

Transitioning Coal-Fired Power Plants in Pakistan

Pathways for Early Retirement and Repurposing

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ABBREVIATION

ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
AMC	Asset Management Company
BESS	Battery Energy Storage System
BRI	Belt and Road Initiative
CCCI	Coal-to-Clean Credit Initiative
CCER	China Certified Emission Reduction
CCP	Core Carbon Principles
CDB	China Development Bank
CEXIM	Export-Import Bank of China
CFPP	Coal-Fired Power Plant
CIDCA	China International Development Cooperation Agency
CMEC	China Machinery Engineering Corporation
COD	Commercial Operation Date
CPEC	China-Pakistan Economic Corridor
CPI	Consumer Price Index
CPPA-G	Central Power Purchasing Agency – Guarantee
CSR	Corporate Social Responsibility
DCF	Discounted Cash Flow
DISCO	Distribution Company
ETM	Energy Transition Mechanism
ETS	Emissions Trading System
FX	Foreign Exchange
FY	Fiscal Year
GENCO	Generation Company
GW	Gigawatt
GWh	Gigawatt-hour
HUBCO	Hub Power Company
ICBC	Industrial and Commercial Bank of China
ICVCM	Integrity Council for the Voluntary Carbon Market
IEEFA	Institute for Energy Economics and Financial Analysis
IGCEP	Indicative Generation Capacity Expansion Plan
IMF	International Monetary Fund
IPP	Independent Power Producer

IRR	Internal Rate of Return
ITMO	Internationally Transferred Mitigation Outcome
JT	Just Transition
KIBOR	Karachi Interbank Offered Rate
kWh	Kilowatt-hour
LIBOR	London Interbank Offered Rate
LNG	Liquefied Natural Gas
MDB	Multilateral Development Bank
MOF	Ministry of Finance
MRV	Measurement, Reporting, and Verification
MW	Megawatt
NDC	Nationally Determined Contribution
NDRC	National Development and Reform Commission
NEPRA	National Electric Power Regulatory Authority
NPV	Net Present Value
O&M	Operations and Maintenance
PACRA	Pakistan Credit Rating Agency
PPA	Power Purchase Agreement
PPIB	Private Power and Infrastructure Board
RFO	Residual Fuel Oil
RLNG	Re-gasified Liquefied Natural Gas
ROE	Return on Equity
SME	Small and Medium Enterprise
SOE	State-Owned Enterprise
SOFR	Secured Overnight Financing Rate
SynCon	Synchronous Condenser
T&D	Transmission and Distribution
tCO ₂	Tonnes of Carbon Dioxide
VCS	Verra Verified Carbon

Note: In this report, “\$” refers to United States dollars. PKR to Pakistani Rupee and RMB to Chinese Yuan. Fiscal Year (FY) in Pakistan runs from 1 July to 30 June.

Swat, Pakistan. Photo by Jalal Ajmal via Unsplash.



EXECUTIVE SUMMARY

Coal-fired power plants (CFPPs) developed under the China-Pakistan Economic Corridor (CPEC) have made a decisive contribution to Pakistan's energy security over the past decade, adding about 6,600 MW of generation capacity since 2017 and helping to ease chronic electricity shortages during a period of acute supply constraints (NEPRA 2023; Government of Pakistan 2024). These assets account for roughly 90 percent of Pakistan's total installed coal capacity. As Pakistan's power system evolves, however, these assets have become increasingly intertwined with a set of strategic challenges that extend well beyond the power sector—encompassing fiscal sustainability, environmental and public health concerns, and the country's international climate commitments.

Three converging challenges underscore the urgency of coal transition. First, imported-coal CFPPs impose severe fiscal burdens through the high-capacity payments indexed to foreign exchange, persistent circular debt¹, low utilization rates, and exposure to volatile imported coal prices, straining public finances and electricity consumers. Second, the sharp decline in the prices of Chinese solar panels, combined with excess supply, has accelerated rooftop solar adoption in Pakistan, where installed distributed solar has reached about 19,159 MW, equivalent to roughly 50 percent of total installed grid capacity. This trend further reduces grid electricity demand and compounds the underutilization of imported-coal power plants. Fixed capacity payments are now being recovered over fewer units of electricity, raising per-unit costs and consumer tariffs. Third, the CFPPs are major sources of CO₂ emissions, making them a main obstacle to Pakistan's commitment to reduce emissions by 50 percent by 2035 under its NDC 3.0.

Against this backdrop, the early retirement of CFPPs has emerged as a politically and strategically important option, rather than a purely technical or environmental issue. If carefully designed and implemented, early retirement can help Pakistan reconcile three objectives often perceived as conflicting: fulfilling its NDC under the Paris Agreement, safeguarding energy security and system reliability, and restoring fiscal sustainability in the power sector. The analysis reframes coal retirement as a win-win-win transition. First, it offers fiscal relief by reducing capacity-payment obligations, easing circular debt, and limiting foreign-exchange exposure. Second, it strengthens the power system by aligning supply with demand realities, improving dispatch efficiency, and enabling a more flexible, renewables-ready grid. Third, it delivers measurable climate and environmental benefits directly supporting Pakistan's NDC targets. Importantly, these gains can be achieved without undermining energy security, provided retirement is phased, sequenced, and aligned with system planning and replacement capacity development.

A central analytical finding is the need for differentiation and sequencing between two portfolios. The three imported-coal CFPPs (Sahiwal, Port Qasim, and China Power Hub, totaling 3,960 MW) carry the highest foreign-exchange exposure, the lowest utilization, and the highest capacity-payment burden (\$1.3 billion annually), making them the strongest candidates for prioritized early retirement. The four local-coal Thar lignite plants (Engro Powergen, Thar Energy Limited, ThalNova, and Thar Block-1, totaling 2,640 MW) were commissioned several years later, operate at higher utilization (about 67 to 83 percent), and anchor an integrated mine-mouth ecosystem in one of Pakistan's most underdeveloped regions. They follow the same retirement logic but on a delayed schedule, providing a buffer to manage supply adequacy and structural adjustment.

¹ Circular debt in Pakistan's power sector refers to the accumulation of unpaid obligations along the electricity supply chain, where one entity's non-payment prevents another from meeting its own payment obligations—creating a self-reinforcing cycle of debt.

Quantitative results show that retiring the three imported-coal plants between 2031 and 2033 yields about \$3.1 billion in capacity-payment savings (present value at end-2025) and avoids roughly 48 MtCO₂ under conservative utilization projections. Retiring the four local-coal plants between 2033 and 2037 yields about \$1.8 billion in savings and avoids roughly 131 MtCO₂. Required carbon prices to finance early retirement range from about \$10 to \$33 per tCO₂ for imported-coal plants and \$5 to \$13 per tCO₂ for local-coal plants, well within prevailing compliance and voluntary carbon market levels. Repurposing options, particularly synchronous condenser conversion paired with solar-plus-battery storage, deliver indicative internal rates of return of 15 to 27 percent, with surpluses sufficient to compensate concessions made by Chinese lenders and to contribute to just transition costs. Total just transition costs are estimated at \$1.2 to \$2.1 billion across the seven plants, covering worker reskilling, continued community services, mine rehabilitation, and livelihood diversification.

Carbon markets can play an enabling role but require careful integrity safeguards. The Verra VM0052 methodology and Gold Standard JUST: Coal Decommissioning provide structured frameworks for transition credits, but neither has yet secured Core Carbon Principles approval from the Integrity Council for the Voluntary Carbon Market. Additionality under take-or-pay PPAs, intra-fleet leakage (where retiring imported-coal plants increases dispatch from more emissions-intensive Thar lignite), and cross-subsidization are material risks. A credible approach requires anchoring transition credits in a National Coal Retirement Plan, with plant-by-plant retirement trajectories, renewable replacement planning, dispatch safeguards, and consistency with Pakistan's NDC. Bilateral cooperation under Article 6.2 of the Paris Agreement and through China's relaunched CCER program offers a possible pathway, particularly if developed jointly through methodology cooperation, MRV systems, registry interoperability, and pilot transactions.

