economic activities that causes the least job losses during the transition process rather than one that is premised on maximizing the benefits in terms of net employment gains or economic rents generated which would entail a different benchmark.

Given the estimated job losses of a complete phase-out by 2030 at 7,156 and given that the total capacity over that time is set to come from 11 coal-fired power plants, the average losses (without accounting for plant size) can be estimated at 651 per plant. Therefore, plants which have an expected impact of less than the average job losses during the transition process can be deemed to be minimally disruptive to economic activity and as such should be higher up the retirement order.

### 2.4.4 Financial Viability

Phasing out coal power plants in Pakistan would require significant financial investment both in terms of decommissioning the existing coal plants and investing in clean energy infrastructure amid a shift in financial priorities. The financial viability of this transition would depend on the availability of funding and the cost of renewable energy technologies. In recent years, the costs of solar and wind energy have decreased significantly, making them increasingly competitive with coal power. Levelized costs for wind power reached USD 0.0486/kWh by 2017, while LCOE for solar power reached an average of USD 0.034/kWh (Zia et. al. 2021).

As a result, investing in renewable energy projects could yield returns on a par with coal-fired plants and therefore, replace an existing equivalent amount of coal. Plants which have weaker cash flows and longer payback periods are likelier to have owners who are willing to consider early retirement. By comparison, plants with higher tariffs, more secure returns and shorter payback periods are less likely to have owners that are willing to sell the asset in the early years of its useful life. For financial viability, key benchmarks to consider include tariffs and remaining useful life of plants. Average (mean) tariffs of the 11 coal-fired power plants in Pakistan are PKR 8.37/kWh. Using the mean as a benchmark, plants which have lower than average tariffs would have relatively weaker cash flows and therefore, are better suited for an early phase-out.

The remaining useful life of the plants shows the number of years the plant would likely exhibit returns. Plants which have longer useful lives should be lower down the retirement order as they can potentially generate greater returns for their owners over the span of their remaining lives. The average (median) remaining tenures of the 11 power plants in Pakistan is 25 years, below which plants can be suitable for an early retirement. There are 4 plants which have remaining tenures below the average. However, as mentioned previously, the decision for early retirement must be holistic based on both the tariff structures and the remaining useful lives as well as the other key benchmarks highlighted earlier.

### 2.4.5 Depleting Gas Reserves

Pakistan's natural gas reserves are depleting at an alarming rate with estimates putting the depletion rate at 9 per cent per annum. A phase-out of coal could increase the country's reliance on gas, at least in the short run if gas is used as an intermediate solution during the phase-out. Technically, boilers for coal-power plants can be converted into boilers for burning gas (International Energy Agency 2021). However, this depends on the economic feasibility of natural gas prices. Relying on imported gas to replace coal would leave Pakistan vulnerable to price fluctuations and geopolitical uncertainties, and therefore, gas prices also need to be considered in the context of a coal phase-out.

Pakistan started importing LNG from 2015 onwards. LNG prices are currently 7-8.5 times higher than domestically produced gas (Isaad and Reynolds 2022). Recent forays into the LNG spot market resulted in Pakistan paying USD 30/metric million British Thermal Units (MMBTU) for LNG as compared to domestic prices of natural gas ranging from USD 3.5 – 4 MMBTU (ibid). Even at a cost of USD 25/MMBTU, LNG derived power equates to a power price of around USD 300/MWh solely based on the fuel cost which is 300 per cent greater than the annual average price of power in Pakistan of USD 75.4/MWh (ibid).

Thus, with the depletion of gas reserves coupled with the volatile and increasing import prices, gas remains an unfeasible interim solution for the coal phase-out process.

### 2.4.6. Coal Gasification and Liquefaction

Coal gasification and liquefaction technologies convert coal into synthetic gas or liquid fuels, which can then be used for power generation or transportation as required. While these technologies can potentially reduce the environmental impact of coal, they are still in their early stages of development and are not yet commercially viable. One of the main challenges associated with such technologies is their high cost in terms of the financial investment that is required, as the infrastructure required for large-scale implementation of these technologies is significant and the initial capital outlays can be substantial.

Coal gasification and liquefaction technologies also do not eliminate GHG emissions entirely as $CO_2$ is still released during the conversion process. Additionally, the conversion process itself is energy intensive, which affects the overall efficiency of the system. Given the availability of cleaner, more cost-effective alternatives, Pakistan should prioritize investments in renewable energy and energy efficiency over coal gasification and liquefaction technologies.

### 2.4.7 Conclusion

The transition from coal power in Pakistan is a multifaceted challenge that requires a holistic approach. While coal phase-out can enhance energy security by reducing dependence on imports, it also poses risks due to the stability coal offers to the power grid. Environmental concerns underscore the urgency of retiring high carbon intensity plants, especially those lacking pollution control. A just transition is crucial, balancing potential job losses in coal with opportunities in renewables. Financially, while renewables are becoming more viable, the phase-out has significant costs. Additionally, Pakistan's depleting gas reserves make it an impractical interim solution. Lastly, while coal gasification and liquefaction offer potential alternatives, they are not yet commercially viable and still pose environmental concerns.

CHAPTER 3

# Financial and Economic Implications of Transitioning Away from Coal

The transition from coal-fired power generation to renewable energy sources is a crucial step towards achieving a sustainable energy system in Pakistan. This chapter examines the financial implications and cost-benefit analysis associated with the transition, focusing on both private coal-fired power plants and those under CPEC.

For private coal-fired power plants, such as the Lucky Electric power plant, Siddiqsons coal-fired power plant, and the Fatima Energy power plant, the financial implications vary under different transition pathways. The baseline scenario, based on the IGCEP 2022-2031, suggests a relatively stable environment for private coal plants. These plants may not experience significant changes in asset values and cash flows until 2050.

Under the accelerated coal phase-out scenario, plants with longer useful lives and higher tariffs are likely to be impacted to a greater extent compared to those with shorter useful lives and lower tariffs. The cash flows of such plants may be constrained, although the value of assets under the accelerated phase-out can vary depending on the renewable source that replaces the retired coal-fired plant and the market sentiment around coal use.

If the coal moratorium on the construction of new coal-fired power plants is maintained, private coal plants face a higher risk of becoming stranded assets. The economic viability of these plants can be severely compromised as coal usage is restricted, leading to reduced revenues and increased operational costs. However, this scenario may provide some short to medium-term financial stability for private coal plants due to an increase in domestic coal demand. However, in the long run, financial distress for investors remains a possibility.

Similarly, the utilization of CCUS technologies may offer short to medium-term financial stability for private coal plants. However, retrofitting costs can be substantial, reducing cash flows and asset values over the long term. Under unconstrained coal use, by comparison, private coal plants may initially benefit from continued coal demand and consumption. However, stricter regulatory measures and potential carbon pricing mechanisms can pose financial risks, such as carbon taxes and mandatory carbon credits for emissions. Long-term credit risks are expected to be higher under this scenario.

The financial implications for CPEC plants are similar to those for private plants, with some notable differences. CPEC plants have sovereign guarantees that may absorb some risks associated with an accelerated transition. However, the risk of plants becoming stranded assets and the potential for financial distress increases in line with the decrease in coal usage in the long run. Cash flows for CPEC plants are likely to be more stable under the coal moratorium scenario due to guaranteed returns.

With regards to financing the transition, the transition to a sustainable energy system requires substantial financial resources. Pakistan's updated NDCs indicate the need for cumulative financing of USD 101 billion solely for the energy transition by 2030, with an additional USD 65 billion by 2040. Funding options include public funds, private investments, international climate finance, and development assistance.