Translating financial feasibility into action requires institutional enablers across three tracks: bilateral China-Pakistan cooperation, Pakistan's domestic policy reforms, and third-party engagement from multilateral development banks and climate funds. The report identifies enabling mechanisms including a China-Pakistan Green Energy Task Force under CPEC, a National Coal Retirement Plan anchored in the IGCEP, an ancillary-services tariff framework developed by NEPRA, integrated just transition planning, joint monitoring through a Green CPEC Tracker, and a public-goods framing that addresses both imported- and local-coal CFPPs together rather than excluding the Thar fleet by category. A practical entry point is a multilateral policy-based loan to ease near-term liquidity pressures, anchor policy and institutional reforms, and unlock concessional refinancing, carbon credit mechanisms, and technical assistance from a broader set of partners. Third-party asset management companies, including potential joint ventures with Chinese AMCs, offer a complementary route that limits sovereign exposure during a period of constrained fiscal space.

The report is organized into six chapters. Chapter 1 maps Pakistan's power sector challenges. Chapter 2 provides plant-level operational, financial, risk, and transition readiness assessments, and examines China's role and available instruments. Chapter 3 describes data, methodology, and scenario design. Chapter 4 develops the four-phase financial pathway and applies it to the seven plants. Chapter 5 sets out enabling collaborative mechanisms across eleven focus areas. Chapter 6 concludes with implications for policymakers, financiers, and partners.

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Kalam, Pakistan. Photo by Umar Farooq via Unsplash.



INTRODUCTION:

PAKISTAN'S POWER SECTOR CHALLENGES

Market Structure, Supply-Demand Balance, and Fuel Mix

Pakistan's power sector has evolved from a vertically integrated structure dominated by the Water and Power Development Authority (WAPDA) into a hybrid system consisting of public and private entities. Key components include WAPDA Hydroelectric, four Generation Companies (GENCOs), ten publicly owned Distribution Companies (DISCOs), and Independent Power Producers (IPPs), which have accounted for more than half of total electricity generation since 2016. The National Grid Company oversees transmission, while the Independent System and Market Operator (ISMO) handles centralized planning and operations. Karachi remains served by K-Electric, a vertically integrated utility that manages generation, transmission, and distribution.

Despite regulatory oversight from the National Electric Power Regulatory Authority (NEPRA), systemic inefficiencies persist. These stem from a single-buyer model, poor governance, chronically high Transmission and Distribution (T&D) losses, and rising capacity charges from “take or pay” contracts. As of FY 2024-2025, T&D losses reached 17.55 percent, much higher than the allowed loss target of 11.43%. Over the same period, circular debt accumulated to PKR 1.6 trillion (NEPRA 2025). Grid electricity demand has stagnated or declined in recent years: total demand fell by 11.80 percent in FY2025 as compared to FY2022.

As of June 2025, total installed capacity stood at 41.1GW: 57 percent thermal (roughly 30 percent gas and 19 percent coal), 28 percent hydro, 9 percent nuclear, 4 percent wind and 2 percent solar (grid-connected). The continued dominance of thermal generation deepens import dependence and fiscal stress. Meanwhile, distributed solar expands quickly, adding 51 TWh of generated electricity in FY25 (NEPRA 2025). This rapid uptake in solar use has created economic and physical challenges for the national grid, as well as opportunities for coal transition (Box 1).

Pakistan nevertheless retains significant renewable energy potential, estimated at 60,000 MW from hydropower, 40,000 MW from solar, 346,000 MW from wind (Abbas and Aslam 2023). Unlocking this potential at grid scale will require structural reforms, efficient grid expansion, stronger project implementation, and improved access to finance.

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Box 1: Distributed Solar in Pakistan: A Structural Variable in Coal Retirement Pathways

Distributed solar has transitioned from a peripheral technology to a system-level variable in Pakistan's power sector. Latest estimates show that installed solar capacity, combining net-metered grid-connected systems ($\approx 6,530$ MW) and off-grid and behind-the-meter installations ($\approx 12,629$ MW), has reached approximately 19,159 MW, equivalent to around 50 percent of total installed grid capacity. This share is rising rapidly, driven not by policy subsidies, but by soaring retail electricity tariffs, collapsing module prices, and rational consumer investment behavior.

For early coal retirement strategies, distributed solar should be viewed as an enabling condition rather than disruption. From a system-planning perspective, it fundamentally alters the load profile confronting the centralized grid. Daytime demand, historically met by baseload coal and thermal plants, is increasingly displaced by behind-the-meter generation. This erosion of daytime net load reduces coal plant utilization factors, increases per-unit capacity costs, and accelerates the financial unsustainability of inflexible coal assets operating under the take-or-pay power purchase agreements. Importantly, this dynamic is endogenous: distributed solar did not create excess capacity, but it magnifies the cost consequences of pre-existing overcapacity.

This same mechanism is what makes solar an asset for retirement planning. High solar penetration lowers system marginal costs during daylight hours, reduces fuel import dependence, and hedges against energy security risks. When paired with grid-scale and distributed storage, demand-side management, and transmission upgrades, solar can replace a significant portion of coal-fired energy without compromising grid reliability.

Recent regulatory moves, however, run counter to this logic. NEPRA has revised the "prosumer regulations", which aims to suppress distributed solar by weakening net-metering incentives or discouraging self-generation. Instead of sustainably improving coal plant economics, these measures risk accelerating grid defection, further reducing utility sales volumes, and deepening the power sector's financial stress.

In contrast, a forward-looking coal retirement framework should explicitly internalize distributed solar trends. This would allow planners to sequence the coal phase-out with minimum system disruption, using solar-driven demand reduction to justify retiring the least efficient and highest-cost coal units first.

Distributed solar is no longer a marginal renewable option in Pakistan; it is a structural reality. Pathways for early coal retirement should recognize that the grid is no longer competing with fossil fuels alone, but with millions of rooftops making rational economic choices, one kilowatt at a time.

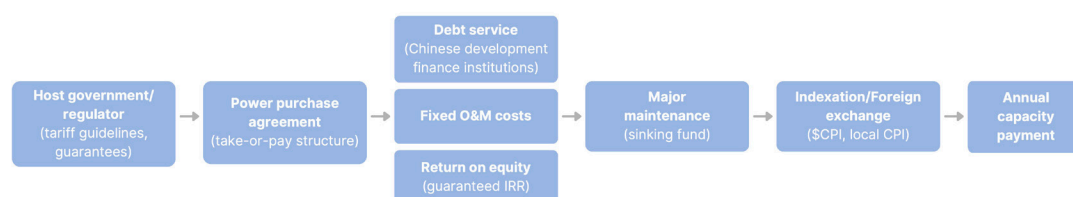
Capacity Charges

Capacity charges are fixed payments guaranteed under take-or-pay power purchase agreements (PPAs) to keep power plants available even when they are not dispatched. Calculated to recover debt service, return on equity, fixed operations and maintenance (O&M), and major maintenance reserves, then divided by firm capacity and adjusted for availability, these charges underpin the financial viability of public-private partnership (PPP) projects by ensuring a stable revenue stream for debt servicing and investor confidence, while imposing substantial fiscal burdens on government off-takers.

In CPEC coal power projects, capacity payments typically cover four elements: debt service obligations to lenders, a guaranteed return on equity, fixed operating and maintenance costs, and major maintenance reserves. The negotiation process balances the interests of three parties: host-country regulators, Chinese developers, and Chinese lenders. Regulators set tariff guidelines, efficiency benchmarks, indexation rules, and allowed return on equity (ROE) caps and floors; developers submit financial models for review; and banks require sovereign guarantees, letters of credit, escrow accounts, and take-or-pay provisions before loan disbursement. The resulting formula embeds availability thresholds (generally 85 to 92 percent), and adjusts for inflation and exchange-rate movements, which can significantly increase fiscal pressures when local currency depreciates.

Figure 1 illustrates how the PPA links regulatory commitments to investor financial obligations, flowing through debt service, fixed O&M, and equity returns, with additional layers for major maintenance and foreign exchange indexation. Because most Chinese-financed overseas plants rely on dollar-denominated loans, depreciation-driven cost escalation has deepened circular debt and raised consumer tariffs in several BRI countries. In response, partner country governments are exploring reform such as refinancing, extended loan tenors, panda bonds,² and carbon-finance mechanisms to mitigate capacity payment burdens and support the early retirement or repurposing of coal assets.

Figure 1: Process of Capacity Payment Determinations



Source: Authors illustration.

Note: CPI = Consumer Price Index; FX = Foreign Exchange; IRR = Internal Rate of Return; O&M = Operations and Maintenance

Table 1 shows that coal-fired power plants are the single largest driver of the surge in capacity payments from FY2021 to FY 2025. Capacity payments to coal plants increased from PKR 205.6 billion (\$1.28 billion) to PKR 669.8 billion (\$2.39 billion), an absolute rise of PKR 464.2 billion or \$1.11 billion, accounting for nearly 46 percent of the total increase in system-wide capacity payments over the period. This sharp escalation reflects the rapid commissioning of coal IPPs under long-term, dollar-indexed take-or-pay contracts, combined with low-capacity utilization amid surplus generation. Unlike gas or legacy thermal plants, where capacity payments grew only marginally, coal plants now carry a disproportionately high fixed-cost burden. This makes them a central contributor to rising circular debt and underscores why coal assets are the primary candidates for early retirement, refinancing, or contract restructuring in Pakistan's power sector reform agenda.

² Panda bonds are renminbi (RMB)-denominated bonds issued in China's domestic bond market by foreign governments, multilateral institutions, or overseas corporations, allowing them to raise funding from Chinese investors in local currency.

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Table 1: Capacity Payments Comparison by Energy Source, FY2021 – FY2025

Fuel Type	In PKR million			In USD million		
	FY2021	FY2025	Absolute change	FY2021	FY2025	Absolute change
Coal	205,636	669,841	464,205	1,277	2,392	1,115
Nuclear	91,329	362,705	271,376	567	1,295	728
IPP Hydel	47,814	209,710	161,896	297	749	452
WAPDA Hydel	95,826	180,453	84,627	595	644	49
RLNG/Gas /HSD	126,091	148,108	22,017	783	529	(254)
Wind	75,975	132,774	56,799	472	474	2
Solar	18,150	38,381	20,231	113	137	24
Thermal	31,661	35,594	3,933	197	127	(70)
RFO	93,977	25,247	-68,730	584	90	(494)
Bagasse	5,718	3,379	-2,339	36	12	(23)
Total	792,930	1,807,398	1,014,468	4,925	6,455	1,530

Source: NEPRA (2025)**Note:** PKR/\$exchange rates used for illustrative conversion: approximately PKR 161 per \$(FY2021) and PKR 280 per \$(FY2025), based on annual average rates.

Utilization data for FY2025 in Table 2 reveal a stark divide within Pakistan's thermal fleet. Plants using local coal operated at 67.2 percent, reflecting dispatch priority³ and take-or-pay protections, while imported coal plants ran at just 22.8 percent amid high global fuel prices, foreign exchange exposure, and weak demand, yet continued to receive full capacity payments. Under take-or-pay terms, developers' capital recovery and guaranteed returns are fully insulated from actual generation, so they remain highly profitable even at low utilization. This mismatch underscores the growing inefficiency of imported-coal IPPs, which impose high fixed costs despite minimal output, strengthening the case for targeted contract restructuring or early retirement.

Table 2: Capacity Utilization of Thermal Power Plants in FY2024-25

Fuel Category	Capacity Utilization (%)	Interpretive Note
Local Coal	67.23%	Highest utilization, reflecting dispatch priority and take-or-pay protections
Gas	56.93%	Relatively high use despite domestic gas constraints
RLNG	34.78%	Moderately utilized due to cost and FX exposure
Imported Coal	22.83%	Under-utilized amid high international prices and declining power demand
RFO	2.44%	Virtually mothballed, emergency or peaking role only

Source: NEPRA (2025)

³ Indigenous Thar coal receives dispatch priority because its lower delivered variable cost secures a higher position on the Economic Merit Order (EMO). This preference is driven by a strategic imperative to shield the power sector from foreign exchange volatility and global fuel price shocks, effectively prioritizing "energy sovereignty" and fiscal stability over pure plant-level heat rate performance.

Policy and Trends Towards Green Energy and a Green Economy

Key sector institutions, including NEPRA and the Private Power and Infrastructure Board (PPIB), are mandated not only to regulate and facilitate private investment but also to advance renewable and green energy development through their tariff setting authority and project facilitation roles. Strengthening this green mandate is critical as Pakistan shifts from a thermal-heavy system toward a more sustainable power mix.

Pakistan's green transition remains structurally challenging despite formal renewable targets and ongoing exploration of carbon pricing frameworks under its international climate commitments. Prior research finds that domestic policy choices "steered Chinese investment towards coal-fired power plants," underscoring how host-country incentives and crisis-driven priorities favored incumbent technologies over renewables (Bhandary and Gallagher 2022). The same study notes that financier risk aversion "translated into steep economic costs for Pakistan," contributing to long-term fiscal and contractual inflexibilities. Complementary assessments highlight that high capacity payments, low plant utilization, and imported fuel exposure have constrained fiscal space and complicated renewable scaling (Song et al. 2023).

Although Pakistan performs reasonably in diversification and economic linkages, it lags in technological innovation, R&D capacity, and governance effectiveness. Structural vulnerabilities, including water scarcity, macroeconomic instability, grid constraints, and persistent circular debt, further impede progress. Advancing the clean energy transition will therefore require a coherent, long-term national framework that balances fiscal sustainability, investor confidence, and environmental imperatives.

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This study focuses on Chinese-financed CFPPs under CPEC for two reasons. First, the seven plants in operation account for roughly 90 percent of Pakistan's total installed coal capacity, including three imported-coal plants totaling 3,960 MW that have recently faced low utilization, high fuel costs, and high capacity payments, placing them at the center of discussions on retirement or repurposing. Second, the shared financing structure of CPEC coal power plants, in particular dollar-indexed capacity payments backed by sovereign guarantees, limits the effectiveness of domestic regulatory action alone and requires a negotiated solution between Pakistani and Chinese counterparts. While the retirement of non-CPEC coal power plants has been discussed domestically and through initiatives like the Asian Development Bank's (ADB) Energy Transition Mechanism, transitioning the CPEC portfolio calls for the efforts of a wider range of stakeholders.

The three imported-coal plants (Sahiwal, Port Qasim and China Power Hub) face severe foreign exchange exposure, declining utilization, and capacity payments of \$1.3 billion annually⁴. They carry negative net fiscal values even before accounting for climate externalities⁵, making them strong candidates for near-term retirement. The four local Thar lignite plants, commissioned 2-8 years later, present a more complex transition calculus. They produce more emissions per unit of electricity due to lower calorific value and thermal efficiency, strengthening the climate case for retirement. However, their deeper linkages with local mining workforces, supply chains and community services mean a substantially higher retirement cost, warranting more careful planning and later-stage transition. This chapter assesses and characterizes the two categories of assets (imported-coal vs. local-coal plants) based on NEPRA tariff data, financial models, and plant-level operational reports.

Operational, Financial and Tariff Profiles

Table 3 sets out key features of operating Chinese-financed CFPPs in Pakistan. All share several common characteristics.