The cost-benefit analysis of the transition highlights various social and environmental factors. An accelerated coal phase-out is expected to contribute to improved water quality and reduced groundwater contamination. The coal moratorium and retrofitting scenarios would also offer emissions savings, albeit to a lesser extent. In contrast, unconstrained coal usage would lead to increased emissions and the slowest increase in green jobs.

The chapter emphasizes the importance of prudent financial planning, risk assessments, and long-term sustainability considerations for investors under each transition pathway, whether for private coal plants or CPEC projects. The financial implications and cost-benefit analysis provide valuable insights for decision-makers and stakeholders involved in the transition to a sustainable energy future in Pakistan.

## 3.1 Financial implications for investors, including cash flow, asset value and credit risks, under different pathways

### 3.1.1 Financial Implications for Private Plants

For private coal-fired power plants other than CPEC such as the 660 MW Lucky Electric power plant, 330 MW Siddiqsons coal-fired power plant, and the 120 MW Fatima Energy power plant, the financial implications vary under the different pathways. The baseline scenario, based on the IGCEP 2022-2031, provides a relatively stable environment for private coal plants. Under this pathway, these plants may not witness much of a change in asset values and cash flows over the longer run (till 2050).

Under the accelerated coal phase-out scenario, plants which have longer useful lives and higher tariffs are likely to be impacted to a much greater extent as compared to plants which have shorter useful lives and lower tariffs. This is primarily because their cash flows are likely to be constrained to a much greater extent although the value of assets under the accelerated phase-out can be higher or lower depending on the value of the renewable source that might replace the retired coal-fired plant and the prevailing market sentiment around coal use.

**Table 2. Different characteristics (size, age, utilization factors, tariffs and useful lives) of private power plants in Pakistan**

| | |
|---|---|
| | Lucky Electric Power |
| Size | 660 MW |
| Age | 0 years |
| Utilization | 72% |
| Tariff | PKR 8.58/KWH |
| Useful life | 28 years |
| | Muzaffargarh sugar mill power station |
| Size | 120 MW |
| Age | 5 years |
| Utilization | 50% |
| Tariff | PKR 9.3/KWH |
| Useful life | 24 years |
| | Siddiqsons power station |
| Size | 330 MW |
| Age | 0 years |
| Utilization | 81% |
| Tariff | PKR 9.22/KWH |
| Useful life | 25 years |

Note: (red = highest, yellow = medium and green = lowest) – (Data taken from ADB's ETM pre-feasibility report)

Table 2 shows the different characteristics which would determine the cash flows, asset values and risks under different pathways. With the smallest size, lowest utilization rate and shortest useful life, credit risks for the Fatima Energy Muzaffargarh power plant to finance its early retirement would be relatively lower under an accelerated phase-out as compared to Lucky Electric coal-fired power plant. However, since the Fatima Energy plant has the highest tariffs, cash flows under the accelerated phase-out may be lower than the other plants.

In the case of a stringent coal moratorium, private coal plants are likely to face higher risks of becoming stranded assets. With restricted coal usage, the economic viability of these plants could be severely compromised as utilization rates dwindle. Reduced revenues and increased operational costs may erode cash flows in the long run, leading to potential financial distress for investors. However, the coal moratorium scenario may provide some financial stability for private coal plants in the short to medium term, as domestic coal demand and consumption is likely to increase over that period with an increasing population and cheaper availability of coal.

Similar to the coal moratorium scenario, the utilization of CCS technologies may provide some financial stability for private coal plants in the short to medium term. Coal can be marketed and branded as "cleaner coal" in the initial stages before consumer demand subsides over the longer run and pressure starts to build up over the repackaged coal product. However, private plants would have to be cautious in this scenario as retrofitting costs can be substantial since CCS technologies have not seen widespread use, in coal fired generation applications which might reduce cash flows as well as asset values over the long term.

Under an unconstrained coal use scenario, private coal plants may initially benefit from continued coal demand and consumption. However, increased coal usage and the emissions increase associated with this scenario may lead to stricter regulatory measures and potential carbon pricing mechanisms, posing financial risks for investors. Carbon taxes might constrain the ability of private coal producers to churn out coal while plants might face further restrictions by having to purchase mandatory carbon credits for each tonne of $CO_2$ emissions produced. Although the overall impact on asset values and cash flows would be unclear in this case,

**Table 3. Different characteristics (size, age, utilization factors, tariffs and useful lives) of coal power plants under CPEC**

| | |
|---|---|
| | **CPHGC** |
| Size | 1320 MW |
| Age | 3 years |
| Utilization | 95% |
| Tariff | PKR 11.1/KWH |
| Useful life | 26 years |
| | **Huaneng Shandong Ruyi (Sahiwal)** |
| Size | 1320 MW |
| Age | 5 years |
| Utilization | 99% |
| Tariff | PKR 8.79/KWH |
| Useful life | 24 years |
| | **Port Qasim Electric Power** |
| Size | 1320 MW |
| Age | 5 years |
| Utilization | 65% |
| Tariff | PKR 8.72/KWH |
| Useful life | 22 years |
| | **Thal Nova** |
| Size | 330 MW |
| Age | 0 years |
| Utilization | 81% |
| Tariff | PKR 8.29/KWH |
| Useful life | 26 years |
| | **Thar Block I / Thar SSRL power station** |
| Size | 1320 MW |
| Age | 0 years |
| Utilization | 81% |
| Tariff | PKR 8.09/KWH |
| Useful life | 27 years |
| | **Thar Block II power station /Engro Powergen Thar** |
| Size | 660 MW |
| Age | 3 years |
| Utilization | 96% |
| Tariff | PKR 10.39/KWH |
| *Useful life* | 25 years |
| | **Thar Block VI power station/ Oracle power station** |
| Size | 1400 MW |
| Age | 0 years |
| Utilization | 81% |
| Tariff | PKR 8.74/KWH |
| Useful life | 21 years |
| | **Thar Energy Limited power station / Thar TEL** |
| Size | 330 MW |
| Age | 0 years |
| Utilization | 81% |
| Tariff | PKR 0.93/KWH |
| Useful life | 29 years |

Note: (red = above average, yellow = average and green = below average) - (Data taken from ADB's ETM pre-feasibility report) nevertheless, long term credit risks are likely to be higher.

### 3.1.2 Financial Implications for CPEC Plants

Coal-fired power plants under CPEC also face financial implications similar to the private plants mentioned above. However, one notable difference is the sovereign guarantees for coal-fired power plants under CPEC. Consequently, the risk of transitioning under CPEC may be lower under the accelerated phase-out scenario for coal-fired plants given that the sovereign guarantees are likely to absorb some of the risks associated with an accelerated transition.

Another key difference is that CPEC plants have guaranteed returns so the overall impact on cash flows is likely to be more significant under an accelerated phase-out. Similarly, although the overall risk of plants becoming stranded assets under a coal moratorium scenario for CPEC projects is likely to be lower, the longer-term stranded asset risk and the potential for financial distress increases in line with the increase in risk faced by private plants as coal usage is reduced in the long run. However, cash flows would likely be more stable in such a scenario for CPEC projects.

Therefore, the financial implications for investors in private coal plants and CPEC plants are quite similar under the different pathways. Accelerated phase-out scenarios and coal moratoriums both pose significant risks. However, the implications for the coal plants under CPEC are slightly different since such plants have sovereign guarantees which may entail lower risk under an expedited transition or even in the case of a coal moratorium. However, the macroeconomic risk (rather than plant risk) associated with an expedited transition is likely to be higher given the threat of sovereign default in this case.