- **Sovereign-guaranteed CPEC framework.** All seven plants operate under long-term power purchase agreements (PPAs) with sovereign guarantees, combining fixed capacity payments indexed to foreign exchange rates and US inflation with variable energy charges tied to fuel costs. This structure was designed to ensure bankability and investor confidence initially, but has created substantial fiscal obligations, with combined capacity payments over \$2 billion (authors' calculation), and rising further with rupee depreciation. As NEPRA's recent data show, Port Qasim's energy purchase price rose from PKR 4.7/kWh at commissioning to over PKR 14.6/kWh by September 2024 (NEPRA 2024), underscoring how imported-coal dependency and exchange-rate volatility continue to raise Pakistan's effective electricity costs.
- **High guaranteed returns and dollar exposure.** Guaranteed return on equity (ROEs) rates are among the highest in Pakistan's power sector, ranging from 27.2 percent for imported-coal plants to 31.6% average for Thar lignite plants, with predominantly dollar-denominated financing from Chinese policy and commercial banks. Combined outstanding debt across the portfolio totaled \$3.1 billion as of 2025, creating substantial foreign-exchange obligations that compound Pakistan's balance-of-payments pressures.

⁴ Results from authors calculation and modeling (elaborated in III and IV).

⁵ Negative net fiscal value is coming from either cross-subsidies (consumers paid) or tariff differential subsidies (budgeted) to cover the gap between the generation cost and electricity tariff.

- **Technical efficiency but environmental pressure.** At a 60 percent capacity factor, a 1,320 MW imported-coal plant emits roughly 5.8 MtCO₂ a year, and a similarly sized Thar lignite plant about 6 MtCO₂ (author calculations). Although these plants use modern supercritical or ultra-supercritical technology and are more efficient than Pakistan's older thermal fleet, heavy reliance on coal makes it harder for the country to meet its target of cutting emissions by 50 percent by 2035 under NDC 3.0. These plants also strain the environment through high water use, poor wastewater treatment, and low ash-recycling rates.

Meanwhile, the imported-coal and local-coal portfolios differ in important ways.

- **Operational performance and fiscal efficiency.** Imported-coal plants operate at capacity factors below 50 percent, generating only 3,335 GWh in 2024 from 3,960 MW of installed capacity, yet still draw \$1.3 billion in annual capacity payments. This translates to roughly \$0.06 in capacity payments per kWh actually delivered, a figure inflated by low utilization since fixed capacity payments are spread across a shrinking volume of generation. By contrast, Thar lignite plants ran at roughly 67 to 83 percent utilization, producing 15,194 GWh from 2,640 MW with \$904 million in capacity payments, or about \$0.006 per kWh generated. This asymmetry illustrates how underutilization of imported-coal plants, combined with take-or-pay terms, pushes the effective cost of their electricity sharply higher.
- **Financing risk concentration.** Imported-coal projects rely mostly on Chinese DFIs and commercial banks, concentrating foreign-exchange exposure and sovereign credit risk in dollar-denominated obligations. This reflects Pakistan's status as a high-risk investment destination and the absence of alternative lenders when these projects were negotiated in the early 2010s. Local-coal CFPPs, by contrast, were financed with substantial participation from Pakistani banks, spreading risk across the domestic financial system. This distinction matters for transition planning, as imported-coal debt restructuring centers on bilateral China-Pakistan negotiation, and Thar refinancing requires coordination across Chinese and Pakistani financial institutions.
- **Exposure to fuel price volatility.** Imported-coal power plants face exposure to global coal prices and shipping cost variation, alongside rupee depreciation that magnifies dollar-denominated fuel expenses. Local Thar CFPPs draw on captive domestic lignite reserves that insulate operations from these external risks. The Pakistan government has proposed converting imported-coal plants to Thar coal, but the latter's lower calorific value and higher sulfur content would reduce output by 10 to 15 percent and raise maintenance costs (NEPRA 2023). One study finds that Engro Powergen Thar, which burns local lignite, incurs significantly higher environmental external costs because its lower calorific value and efficiency require nearly twice the coal per unit of electricity compared with imported coal (Babar and Waleed 2024).
- **Regional integration and social dependencies.** Imported-coal plants operate in relatively developed regions where diversified local economies provide employment alternatives for current workers, though significant support would still be needed. Local Thar CFPPs anchor an integrated mine-mouth ecosystem in Pakistan's most underdeveloped region, creating jobs and supporting surrounding communities. Their deeper social dependencies mean transition plans must address not only employment but also mine cost recovery and continuity of community services.

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Table 3: Chinese-financed CFPPs Portfolio

		Imported-coal CFPPs				Local-coal CFPPs				
		Sahiwal	Port Qasim	China Power Hub	Portfolio Total/Average	Engro Powergen	Thar Energy	ThalNova	Thar Coal Block-1	Portfolio Total/Average
Operational Profile	Capacity (MW)	1,320	1,320	1,320	3,960	660	330	330	1,320	2,640
	Location	Punjab	Sindh	Balochistan	/	(Sindh) Thar II	(Sindh) Thar II	(Sindh) Thar II	(Sindh) Thar I	/
	Commissioned	2017	2018	2019	2017-2019	2019	2022	2023	2023	2019-2023
	Utilization Rate (2023-24)	41.4%	6.8%	13.9%	Under 50%	82.7%	78.6%	80.2%	67.5%	~69%-75%
	Annual Generation (GWh, 2023-24)	2076	782	477	3,335	3766	1948	1980	7500	15,194
	Average Fuel Cost (USD/kWh, 2023-24)	0.0734	0.0561	0.0759	~ 0.0685 avg	0.0133	0.0444	0.0444	0.0534	~0.0389 avg
Financial Profile	Project Cost	\$1,800m	\$2,085m	\$1,995m	\$5,880m	\$995m	\$498m	\$498m	\$1,912m	\$3,903 m
	Guaranteed ROE	27.20%	27.20%	27.20%	27.2% avg	30.65%	30.65%	30.65%	34.49%	31.61%
	Outstanding Debt (2025)	\$436m	\$571m	\$622m	\$1,629m	\$324m	\$280m	\$288m	\$554m	\$1,446m
Tariff Profile	Capacity Charge (USD/KWh, Oct-Dec 2025)	0.0332	0.0342	0.0407	~0.0362 avg	0.0397	0.0415	0.0413	0.0409	~0.0408 avg
	Energy Purchase Price (USD/KWh, Oct-Dec 2025)	0.0014	0.0014	0.0025	~0.0018 avg	0.0056	0.0037	0.0037	0.0024	~0.0039 avg
	Annual capacity Payments (2024)	\$397m	\$418m	\$480m	\$1,295m	\$220m	\$126m	\$116m	\$442m	\$904m
	Capacity payments for per unit of electricity generated (US/ KWh)	0.0191	0.0535	0.1006	~0.06 avg	0.0058	0.0065	0.0059	0.0059	~0.006 avg

Source: Authors compiled from public information, such as CPEC Official Website; Pakistan Credit Rating Agency (PACRA); National Electric Power Regulatory Authority (NEPRA)

Note: CCCC = China Communications Construction Company; CDB = China Development Bank; CMEC = China Machinery Engineering Corporation; CHEXIM = Export and Import Bank of China; FFC = Fauji Fertilizer Company; HBL = Habib Bank Ltd.; HUBCO = Hub Power Company Ltd; ICBC = Industrial and Commerce Bank of China; SPIC = State Power Investment Corporation; TEL = Thar Energy Limited

Risk Assessment

Chinese-financed coal-fired power plants (CFPPs) in Pakistan face a range of interconnected risks spanning policy, financial, operational, and environmental dimensions (Table 4). Policy and climate risks are intensifying as Pakistan advances its clean energy targets and as global space for coal financing narrows, raising concerns over stranded assets. Persistently low utilization and mounting circular debt compound pressures on financial viability and liquidity, while dollar-denominated debt and reliance on imported coal keep foreign-exchange exposure high. Fuel supply constraints and infrastructure bottlenecks further complicate operational reliability. Environmental and social pressures, including air pollution, water stress, and land disputes, add to the long-term sustainability challenges these assets face.

Considered together, these risks underscore the importance of an orderly, phased transition strategy that can ease fiscal and financial pressures while aligning Pakistan's power sector with evolving climate commitments and energy security needs.

Table 4: Risk Assessment of Chinese-financed Coal-Fired Power Plants (CFPPs) in Pakistan

Risk Type	Estimated Mitigation Cost	Key Drivers	Mitigation Options
Policy and Climate Risk	Stranded assets exposure; High retrofit costs (e.g., CCS not economically viable)	60 percent clean energy target by 2030; Tightening global climate policy; Declining coal competitiveness	Structured early retirement; Carbon credit monetization; Phased refinancing; Transition funds
Financial Viability Risk	Ongoing capacity payments; Fiscal burden via circular debt	Low utilization; High fuel cost; Weak demand; PPA rigidity	Early retirement; Tariff restructuring; Debt refinancing; Repurposing (solar or storage)
Foreign Exchange Risk	~\$800m deferred repayments; Foreign exchange losses	Dollar-denominated debt and roe requirement; Imported coal exposure; PKR depreciation	Shift to domestic fuels; Renewables scaling; Debt reprofiling; RMB refinancing
Fuel Supply Risk	\$1-2 billion additional investment for Thar mining & transport	Imported coal dependency; Logistics gaps; Water scarcity; Security risks	Diversification to renewables; Phased coal reduction; Mine-mouth optimization
Liquidity & Counterparty Risk	PKR 1.6 trillion (\$5.7 billion) circular debt; Debt repayment arrears	Payment delays; 10-year high-interest loans; Sovereign fiscal stress	Payment reform; Securitization; ETM-style buyout; Multilateral guarantees
Environmental and Social Risk	Health externalities; Water stress; Land compensation	SO ₂ and PM2.5 exceedances; Water-intensive operations; Land disputes	Early retirement; Pollution controls; Just transition funding; Renewables investment

Source: Authors' estimates.

Notes: CCS = Carbon capture and storage; ETM = Energy Transition Mechanism; PKR = Pakistan Rupee; ROE = Return on equity.

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Transition Readiness Assessment

Table 5 presents results from a domain analysis on the early CFPP retirement in Pakistan using World Economic Forum (WEF)'s self-assessment tool. The analysis reveals that while most CFPPs remain economically stable under existing PPAs, the long-term viability of coal assets is increasingly uncertain due to evolving market dynamics and the competitiveness of renewables. Across both plant categories, repurposing⁶ emerges as a technically and economically feasible strategy, but overall institutional readiness for coal transition remains low, implying that transition momentum will likely depend on financial innovation rather than compliance mandates.

Imported and local plants present distinct transition profiles that reinforce the case for differentiated sequencing. The imported-coal CFPPs, including Sahiwal, Port Qasim, and China Power Hub, represent the earliest and costliest phase of CPEC power investments ("first-generation" coal portfolio). Built between 2017 and 2019 with individual cost ranging from \$1.8 billion to \$2.1 billion with 75 percent debt financing from Chinese state-owned banks, these projects carry rigid repayment schedules that constrain refinancing or early retirement. Despite remaining viable under the current PPAs, they face rising pressure as global coal prices and currency depreciation raise operating costs. Their coastal or grid-linked sites offer strong repurposing potential, especially for synchronous condensers and large-scale BESS hubs, but financial lock-in and sovereign guarantee make early phase-out economically challenging without substantial compensation or concessional refinancing.

The local-coal CFPPs, including Engro Powergen Thar, Thar Energy Limited, Thar Block 1, and ThalNova, present a different set of constraints. Newer and lower in capital cost, they benefit from domestic lignite that insulates them from import shocks, while anchoring the Thar mining ecosystem and providing employment in one of Pakistan's least-developed regions. Their favorable book values and lower foreign exchange exposure provide more room for phased transition planning rather than abrupt retirement. All four sites are technically suitable for future hybridization or solar repurposing given the available land and grid connectivity. However, their young age and longer remaining loan tenor reduce near-term transition incentives. The Thar plants thus represent a "second-generation" coal portfolio, less exposed to external shocks, but more deeply embedded in local development priorities.

For both categories, the social dimension remains a critical constraint: each contributes to local employment and the local economy, with the scale of dependencies varying significantly across sites, making early retirement politically sensitive regardless of financial feasibility. System-level risks from early retirement appear manageable with robust planning, but organizational readiness among asset owners is limited, suggesting a need for targeted capacity building, stakeholder coordination, and structured transition governance.

⁶ Repurposing refers to the conversion of retired coal plant sites into alternative grid-support or clean energy facilities, allowing continued use of existing transmission connections and infrastructure. For example, installing synchronous condensers at former coal sites helps provide voltage control, reactive power, and system inertia—services that are increasingly important as variable renewables replace conventional generation. Similarly, deploying Battery Energy Storage Systems (BESS) enables energy shifting, frequency regulation, reserve provision, and peak load management.

Table 5: Plant-level Transition Readiness Assessment

	Plant	Economic and Operational Viability	Financial and Investment Profile	Repurposing and Transition Potential	Social and System Impacts	Readiness
Operational Profile	Sahiwal	Among the most efficient plants, economically stable under the current tariffs structure.	Moderate remaining book value; exposure to dollar-denominated debt adds FX risk.	Conversion to SynCon + staged addition of BESS.	Large local employment base; potential strong social implications.	Technically advanced but limited internal transition planning; foreign JV governance.
	Port Qasim	High load factor and strategic location near Karachi port; stable dispatch but rising coal import cost risk.	Large foreign debt component; refinancing possible via concessional or blended mechanisms.	SynCon + large BESS hub using port-adjacent grid; coastal site allows hybrid repurposing (solar + storage); infrastructure reuse feasible.	Moderate workforce size; potential to redeploy to port-related logistics.	Dependent on policy clarity for carbon transition.
	China Power Hub	Relatively new and efficient; still within cost-recovery period.	Limited refinancing flexibility due to sovereign guarantees and early loan stage.	Repurposing potential for hybrid generation (solar + storage) through transforming to solar/BESS park plus limited SynCon services	Small community impact but supports local service economy.	Low readiness for early transition; ownership and financing structure are rigid.
Local-coal CFPs	Engro Powergen Thar	Domestic lignite source ensures low fuel-cost risk; strong base-load reliability.	Lower foreign-exchange exposure; favorable project financing structure.	Medium-term repurposing is possible through gradual hybridization (solar/wind).	Direct employment and community linkages; manageable transition impact.	Active in ESG reporting; potentially an early mover for transition pilots.
	Thar Energy Limited (TEL)	Economically viable due to cheap local lignite; recent commissioning ensures operational stability.	Early in cost-recovery period; limited incentive for near-term retirement.	Repurposing viable post-2035 once cost recovery is achieved.	Small workforce but dependent local economy in Tharparkar.	Early retirement not viable before 2035; needs an integrated transition roadmap.
	Thar Block-1	Large-scale plant; low fuel cost; efficient operation.	Strong Chinese financing; limited debt flexibility.	Very high solar repurposing potential given the site expanse and grid access.	New site with minimal relocation risk; significant and localized social footprint.	Governance is centralized; limited local institutional participation.
	Thal Nova Power Thar	Operational efficiency similar to TEL; cost-competitive with imported coal plants.	Local-foreign equity mix allows some refinancing innovation.	High technical suitability for conversion to hybrid or flexible generation.	Small local workforce; potential to retrain for O&M of renewables.	Could serve as a demonstration for Thar cluster transition planning.