While baseline and CCUS scenarios provide relative stability in the short to medium term, long-term transition plans are necessary for CPEC projects. Hence, costs and technological uncertainties associated with the utilization of CCUS technologies also need to be carefully evaluated. Although unconstrained coal use may bring short-term benefits, investors might face heightened risks owing to potential regulatory measures and carbon pricing risks, especially for CPEC projects which might face more scrutiny overseas due to geo-political considerations. Thus, prudent financial planning, risk assessments, and consideration of long-term sustainability are crucial for investors under each pathway for both CPEC as well as other projects.

## 3.2 Cost-Benefit Analysis of Transition

### 3.2.1 Energy Transition Financing

The transition to a sustainable energy system requires substantial financial resources to support the development and deployment of renewable energy projects, infrastructure upgrades, and the retirement of carbon-intensive assets. As per Pakistan's updated NDCs, to achieve the conditional target of 50 per cent emissions reduction by 2030, 35 per cent of the reduction target is contingent on international financing while 15 per cent is based on domestic resources. Additionally, cumulative financing of USD 101 billion is required solely for the energy transition by 2030, and an additional USD 65 billion by 2040 (Government of Pakistan 2021).

This substantial funding is necessary to support various aspects of the transition including the replacement of coal power plants. In Pakistan, financially viable coal power exists only from lignite mining in Thar region. To expedite the energy transition, buying out relatively new coal power projects including the local Thar coal mines has been proposed, which would involve an estimated cost of USD 18 billion (ibid). Additionally, another USD 13 billion would be required to replace these coal power plants with solar energy. Financing options for these initiatives could involve a combination of public funds, private investments, and international climate finance and development assistance (ibid).

Pakistan aims to reach 60 per cent of its electricity production from renewable sources as well as hydropower by 2030. This ambitious target would require an estimated investment of USD 50 billion by 2030 and USD 80 billion by 2040. Most of the capacity additions (more than 12 GW of capacity) in the upcoming years are expected to be of hydropower, which would require an estimated investment of about USD 20 billion.

Furthermore, upgrading Pakistan's transmission network is essential to accommodate the integration of renewable energy sources, particularly solar and wind power especially in the case of an energy transition. It is estimated that approximately USD 20 billion will be required to upgrade the transmission network by 2040. This investment will become even more significant as the share of variable renewable energy increases. Innovative financing mechanisms, such as public-private partnerships, green bonds and concessional loans, could be explored to support the necessary upgrades.

Given that the financing requirements for renewable energy projects, transmission network upgrades, and the retirement of coal power plants are substantial,

**Table 4. Environmental characteristics by plant**

| | |
|---|---|
| **Plant Name** | **CPHGC** |
| Carbon Intensity (tCO2/MWh) | 0.87 |
| Ground Water Contamination | Low |
| **Plant Name** | **Huaneng Shandong Ruyi (Sahiwal)** |
| Carbon Intensity (tCO2/MWh) | 0.88 |
| Ground Water Contamination | High |
| **Plant Name** | **Lucky Electric Power** |
| Carbon Intensity (tCO2/MWh) | 0.93 |
| Ground Water Contamination | Low |
| **Plant Name** | **Muzaffargarh sugar mill power station** |
| Carbon Intensity (tCO2/MWh) | 1.4 |
| Ground Water Contamination | High |
| **Plant Name** | **Port Qasim Electric Power** |
| Carbon Intensity (tCO2/MWh) | 0.89 |
| Ground Water Contamination | Low |
| **Plant Name** | **Siddiqsons power station** |
| Carbon Intensity (tCO2/MWh) | 0.98 |
| Ground Water Contamination | Low |
| **Plant Name** | **Thal Nova** |
| Carbon Intensity (tCO2/MWh) | 1.07 |
| Ground Water Contamination | Low |
| Plant Name | Thar Block I / Thar SSRL power station |
| Carbon Intensity (tCO2/MWh) | 0.93 |
| Ground Water Contamination | Low |
| **Plant Name** | **Thar Block II power station /Engro Powergen Thar** |
| Carbon Intensity (tCO2/MWh) | 0.98 |
| Ground Water Contamination | Low |
| **Plant Name** | **Thar Block VI power station/ Oracle power station** |
| Carbon Intensity (tCO2/MWh) | 0.93 |
| Ground Water Contamination | Low |
| **Plant Name** | **Thar Energy Limited power station / Thar TEL** |
| Carbon Intensity (tCO2/MWh) | 0.98 |
| Ground Water Contamination | Low |

Note: (red = above average, yellow = average and green = below average) – (Data taken from ADB's ETM pre-feasibility study) both domestic resources and international financing will play crucial roles in supporting the transition.

### 3.2.2 Social and environmental benefits and costs

In terms of social and environmental benefits and costs under the different pathways green jobs and emissions savings are expected to be the highest under an accelerated coal phase-out. The accelerated phase-out is expected to contribute to improved water quality and reduced groundwater contamination, particularly in regions where contamination is high.

CHAPTER 4

# Managing Coal Power Phase Down – Policy and Financial Approaches

## 4.1 Assessing Pakistan's readiness for shifting from coal and laying the groundwork with supportive policy and regulatory frameworks

There are several aspects to cater for in terms of developing a holistic set of supportive and inclusive policies and regulatory frameworks. Following are some of the pertinent drivers and supportive policies and their readiness in terms of addressing the challenge of an effective coal phase-out in Pakistan.

### 4.1.1 Carbon Pricing/Taxation/Credits

A strong and inclusive carbon market which adequately prices a unit of carbon emitted, is essential for Pakistan to shift away from coal-fired power. Many countries have implemented carbon pricing mechanisms such as carbon taxes and cap-and-trade systems, which put a price on carbon emissions. Such pricing mechanisms provide a financial incentive for businesses to reduce their emissions and transition to cleaner energy sources. The objective behind these measures is to incentivize investment and encourage action towards reducing emissions.

One well-known example of a successful carbon pricing mechanism is the European Union's Emissions Trading System (EU ETS), which has helped reduce emissions in the EU. As of 2022, around 47 countries have imposed a carbon tax or developed an emissions trading scheme, with a total of 70 carbon pricing initiatives implemented globally (World Bank 2022). Pakistan is actively exploring the potential benefits of implementing carbon pricing mechanisms as part of its efforts to combat climate change, specifically options such as a tax on emissions or the establishment of an emissions cap-and-trade system (United Nations Framework Convention on Climate Change 2018).

Carbon markets present a crucial stepping stone in the transition away from coal-fired power generation. For coal producers, carbon taxes and carbon credits would entail a higher marginal cost of production, taking into account the socio-environmental cost of emissions, thereby creating a financial disincentive for the continued reliance on coal-fired power generation and encouraging the exploration of alternative, cleaner energy sources. Emitters would be liable to pay a carbon tax based on their gross emissions, thereby discouraging emissions or to purchase carbon credits which would allow them to emit over a certain limit.

By incorporating the actual cost of carbon emissions arising out of coal production, carbon pricing mechanisms would disincentivize coal producers to expand production beyond a certain limit, incentivize investment in emissions reduction technologies, improve process efficiency, and explore renewable energy options. This flexibility would provide opportunities for coal producers to gradually transition their operations and reduce their carbon footprint.

Moreover, by adequately pricing carbon emissions, such a market would create incentives for businesses to reduce their reliance on coal and adopt cleaner energy sources. In addition, coal-intensive industries would have the opportunity to offset their emissions by investing in emissions reduction projects or purchasing carbon credits from low-carbon sectors. The revenue generated from carbon pricing initiatives can be reinvested in the development of renewable energy infrastructure, facilitating a smoother and more sustainable transition away from coal.