Source: Authors based on WEF coal retirement self-assessment tool.

Note: BESS = Battery Energy Storage Systems; ESG = Environment, Social and Governance; JV = Joint Venture; SynCons = Synchronous Condensers.

China's Role and Instruments for CFPP Early Retirement

China has the opportunity to be a central actor in Pakistan's coal transition. As the seven CFPPs covered in this report are mainly supported by financing from Chinese banks and equity investments from Chinese SOEs, any negotiation of loan and contractual terms require their direct engagement. At the same time, China has both the policy mandate and the financial toolkit to support an orderly transition, and doing so is increasingly aligned with its own strategic interests.

The financial case for China. Chinese lenders and investors have a direct financial stake in resolving Pakistan's CFPP payment crisis. Outstanding dues to CPEC power projects now exceed PKR 300 billion (approximately \$1.1 billion) and continue to accumulate (The Express Tribune 2025), weighing on the financial sustainability of these plants and increasing the exposure carried on Chinese lenders' balance sheets. The persistence of unresolved arrears serves neither party: it constrains Pakistan's fiscal position while deferring returns to Chinese investors. A phased financing approach (discussed in Chapter 4) combining arrears resolution, concessional refinancing, carbon-financed retirement, and repurposing could support the recovery of principal over time while converting underutilized assets into clean energy infrastructure. From this perspective, early retirement should be understood not as a financial concession, but as a credible path to loan and investment recovery.

Policy framework. China's 2021 announcement to "step up support for other developing countries in developing green and low carbon energy and will not build new coal-fired power projects abroad" marked a turning point in its outbound energy investment policy. Domestically, China is advancing a managed transition of high-emission industries alongside a deepening national emissions trading system (ETS). In August 2025, it issued guidelines for the shift from intensity-based benchmarks toward absolute emissions caps and for the planned expansion of national ETS coverage (International Carbon Action Partnership 2025). China's Nationally Determined Contribution (NDC) 3.0, announced by President Xi at the UN Climate Summit in September 2025, further commits to expanding carbon markets to cover all high-emission sectors by 2035 (Patel and Evans 2025).

These signals point to a strategy in which carbon pricing and market-based mechanisms are central to China's decarbonization policy rather than peripheral add-ons (International Carbon Action Partnership 2024; Ministry of Ecology and Environment of China 2024). They also create a policy bridge to Article 6.2 cooperation under the Paris Agreement (UNFCCC 2021 Article 6 Rulebook), where internationally transferred mitigation outcomes (ITMOs, i.e., carbon credits tradeable between countries) can be deployed to mobilize finance, de-risk early action, and support structural transitions such as the early retirement of CFPPs. For partner countries, this opens space for results-based transition finance, where avoided emissions from coal phase-down are monetized under high-integrity carbon market frameworks (ICVCM 2023; Schneider and La Hoz Theuer 2019), while safeguards ensure environmental integrity and prevent the outsourcing of mitigation ambition. In effect, China's NDC 3.0 and carbon-market strategy provide a template for coupling domestic decarbonization discipline with outward-facing climate finance, positioning CFPP early retirement as a bankable climate outcome rather than a stranded asset. The credibility of such credits, particularly the additionality challenge, is examined in detail in Section 5.7 and Annex 5.

Industry readiness. Chinese SOEs involved in Pakistan’s CFPPs have the operational capacity to support transition. Equity holders, including Huaneng, PowerChina, SPIC and CMEC, have active and growing renewable energy portfolios at home and have delivered solar, wind, and storage projects internationally. The institutional knowledge and project execution capacity required for transition thus already reside within the Chinese entities currently managing CPEC energy assets. Recent analysis further suggests that debt refinancing bundled with renewable investments can increase enterprise value, strengthening the commercial case for equity holders to pursue early retirement over business-as-usual scenarios (Nedopil et al. 2024).

Financing instruments. Outstanding CFPP loans are predominantly held by Chinese DFIs and state-owned banks, who have previously employed a range of restructuring tools like tenor extensions and interest rate reductions, as reflected in COVID-era debt relief measures (Brautigam and Wang 2021), Kenya’s conversion of Standard Gauge Railway loans into renminbi-denominated debt (Miriri 2025), and Zambia’s debt-restructuring agreements with Chinese lenders including CEXIM, which covered more than \$4 billion through extended maturities and a three-year grace period (Hill 2025). Panda bonds offer an additional route to refinance dollar-denominated coal debt at lower cost (Dilawar 2025; Babar and Waleed, 2024).

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China-Pakistan border crossing checkpoint. Photo by Sun_Shine via Shutterstock.



METHODOLOGY

Analytical Framework

This study applies a discounted cash flow (DCF) methodology to evaluate feasible financing options for the early retirement of coal-fired power plants (CFPPs), drawing on the framework developed by Clark et al. (2023) and adapting it to Pakistan's CPEC plant-level data. DCF analysis is a standard approach in project finance and infrastructure valuation. It converts future cash inflows and outflows into present values at a common base year, allowing consistent comparison across financing scenarios.

The model is constructed at the plant level and projects annual cash flows over the remaining PPA life of each CFPP, typically 30 years from commercial operation date (COD). Major cash flow components include:

- **Revenue:** Fixed capacity payments (indexed to foreign exchange rates and US inflation and payable irrespective of dispatch) and variable energy revenues based on actual dispatch;
- **Costs:** Fixed and variable operating and maintenance (O&M) expenses, fuel costs, and interest on working capital;
- **Financing:** Principal and interest on outstanding loans;
- **Tax:** Corporate income tax at Pakistan's statutory rate.

From these annual cash flows, the model derives net present values (NPVs) or required buyout cost for different retirement years and carbon prices required to fund early retirement.

Plant-level Inputs

Table 6 summarizes the key parameters used in the model, illustrated using the Sahiwal and Engro Powergen as examples. Most inputs are compiled from publicly available sources, including NEPRA tariff documentation, PACRA credit rating reports, and the official CPEC website. Based on these data, plant-specific annual loan repayment schedules, generation and emissions profiles, revenues, fuel and O&M costs, and interest on working capital are derived and incorporated into the cash flow calculations. Discount rates are assumed to be uniform across all CFPPs, at 6 percent for debt and 12 percent for equity.⁷

⁷ Discount rates reflect the opportunity cost of different types of capital. A 6% rate is applied to debt, consistent with the rate historically used under the IMF–World Bank Low-Income Country Debt Sustainability Framework for present value and concessionality calculations and is considered appropriate given country and sector risk characteristics. For equity, a 12% rate is used, broadly aligned with the traditional economic internal rate of return (EIRR) benchmark applied by many multilateral development banks, and reflects prevailing country- and sector-specific risk conditions.

Table 6: Example Plant-Level Model Inputs: Sahiwal and Engro Powergen Thar

Input	Sahiwal	Engro Powergen Thar	Unit	Source
Fuel source	Imported	Local	--	
Coal plant type	Supercritical	Subcritical	--	CPEC official website and news report
Installed capacity	1320	660	MW	CPEC official website
Reference (net) capacity	1244	603	MW	NEPRA quarterly performance report, Jul-Dec 2024
Auxiliary consumption	5.25	6	%	NEPRA quarterly performance report, Jul-Dec 2024
Commercial operation date (COD)	2017	2019	--	CPEC official website and news report
Plant design Life/ PPA term	30	30	years	PACRA credit rating reports
Total investment	1912	995	Million USD	CPEC official website
Debt Fraction	75	75	%	PACRA credit rating reports
Original loan principal	1434	746	Million USD	PACRA credit rating reports
Original loan interest rate	Quarterly LIBOR plus 4.5%	Local loan: quarterly KIBOR plus 3.5%; Foreign loan: quarterly LIBOR + 4.5%	--	NEPRA tariff documentation
Loan term	10 years plus grace period equivalent to construction period	10 years plus grace period equivalent to construction period	--	NEPRA tariff documentation
Return on Equity (ROE)	27.2% per annum	30.65% per annum	--	PACRA credit rating reports
Regulated return on equity period	30	30	years	Same as PPA term
Interest on working capital	Quarterly-KIBOR of 11.91% plus 200 basis point	Quarterly-KIBOR of 11.91% plus 200 basis point		NEPRA tariff documentation
Carbon intensity	0.88	0.98	tCO ₂ /MWh	State of Industry Report 2024, NEPRA
Corporate Tax Rate	29	29	%	PWC Pakistan tax summary

Source: Compiled by authors based on sources identified. Only key input parameters are shown.