To develop a specialized carbon market, a comprehensive policy framework that outlines the objectives, rules, and regulations for the market needs to be developed. The framework should clearly define what constitutes a 'carbon emission' and how such emissions would be measured, reported, and verified in real-time. Additionally, the sectoral contributions of the largest carbon emitters such as coal power generation companies, and even the disaggregation towards emissions by individual plants/units need to be identified, and a carbon offset programme, allowing emitters to offset their emissions by investing in emissions reduction projects, needs to be established.

Lessons learned from other countries that have implemented carbon pricing mechanisms can inform Pakistan's approach. Transparency, clear institutional arrangements, and effective monitoring and reporting systems are crucial aspects that need to be considered. Capacity-building efforts and awareness-raising campaigns will also be necessary to ensure the successful implementation of carbon pricing measures and garner support from both the public and private sectors. If Pakistan moves forward in formulating a carbon pricing mechanism, it will need to carefully tailor the approach to its unique national context and prioritize compatibility with its development objectives.

Furthermore, the establishment of a specialized carbon market would not only contribute to the efforts in mitigating climate change but also enhance Pakistan's energy security, reduce environmental pollution, and increase sustainable job creation thereby mitigating some of the job losses that might arise out of transitioning away from coal.

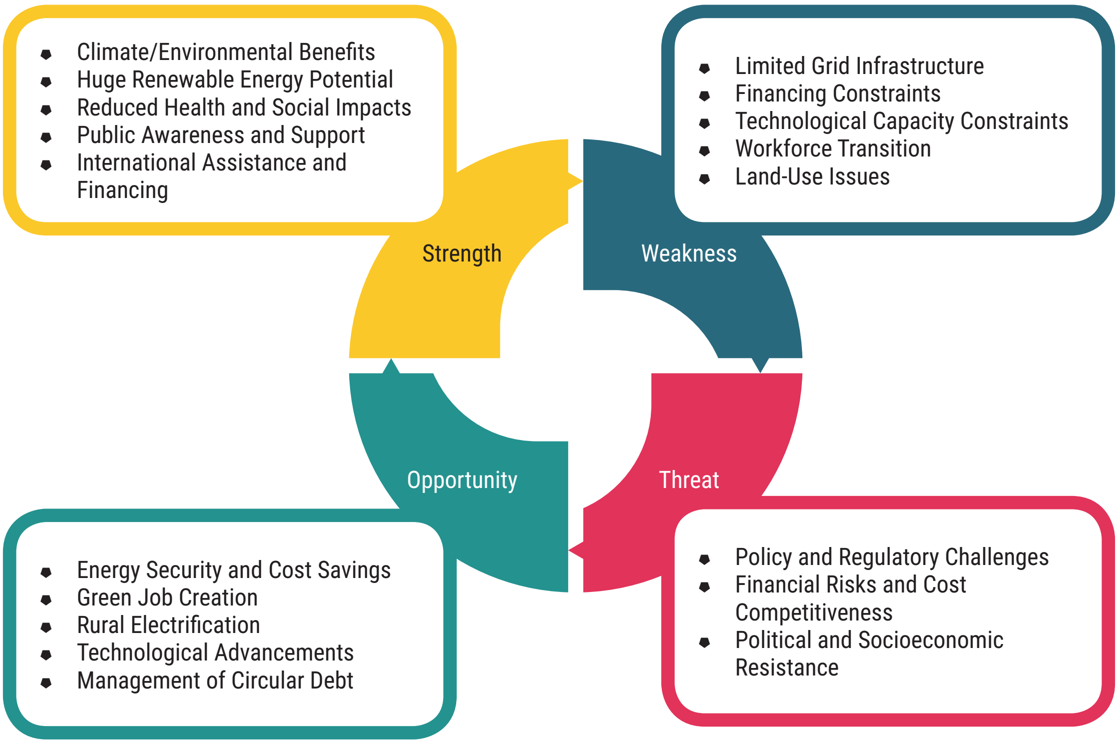
### 4.1.2 SWOT Analysis of Transition

Figure 16 outlines a SWOT analysis of the energy transition in Pakistan. This examines the strengths, weaknesses, opportunities and threats that surround the energy transition process.

**Strengths**

**Climate/Environmental Benefits:** Shifting away from coal would significantly reduce greenhouse gas emissions, improving air quality and mitigating the impact of climate change. Based on an estimated total final consumption of coal of 325,000 TJ by 2030 (based on fitted model - see Figure 8), and a correlation of 0.922 between the final consumption

Figure 16. **SWOT Analysis of Energy Transition**



of coal and annual $CO_2$ emissions from coal usage and consumption, it can be estimated that a complete transition away from coal by 2030 would reduce emissions by 299,786 $MtCO_2e$.

**Renewable Energy Potential:** Pakistan has abundant renewable energy resources, including solar, wind, and hydro power. The country's geographical location and climate conditions make it suitable for harnessing these resources. Estimates show that Pakistan's wind potential is 50,000 MW (International Trade Administration 2022) while solarization of only 0.071 per cent of Pakistan's area would be enough to completely meet the country's energy requirements (Knight 2021).

**Health and Social Impacts:** Moving away from coal would improve public health by reducing air and noise pollution-related illnesses and associated healthcare costs. It would also create a cleaner and safer living environment for communities situated near coal-fired power plants. In addition, there is a high probability of ground water contamination as well as land-use issues in the vicinity of coal-fired power plants which can be ameliorated by transitioning away from coal.

**Public Awareness and Support:** There is growing awareness and support among the general public, civil society, and environmental organizations in Pakistan for transitioning away from coal and embracing renewable energy. This support can drive the momentum for policy changes and promote a sustainable energy transition.

**Access to International Assistance and Financing:** Pakistan has access to international assistance and financing mechanisms for transitioning away from coal in the form of the ADB's ETM as well as collaborations with other international organizations, such as UNESCAP and the World Bank, which can provide financial support, technical expertise, and capacity-building opportunities for the transition.

## Weakness

Limited Grid Infrastructure: Pakistan's existing grid infrastructure may not be adequately equipped to handle the integration of renewable energy sources. Current estimates put the ability of the grid to integrate renewable energy sources at 9,332 MW (World Bank 2022). Transitioning to alternative energy sources requires significant infrastructure development, including transmission lines, storage facilities, and grid integration. Upgrading and expanding the grid infrastructure to accommodate variable renewable energy generation would require substantial investments and coordination among various stakeholders.

Financing Constraints: Access to affordable financing for renewable energy projects can be challenging, especially for smaller-scale initiatives. Initial investments in renewable energy projects can be higher compared to coal power plants (ibid). The transition may require financial resources and support to make cleaner energy options economically viable and affordable for consumers with the total system costs in the case of the Government's 30 per cent renewable target by 2030 coming out to be USD 84.8 billion (ibid). The main financing challenges for renewable energy projects arise out of long payback periods and high up-front costs (Owusu-Manu et al. 2021). Attracting private investments and developing innovative financing models are necessary to overcome this weakness.

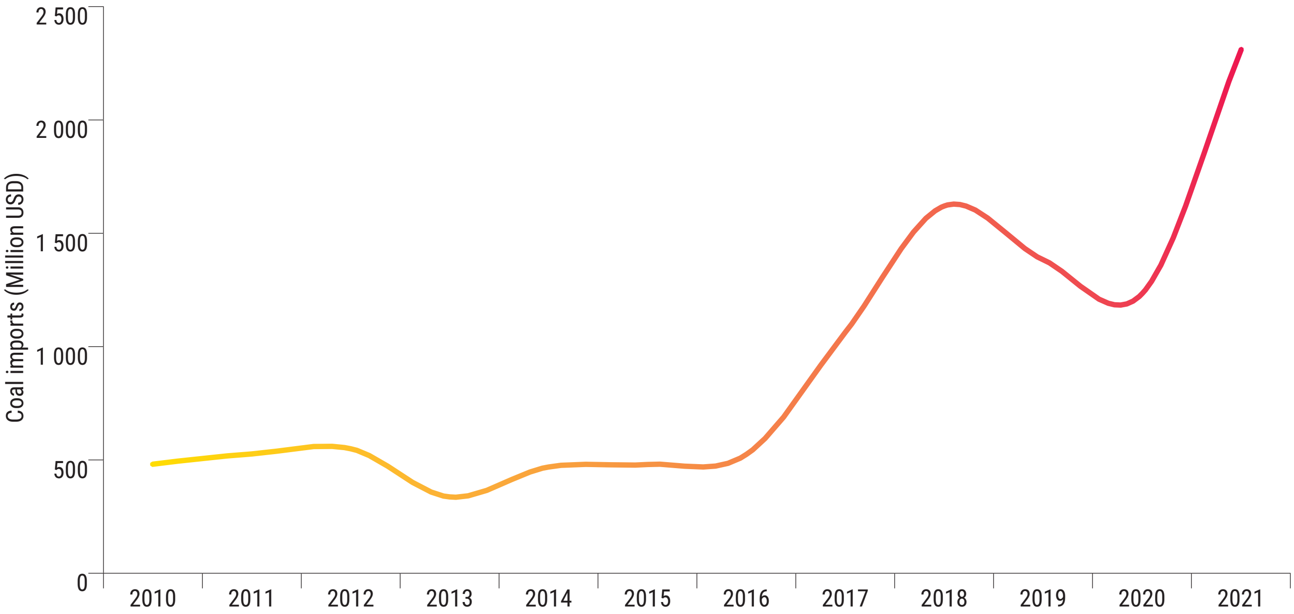
Technological Capacity Constraints: There is no indigenous manufacturing of renewable energy technologies in Pakistan. Thus, there is a need to strengthen local technological capacity and expertise in areas such as renewable energy manufacturing, installation, operations, and maintenance.

Workforce Transition: Shifting away from coal would necessitate a workforce transition. Retraining and re-employment opportunities should be provided to coal industry workers along with support to affected regions and communities, to ensure a just and equitable transition for affected communities. Using an employment per MW figure of 0.772 for coal-fired power plants (International Labour Organization 2011), it can be estimated that a complete transition away from coal by 2030 would lead to 7,156 job losses by 2030.

## Opportunities

Green Job Creation: The transition to cleaner energy sources can generate employment opportunities and stimulate economic growth in manufacturing, construction, installation,

Figure 17. **Pakistan coal imports in USD from 2010-2021**




*Source: Data taken from trendeconomy.com.*

operation, and maintenance. Based on employment per MW of 1.83 for hydropower (International Labour Organization 2011), 26.6 jobs per MW for residential-scale solar (Solar Energy Industries Association 2021), and 14 jobs per MW for wind power (Aldieri et. al. 2019), it can be estimated that green job creation with capacity additions of 12,440 MW in solar, 5,028 MW in wind and 11,762 MW in hydropower (IGCEP 2022-31) would be 422,820 (upper-bound estimate), far exceeding the job losses from the transition.

Energy Security and Cost Savings: Transitioning away from coal would enhance Pakistan's energy security by reducing dependence on imported fossil fuels. Average annual coal imports from 2010 to 2021 were USD 913,988,367 (Figure 17). This can lead to cost savings in the long run, especially as renewable energy costs continue to decline and become more competitive compared to traditional energy sources.

Rural Electrification: Pakistan's rural areas face challenges in accessing reliable electricity. Overall access to electricity stood at 75.4 per cent as of 2020 (World Bank 2022) with access to electricity mainly lacking in rural areas, and transitioning to decentralized renewable energy systems, such as off-grid solar systems presents an opportunity to provide electricity to remote communities, improving living standards and supporting socioeconomic development.

Management of Circular Debt: Transitioning away from coal in Pakistan presents an opportunity to address the significant challenge of managing the PKR 2.5 trillion circular debt in the country's energy sector. By shifting towards cleaner and more sustainable energy sources, Pakistan can reduce its reliance on expensive coal imports. This transition would lead to a more efficient and cost-effective energy system, while also reducing the power sector subsidies currently being given to coal-fired power plants. Additionally, capacity payments paid to IPPs would also be reduced, presenting an opportunity for better management of the circular debt issue.

Technological Advancements: Transitioning away from coal would also provide an opportunity to embrace technological/ advancements in the renewables and alternative energy space such as innovations in solar panels, wind turbines, energy storage and smart grid systems, which can further drive down costs and increase efficiency, as well as alternative fuels like green hydrogen and methanol.

Threats

Policy and Regulatory Challenges: Inadequate policy frameworks, inconsistent policies/regulations, a lack of clarity in energy systems planning, and bureaucratic hurdles can pose challenges to the transition. Addressing policy uncertainties, ensuring policy continuity, and streamlining regulatory processes is crucial for creating an enabling environment for clean energy investments.

Financial Risks and Cost Competitiveness: While the cost of renewable energy has been declining, there is still a perception that renewable technologies are more expensive than coal. Convincing stakeholders about the long-term cost competitiveness and financial viability of renewable energy options is essential to overcome this threat.

Political and Socioeconomic Resistance: Transitioning away from coal may face resistance from political and socioeconomic stakeholders in some quarters from the coal industry and communities reliant on the sector, particularly in regions such as Thar where coal mining and associated industries have particular economic significance. Overcoming political hurdles, engaging with local communities, providing alternative livelihood opportunities, and ensuring a just transition can help address these concerns.

## 4.2 Addressing commercial arrangements, including contracts for power purchase and fuel supply during the transition

As the coal-fired plants under CPEC are relatively young, with their average useful life being approximately 23 years and ranging from 21 to 28 years depending on the age of the plant, therefore, addressing commercial arrangements is crucial in the context of transitioning away from coal-based power in Pakistan. Commercial arrangements involve PPAs, which are contracts between power plant owners and purchasers outlining the terms and conditions for selling electricity. These agreements provide a reliable revenue stream for the plant owners. On the other hand, fuel supply agreements (FSAs) are contracts between power plant owners and fuel suppliers, specifying the terms of coal supply to ensure a consistent fuel source for the plant.

The PPAs and FSAs are long-term contracts, usually extending over the useful life of the plant. In terms of considering the prospects of retiring coal-fired power plants in Pakistan it is vital to evaluate these arrangements thoroughly as coal-fired power is expected to account for about 23 per cent of Pakistan's power generation in 2023, and was responsible for around 32 per cent of Pakistan's emissions in 2022 (see Figure 4).

The pricing structure, or tariff, determines the rate at which power purchasers buy electricity under the PPA from the coal power plants and consists of an availability or capacity charge and an output charge referenced to the volume of power supplied. PPAs usually stipulate that the project company provides a certain level of capacity and delivers the generated energy as per the agreement's provisions.

In terms of transitioning away from coal, a thorough review of the PPAs and FSAs associated with the current coal-fired power plants would involve an assessment of the terms, duration, pricing mechanisms, termination clauses, and any other relevant provisions contained in these agreements including interest rates, repayment terms etc.