As noted above, capacity payments and energy purchase payments are the two primary revenue streams for CFPP owners, and the two major cash outflows from the Central Power Purchasing Agency (CPPA-G) to those owners. Table 7 presents a comparison of tariff components for the Sahiwal plant in July-September of 2019 and 2025. The increases in capacity charges, particularly fixed O&M, return on equity (ROE), and debt repayment on outstanding principal, stem from rises in several indexation values, including the PKR/\$ exchange rate, the US Consumer Price Index (CPI), Pakistan's National CPI, imported coal prices, and benchmark interest rates such as quarterly KIBOR and SOFR.

Table 7: Sahiwal's Quarterly Tariff data in 2019 and 2025

Tariff Component	Jul-Sep 2019 Quarter	Jul-Sep 2025 Quarter
Capacity Charge (Rs./kW/h)		
Fixed O&M - Foreign	0.2613	0.5664
Fixed O&M - Local	0.1812	0.3976
Cost of Working Capital	0.409	0.7891
Return on Equity	1.4844	2.5896
Principal Outstanding	1.7482	4.2858
Interest Charge	1.2543	0.9258
Total	5.3384	9.5543
Energy Purchase Price (PKR/kWh)		
Variable O&M - Foreign	0.1245	0.2699
Variable O&M - Local	0.0575	0.1264
Total	0.182	0.3963

Source: Authors compiled based on NEPRA Tariff documentation.

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SCENARIO DESIGN

The scenarios are designed to reflect the liquidity challenges that CPPA-G has faced since 2023 in meeting capacity payments obligations to Chinese independent power producers (IPPs) (Alam 2023), leaving IPPs unable to fully service their debt to Chinese lenders. While no official figures have been disclosed, the model assumes that 50 percent of scheduled debt repayments (including both principal and interest) in 2023, 2024 and 2025 were not paid.

For each of the seven coal power plants, the model evaluates 28 scenarios structured across three dimensions: (1) how missed debt repayments from 2023 to 2025 are treated, (2) the projected utilization rate for the remaining plant life, and (3) the refinancing instrument applied. In all scenarios, the **required ROE component** in tariff agreement is reduced to a lower level to reflect a mutually agreed adjustment, in which plant owners accept lower returns in exchange for improved debt sustainability and project continuity.

Dimension 1: Treatment of missed debt repayments from 2023 to 2025 (2 cases)

- Missed debt repayments are carried forward: Arrears (assumed 50 percent of total due for 2023-2025) are added to the outstanding debt at the end of 2025, increasing the debt burden carried forward.
- Missed debt repayments are resolved through burden-sharing: Arrears (assumed at 50 percent of total due for 2023-2025) are split equally between Pakistan, who pays its share through a policy loan. China provides financial concession in terms of its share, resetting the 2025-end loan balance to the scheduled level.

Dimension 2: Utilization rate projection (2 cases)

- *Optimistic*: Assumes partial electricity demand recovery, with utilization rates returning to its pre-2025 average level by 2030 and remaining stable thereafter.
- *Conservative*: Follows Indicative Generation Capacity Expansion Plan (IGCEP) 2025-35 projections under “Unconstrained Capacity Addition” scenario, which assumes structurally lower utilization for imported-coal plants due to solar penetration and the prioritized dispatch of domestic coal.

Dimension 3: Refinancing instruments (7 options)

- Base case with no refinance (interest rate and tenor unchanged)
- Refinance at original interest rate (tenor +3 years)
- Refinance at 3 percent (tenor unchanged)
- Refinance at 3 percent (tenor +3 years)
- Refinance at 3 percent (tenor + 10 years)
- Issue 5-year panda bonds
- Issue 10-year panda bonds

The full scenario matrix is set out in Table 8.

Table 8: Scenarios Design Matrix

Dimension 1	Dimension 2	Dimension 3
S1: Missed debt repayments for 2023-2025 are carried forward Arrears (assumed 50 percent of total due for 2023-2025) are added to the outstanding debt at the end of 2025	S1.1: Optimistic Utilization Rate Projection Utilization gradually recovers between 2026 and 2030, returning to its pre-2025 average level by 2030.	S1.1.1: Base case with no refinance (new debt principal, interest rate and tenor unchanged)
		S1.1.2: Refinance at original interest rate (tenor +3 years*)
		S1.1.3: Refinance at 3% (tenor unchanged)
		S1.1.4: Refinance at 3% (tenor +3 years)
		S1.1.5: Refinance at 3% (tenor + 10 years)
		S1.1.6: Issue 5-year panda bonds
		S1.1.7: Issue 10-year panda bonds
	S1.2: Conservative Utilization Rate Projection Following <i>Indicative Generation Capacity Expansion Plan (IGCEP)</i> 2025-35 projections under "Unconstrained Capacity Addition" scenario	S1.2.1: Base case with no refinance (new debt principal, interest rate and tenor unchanged)
		S1.2.2: Refinance at original interest rate (tenor +3 years)
		S1.2.3: Refinance at 3% (tenor unchanged)
		S1.2.4: Refinance at 3% (tenor +3 years)
		S1.2.5: Refinance at 3% (tenor + 10 years)
		S1.2.6: Issue 5-year panda bonds
		S1.2.7: Issue 10-year panda bonds
S2: Missed debt repayments for 2023-2025 are resolved through burden-sharing Arrears (assumed at 50 percent of total due for 2023-2025) are split equally between Pakistan and China, resetting the 2025-end loan balance to the scheduled level.	S2.1: Optimistic Utilization Rate Projection Utilization gradually recovers between 2026 and 2030, returning to its pre-2025 average level by 2030.	S2.1.1: Base case with no refinance (interest rate and tenor unchanged)
		S2.1.2: Refinance at original interest rate (tenor +3 years)
		S2.1.3: Refinance at 3% (tenor unchanged)
		S2.1.4: Refinance at 3% (tenor +3 years)
		S2.1.5: Refinance at 3% (tenor + 10 years)
		S2.1.6: Issue 5-year panda bonds
		S2.1.7: Issue 10-year panda bonds
	S2.2: Conservative Utilization Rate Projection Following <i>Indicative Generation Capacity Expansion Plan (IGCEP)</i> 2025-35 projections under "Unconstrained Capacity Addition" scenario	S2.2.1: Base case with no refinance (interest rate and tenor unchanged)
		S2.2.2: Refinance at original interest rate (tenor +3 years)
		S2.2.3: Refinance at 3% (tenor unchanged)
		S2.2.4: Refinance at 3% (tenor +3 years)
		S2.2.5: Refinance at 3% (tenor + 10 years)
		S2.2.6: Issue 5-year panda bonds
		S2.2.7: Issue 10-year panda bonds

Source: Authors compilation.

Note: * The revised tenor is set to the original remaining term plus three years. For example, Sahiwal has three years of debt repayment remaining at the end of 2025; under this scenario, the outstanding debt as of end-2025 is refinanced over six years, with the interest rate unchanged.