To mitigate transition risks, a careful evaluation of the financial implications of transitioning away from coal, particularly an analysis around the potential costs associated with terminating the existing agreements, such as early termination payments or liquidated damages, and a comparison with the financial benefits of early retirement such as potential savings in operational costs and revenue from renewable energy incentives or feed-in tariffs, is required.

Thereafter, the terms and conditions of the PPAs/FSAs would need to be modified or terminated in line with the transition objectives. This could involve adjusting the pricing mechanisms, capacity obligations, and energy delivery provisions to ensure a smooth transition and sustainable revenue streams for the project owner. Furthermore, identification and mitigation of risks associated with contract modifications, regulatory compliance, and potential legal disputes would also be essential during the transition.

Once the new agreements are in place, mechanisms to track compliance, performance, and outcomes of the transition would need to be established to ensure regular reporting obligations to relevant regulatory bodies, ensuring transparency and accountability throughout the process.

## 4.3 Financing mechanisms

### 4.3.1 Cost of Debt Financing Mechanisms

To effectively manage the phase-out of coal-fired power plants, transactions may employ a combination of financing mechanisms aimed at adjusting risks and returns for stakeholders involved, ultimately reducing the operational lifespan of coal plants (Bhat et. al. 2023). These mechanisms involve reducing the cost of debt through various financing strategies like securitizations and debt instruments linked to key performance indicators (KPIs), as well as lowering the cost of equity through the utilization of managed transition vehicles, blended finance tools and similar approaches (ibid). By utilizing these financing mechanisms, stakeholders can mitigate risks, optimize returns, and facilitate a smoother transition away from coal power generation. In addition, the just transition dimension of the challenge also requires financing, to provide the require transition measures that are needed to mitigate impacts on workers and communities.

Cost of debt financing mechanisms, in principle, would work by reducing the weighted average cost of debt of coal plants opting to transition away from coal by effectively 're-pricing' the outstanding debt by a factor that makes the cash flows from the new cost of debt equivalent to the cash flows from the 'natural' retirement case. In this case, re-pricing can broadly take multiple forms such as lower interest rates,

Figure 18. **Financing Mechanisms Shift Costs, Benefits, and Risks across Stakeholders** (Source: Bhat et. al. 2023)

| Business-as-usual constraints | Solutions through financing mechanisms for managed phaseout |
|---|---|
| Asset owner are locked into operating uneconomic coal assets via financial, market-related contractual, and social obligations. | Financing mechanisms can help by giving asset owners options to repay outstanding financial obligations in less time; free up capital to buy out or mitigate counterparty losses associated with long-term contractual obligations; and provide support to offset possible social or economic costs to affected workers and local communities. |
| Lenders are stuck receiving returns from assets misaligned with climate commitment. | Financing mechanisms can refinance financial obligations, enabling repayment of corporate or asset-level debt over an accelerated time-line. |
| Energy off-takers are locked into long-term contracts to purchase coal power. | Financing mechanisms can give power purchase agreement (PPA) counterparties fair solutions to contractual obligations, facilitating work-arounds for renegotiating or at lest covering penalties for early termination of PPAs. |
| Customers are stuck paying for uneconomic coal power. | Financing mechanisms can give customers cheaper and cleaner electricity, reducing customer obligations to pay for uneconomic coal, including possible price spikes for unmanaged phaseout |
| Coal suppliers may have to be compensated for the remainder of contracts to supply coal to plant owners | Financing mechanisms can accelerate repayment or buy out long-term fuel supply contracts. |
| Employees face the risk of receiving little to no support if the plant closes under an unmanaged transition. | Financing mechanisms can free up capital and/or tap concessional or alternative revenue streams to ensure a just transition for affected workers, including for retraining, reskilling, and replacing them. |
| Local communities are stuck with the negative health and economic impacts of relying on coal power | Financing mechanisms can give communities cleaner electricity and a just transition, freeing up capital and/or tapping into concessional financing to invest in local economic development, energy security, or grid updates to offset any economic losses from early plant closure. |

refinancing with adjusted loan tenors, KPI-linked loans and bonds, and even sovereign guarantees.

Thus, even with fewer years of operation, the discounted cash flows would initially be higher under the transition, making them equivalent to the cash flows under the normal retirement case over the life cycle of the coal plant. However, it should be noted that such a transition would require either the presence of a robust carbon market for the sale and purchase of carbon credits or an equivalent replacement with renewables that accrues a rate of return post-transition which would make the investor indifferent between the two investments.

In the case of Pakistan, given the absence of a robust carbon market and the traditionally higher investment cost and risk perceived with renewables, cost of debt financing mechanisms would not be particularly applicable. This might be due to factors such as the inability of coal power producers to leverage debt refinancing or gain access to financial tools, KPI-linked loans and bonds that are 'adequately' priced for the transition returns to be equivalent to the returns under the normal retirement case, or even to renegotiate contracts with existing coal suppliers, employees, or the off-taker.

Figure 18 shows how financial mechanisms can enable different stakeholders to undertake a just transition. With a weak enforcement structure and lack of financial incentives, coal power producers may be unwilling to undergo such a process. In addition, financial intermediaries may also be unwilling to re-price outstanding debt given the higher risk that is associated with renewables in Pakistan (for example wind curtailment issues of wind producers with guaranteed off-take is common in Pakistan, thereby such a transaction would incur a higher risk premium) as well as the country's poor creditworthiness in general. The absence of a well-developed carbon market (both primary and secondary) that would allow sale/resale of credits is also unlikely to incentivize coal producers to seek cost of debt financing mechanisms to undergo a transition away from coal.

#### 4.3.2 Cost of Equity Financing Mechanisms

Similar to cost of debt financing mechanisms, cost of equity financing mechanisms work by reducing the weighted average cost of capital of coal IPPs, this time by reducing the cost of equity to a value that makes the discounted cash flows of the transition equal to the discounted cash flows of the normal retirement scenario over the long run. This type of financing is applicable in the case where an asset cannot take on more debt, but ownership of the asset can be legally transferred.

Cost-of-equity financing mechanisms encompass a range of financial products, services, and strategies that are designed to reduce the cost of capital associated with transitioning away from coal power. These mechanisms offer opportunities to lower the financial burden and enhance the attractiveness of alternative investments. Two notable approaches in this context are managed transition vehicles (MTVs) and the sale of coal assets to investors who possess expertise and competitive advantages in responsible decommissioning (ibid).

MTVs serve as specialized investment vehicles that focus on supporting the transition away from coal by leveraging diverse funding sources and strategies. By pooling resources and expertise, MTVs can lower the overall cost of equity for coal phase-out projects. On the other hand, selling coal assets to investors with specialized knowledge in environmentally responsible decommissioning can reduce operating costs, as these investors can leverage their technical expertise to efficiently manage the decommissioning process. These financing mechanisms not only help reduce the financial risks associated with transitioning away from coal but also attract investors who are aligned with sustainable and responsible energy practices.

A cost of equity financing mechanism might be better suited in the case of Pakistan, especially with regards to the establishment of MTVs for phasing out coal given the huge potential of renewables in Pakistan (especially solar projects) that could entice investors to take the risk of managing the transition away from coal and towards an equivalent amount of renewables such as concentrated solar projects, for example.

In addition, equity financing provides greater flexibility and higher risk tolerance as compared to cost of debt financing mechanisms, so it would be more appropriate in transitioning away from

Figure 19. **Change in macro indicators for the cost of capital, nominal values, 2016-2020**


*Source: IEA, 2021.*

coal in Pakistan given the higher risks such a transition entails for the country. Furthermore, an equity financing approach might be more suited for managing the coal transition in Pakistan given the greater risk sharing that is associated with the approach, allowing shareholders in the MTV to diversify and share risk. However, one constraint to such an approach would be the lack of regulations around the utilization and operations of the MTV.

Figure 19 shows economy-wide debt financing costs have broadly come down for most countries, including for Pakistan from 2016 to 2020. Debt-risk premiums have fallen by 1.8 per cent in Pakistan, while equity market risk premiums have fallen by a further 3.9 per cent over the period. Thus, equity financing mechanisms are likely more suited for Pakistan in terms of transitioning away from coal-based power.

### 4.3.3 Energy Transition Mechanism (ETM)

ETM is the third financing option to phase-out coal in Pakistan. ADB has introduced the ETM as a solution to expedite the retirement of coal-fired power plants in Asia and the Pacific. This mechanism aims to provide financial support to governments and private sector entities, expediting the retirement of coal plants while promoting investment in renewable energy sources. ETM adopts a blended finance approach which comprises public, private and philanthropic funds for the purchase of coal-fired power plants for their early retirement (Asian Development Bank 2023).

The first stage in the ETM is identification of eligible coal plants, which are assessed based on predetermined criteria such as age, efficiency, utilization rates and location to determine their eligibility for retirement. Thereafter, a retirement plan is designed after collaborating with plant owners and gauging their willingness to undergo the early retirement process that outlines the timing of retirement, associated costs, and the impact on workers and local communities. To cover the expenses associated with retirement, the ETM provides financial assistance in the form of grants or loans to the plant owners. ADB's team works alongside the plant owners to explore opportunities for repurposing the vacated plant sites. Potential options include renewable energy projects, commercial developments, or public parks.

While still in its developmental phase, the ETM holds significant potential as a tool for expediting the transition to clean energy in Asia and the Pacific region. Pakistan is the 4th country under the ADB's ETM after Indonesia, the Philippines, and Vietnam and the country is currently in the pre-feasibility stage to check whether it is eligible for the ETM process.

Certain criteria are considered when prioritizing coal plants for early retirement under the ETM. Firstly, plants with strong cash flows, indicated by high utilization rates and which rank high on the merit order are given preference. Additionally, plants with long remaining PPAs ensuring government-guaranteed cash flows and returns are attractive for early retirement under the ETM. However, plants reliant on imported fuel face greater financial risks and weaker cash flows due to foreign exchange demands (ibid).

Consequently, coal-fired power plants with higher exposure are prioritized for early retirement under the ETM. Lastly, plants that receive high tariffs impose greater expenses on the national government, making it beneficial for them to close such costly-to-run assets by potentially selling them to the ETM (ibid).

Based on the different indicators, the ADB has assigned scores to different plants to determine the pre-feasibility of phasing them out. Nevertheless, the applicability of the ETM for Pakistan given its national context, goals and priorities remains to be seen.

## 4.4 Potential funding envelopes or institutional arrangements to support applicable mechanisms

### 4.4.1 Just Energy Transition Partnerships (JETPs)

JETPs are a financing cooperation mechanism that aims to support emerging economies' transition away from fossil fuels and towards clean energy, while ensuring the transition is equitable across gender, generations, and social strata.[2] This considers the needs and aspirations of different social groups and promotes local ownership and participation and requires addressing potential social and economic impacts of the transition. JETPs have emerged as a potential solution to accelerate the global clean energy transition while ensuring a just and inclusive process. These partnerships aim to provide lower-cost finance, promote investment-grade domestic policies, manage the transition from fossil fuels, and support affected workers and communities.

The JETP model combines public and private investments to assist developing countries in their energy transition. It goes beyond driving the shift towards clean energy by promoting the green economy and addressing the socio-economic needs of vulnerable communities affected by the transition. The partnerships employ various financial instruments such as concessional loans, market-based loans, grants, guarantees, and private investments. These funds are utilized to phase out coal energy, invest in renewable energy infrastructure, and provide support to communities impacted by the transition.

Given that global energy investments need to increase three-folds to bring them in line with sustainability and climate targets, this transition requires a reallocation of capital towards renewable energy, energy efficiency, end-use electrification and low carbon fuels, and away from fossil fuels. To address this transition cost, financing mechanisms are required that can:

1. Provide low cost financing for clean energy
2. Promote investment grade domestic policies
3. Manage transition of fossil fuels and coal phase-out
4. Support just transition for affected workers and communities

2 As JETPs are in the early stages of implementation there is limited information available to enable deeper analysis and extract lessons learned.

JETPs have strong potential to demonstrate such approaches, at scale, and to provide a model that can be replicated around the world.

There are 3 main components of a JETP including a coal phase-out commitment and plan, targets for the power sector, and a Comprehensive Investment Plan:

- **Coal Phase-out Commitment:** A key element of JETPs is a commitment to phasing out coal-based power generation. This includes setting targets and developing a comprehensive plan for the retirement of coal-fired power plants. The plan outlines strategies to replace coal capacity with cleaner and renewable energy sources.

- **Targets for Power Sector:** JETPs define specific targets for the power sector, aiming to reduce greenhouse gas emissions and transition towards a low-carbon energy system. These targets can include peak power emissions reduction, net-zero emissions by a certain year, and accelerated retirement of coal-fired power plants.

- **Comprehensive Investment Plan:** The CIP forms a crucial component of JETPs and encompasses various aspects. It includes a decarbonization vision and energy transition pathways that outline the desired future state of the country's energy system. The CIP also includes a portfolio of JETP programs across different investment focus areas such as early coal retirement, renewable energy deployment, grid development, and energy efficiency measures. Additionally, the CIP incorporates implementation plans, policies, financing mechanisms, and just transition enablers required to achieve the outlined objectives.

The structure of a JETP typically consists of three key stakeholders: the International Partners Group, the task force, and the JETP Secretariat.

- **The International Partners Group** comprises donor countries, often including G-7 nations and organizations such as the Glasgow Financial Alliance for Net Zero (GFANZ). These provide the capital necessary to finance the energy transition efforts in the partner countries which can include a mix of concessional and commercial finance. The financing mechanisms are designed to mobilize larger volumes of finance from local private actors and international investors, with a focus on funding asset needs, ensuring fiscal sustainability, and establishing risk-sharing arrangements. The donor countries have their own objectives and priorities that shape the details of the JETP, such as the amount and type of finance provided.

- **The Task Team** represents the host country and serves as the interface between the JETP and the ministerial committee responsible for energy transition policies. It engages with the JETP and aligns the transition goals with the host country's policies and strategies and is responsible for ensuring the political feasibility and effective implementation of the JETP within their jurisdiction.

- **The JETP Secretariat** plays a crucial role in bridging the gap between the donor countries and the host country's political landscape, working towards developing a financing package and plan that satisfies both the International Partners Group and the task force. The JETP Secretariat typically establishes several working groups to address specific aspects of the energy transition. These groups may include a Technical Working Group, Financial Working Group, Policy Working Group, and Just Transition Working Group. Each group focuses on its respective area of expertise and collaborates to develop strategies and initiatives for successful energy transition implementation.

Indonesia, for instance, has established a JETP with international partners to combat climate change and transition to renewable energy (Bhabra 2023). As part of this initiative, Indonesia aims to increase its share of renewables to 34 per cent of its power generation by 2030. The partnership involves an initial investment of USD20 billion over the next 3 to 5 years (ibid). Led by the US and Japan, and supported by countries like the UK, Germany, France, the EU, Canada, Italy, Norway, and Denmark, the JETP aligns with Indonesia's commitment to limit global warming to 1.5°C. It sets specific targets for emissions reduction, carbon neutrality, renewable energy deployment, energy efficiency measures, and retiring coal-fired power plants, and the partnership encompasses policy reforms, private sector engagement strategies, and immediate steps to address Indonesia's energy transition requirements (ibid).

Similarly, South Africa has also agreed to establish a JETP worth USD 8.5 billion to accelerate the country's transition from coal to clean energy (Ha-Duong 2023). The plan aims to achieve decarbonization commitments while promoting sustainable development and a just transition for affected communities. However, there are concerns regarding the funding structure, as a significant portion of the promised funds consist of concessional and commercial loans, with only a small fraction designated as grants (3 per cent of the total financing). A heavy reliance on loans may increase South Africa's debt burden and leave workers behind (ibid).

Vietnam is the 3rd country to have entered into a JETP to achieve climate neutrality by 2050 with the assistance of international collaborators (ibid). The partnership involves USD 15 billion in funding by 2030 and aims to support Vietnam's transition to a low-carbon economy. Pakistan can also seek international collaboration and financial support through a JETP with the partnership assisting Pakistan in transitioning away from coal and towards cleaner energy sources while addressing the socio-economic impacts of the transition. It would require a combination of concessional loans, grants, private investments, and guarantees to support the phase-out of coal power plants, invest in renewable energy infrastructure, and provide assistance to communities affected by the transition.

Ensuring transparency and fairness in funding allocation, as well as engaging with civil society organizations and NGOs, would be crucial for an inclusive and participatory process. By leveraging the JETP model, Pakistan can benefit from international expertise, financial resources, and technology transfer to accelerate its transition away from coal. The partnership would enable Pakistan to address environmental concerns, reduce greenhouse gas emissions, and promote sustainable development while creating green employment opportunities and empowering affected communities during the transition.

However, a JETP in Pakistan may look quite different in terms of financing compared with Indonesia and Vietnam, which have stronger track records in terms of attracting FDI and lower country/equity market risk premia. Pakistan is likely to require a greater share of philanthropic capital and grants as compared to debt. A more tailored approach to Pakistan will require administrative processes to be streamlined, and regulatory barriers to be reduced to facilitate the development of renewable energy projects, including simplified permitting and licensing procedures. Moreover, transaction templates and standardized agreements that are relevant to Pakistan's context would need to be developed to reduce the time and costs associated with negotiating project-specific financing arrangements.

CHAPTER 5

# Conclusion and Recommendations

Pakistan, like many other countries, faces significant challenges in transitioning away from coal. In recent years, coal has been providing a substantial portion of the country's electricity generation. However, the adverse environmental and health impacts of coal combustion, coupled with the urgent need to combat climate change, necessitate a transition to cleaner energy sources.

One of the main challenges of phasing-out coal in Pakistan is the existing coal capacity and long-term agreements associated with coal projects, such as those under CPEC. The government faces difficulties in shutting down these plants immediately due to capacity payments and circular debt issues. Additionally, global economic factors, such as the Russia-Ukraine conflict and Covid-related logistics issues, have led to high natural gas prices and increased reliance on coal for power generation.

Investments in greener energy need to increase significantly by 2030 compared to 2021 levels to put the country on a path to sustainability. This requires scaling up and reallocating capital towards low-carbon fuels, energy efficiency, while reducing investments in fossil fuels. Identifying cost-effective financing mechanisms, including grants, concessional finance, and innovative financial instruments is crucial to mobilize the necessary capital for the transition.

JETPs, which aim to align national climate goals with net-zero emissions targets and promote investments in renewable energy while managing the transition away from fossil fuels, are one potential source of financing the transition away from coal. Although coal has been a major source of energy in countries like Indonesia, Vietnam, and South Africa, these countries are primarily engaging in JETPs given the need to phase out coal power and prioritize renewable energy sources. JETP funds are designed to be targeted and catalytic, mobilizing financing from multiple sources.

ETM is playing a crucial role in facilitating the energy transition and accelerating the retirement of coal-fired power plants in developing countries such as Indonesia. However, it is important to address certain challenges and considerations associated with the ETM process. For instance, the lack of a direct communication line for stakeholders to voice their concerns and the absence of comprehensive stakeholder mapping particularly involving communities affected by coal plants needs to be addressed.

Transparent data disclosures, openness, and stakeholder engagement are essential in ensuring that all concerns are taken on board in any coal phase-out process. Furthermore, a supporting policy framework is required to effectively manage workforce transitions associated with any coal phase-out.

Phasing-out coal in Pakistan is a complex task that requires a holistic and multifaceted approach. The phase-out of coal presents both challenges and opportunities for Pakistan's energy transition. The transition process requires a comprehensive approach that goes beyond power generation and encompasses other energy scenarios, such as the fossil-fuel dominated industrial sector. To facilitate this transition, it is crucial to enhance the focus to incorporate a broader range of sectors and stakeholders.

| Recommendations |
|---|
| A comprehensive energy transition plan needs to be formulated that outlines clear targets, timelines, and sector-specific strategies for phasing-out coal, promoting renewable energy and building out enabling infrastructure, such as electricity grids. This plan should involve extensive stakeholder consultations and take into account environmental, social, and economic considerations. |
| A medium to long-term policy and regulatory framework needs to be developed to provide certainty and support for public-private partnerships and encourage cost reduction and indigenous production of renewable energy equipment and technologies. |
| Well-designed and bankable remuneration schemes, with appropriate risk allocation between public and private actors, are critical to creating profitable investment opportunities that provide investors with an adequate and reasonable return on capital. Competitive auction mechanisms with these features have supported renewable power investments, at reduced cost, in many countries around the world. |
| Public awareness campaigns are needed to discuss the benefits of a coal phase-out and renewable energy adoption through education campaigns and targeted communication strategies. |
| International collaborations and partnerships to leverage global expertise, access funding opportunities, are essential to benefit from knowledge sharing on successful coal phase-out experiences. |
| Robust monitoring and evaluation mechanisms need to be established when moving towards a coal phase-out to track the progress of the phase-out and renewable energy deployment. Regular assessments will help identify challenges, make necessary adjustments, and ensure the implementation of effective policies and programs. |
| The phase-out of coal will have socio-economic implications, particularly in regions dependent on coal mining and power generation. Ensuring a just transition for affected workers and communities is essential, which involves reskilling and retraining programs, job creation in alternative sectors, and social protection measures. |
| The institutional capacity of energy-related government agencies, regulatory bodies, and research institutions needs to be enhanced to effectively manage the energy transition. |
| Technology and data accessibility also play a significant role in the energy transition process. Open data and tools for energy transition planning, along with reduced usability barriers associated with electricity systems modelling, can facilitate effective stakeholder engagement and informed decision-making. |
| Building local capacity and ownership in the design and implementation of JETPs is crucial for their success. This would involve closer coordination between different stakeholders and active involvement of provinces and local communities. |
| The establishment of JETPs with focused and actionable commitments, plans, and targets can provide the necessary signals to incentivize renewable energy financing in Pakistan. Such a plan can help accelerate the financing of renewable energy projects, delink energy and politics, and provide the stability and environmental conditions that investors seek. |
| There is a need for an inclusive platform where stakeholders can actively participate and provide inputs with respect to the phase-out process. It should ensure that all relevant documents and information are uploaded including translations in local languages to promote transparency and enable broader community participation. Additionally, there is a need to assess and compensate communities adversely impacted by polluting assets. |

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