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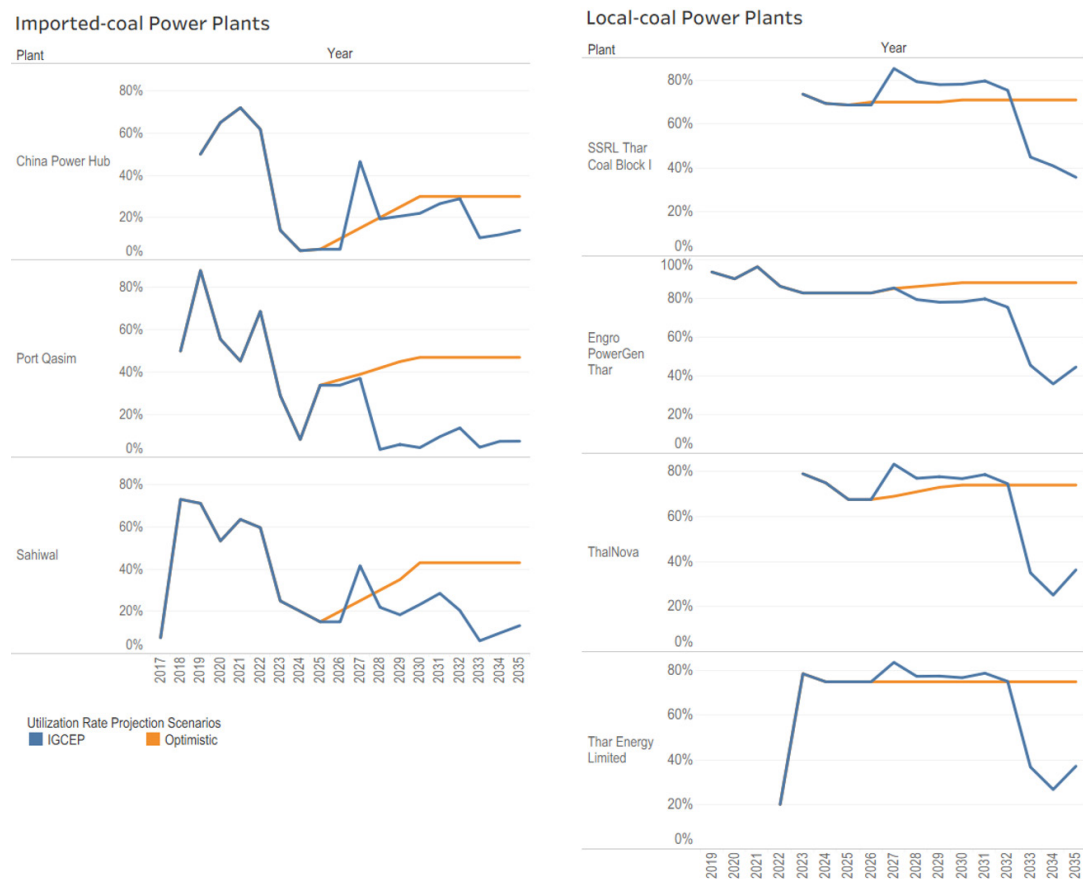
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Figure 2 presents the projected utilization rates under the two scenarios described above. The line prior to 2025 reflects actual utilization rates since COD, showing a clear downward trend. After 2025, the optimistic and conservative (IGCEP) projections start to diverge markedly for imported-coal power plants, but remain relatively similar for local-coal power plants until the IGCEP projection declines sharply around 2032–2033.⁸

Figure 2: Plant-Level Utilization Rate Projection from COD to 2035



Source: Authors calculation based on draft IGCEP2025 (Unconstrained Capacity Addition Scenarios).

Note: COD = Commercial Operation Date.

⁸ The sharp decline in 2032–2033 is primarily driven by the completion of debt repayment cycles for the first wave of Thar coal projects and the integration of large-scale storage and hydel projects (such as Diamer-Bhasha) into the base-load mix.



FINANCIAL PATHWAYS FOR EARLY RETIREMENT

This chapter presents the financial pathways through which Chinese-financed CFPPs can be retired 15 to 20 years ahead of PPA expiry. The framework rests on a four-phase sequence:

1. **Arrears resolution and concessional refinancing.** Accumulated 2023-2025 debt arrears are resolved through burden-sharing between Pakistan and China, and the remaining outstanding debt is refinanced at lower interest rates or longer tenors, easing near-term liquidity stress and lowering the cost of subsequent retirement.
2. **Buyout of remaining cash flows.** Early retirement is financed either through a cash buyout or through monetized carbon credits earned from avoided emissions to compensate forgone cash flows for both debt and equity holders.
3. **Repurposing of the retired site** for clean energy generation, storage, or grid services, generating the revenue stream needed to recover the upfront concessions made by China and to cover just transition costs.
4. **Just transition support** for affected workers and communities, run in parallel with the financing steps.

The chapter is organized around these phases. Sections 4.1 and 4.2 examine the cash and carbon buyout mechanisms used in Phases 1 and 2, under different refinancing options. Section 4.3 quantifies the long-term economic and emissions value of repurposing (Phase 3). Section 4.4 estimates the just transition cost (Phase 4). Section 4.5 integrates all components into a phased financing arrangement, illustrated for the Sahiwal CFPP, with results extended to all seven plants in Table 13 and Table 14.

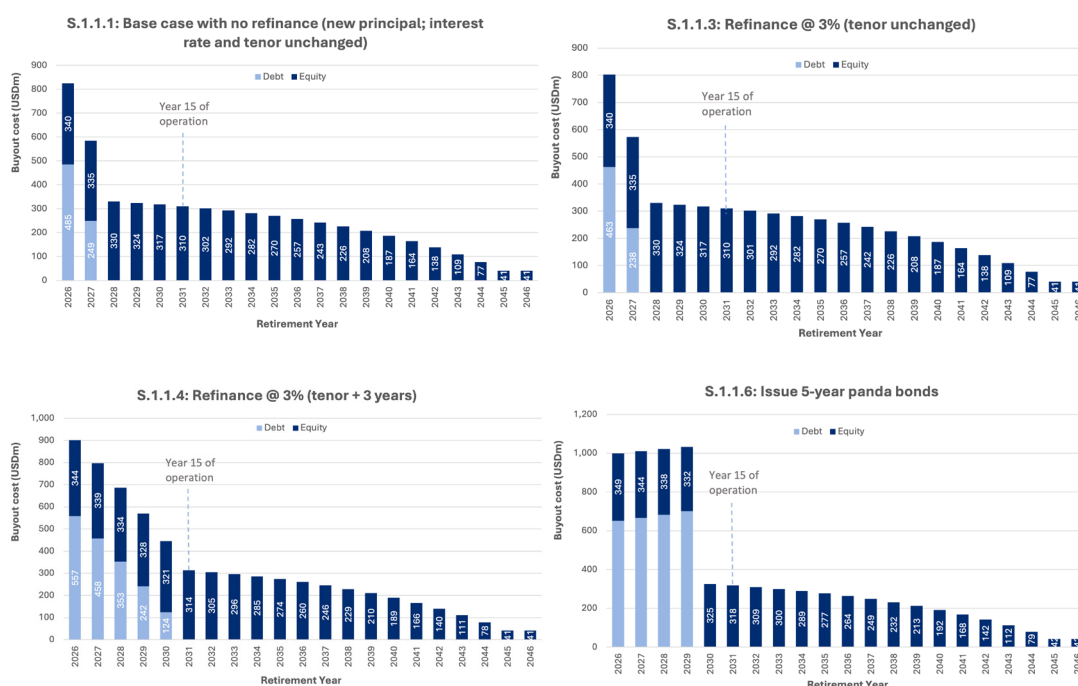
Together, these mechanisms enable retirement 15 to 20 years ahead of PPA expiry while maintaining fiscal sustainability and power supply reliability.

Cash Buyout after Concessional Refinancing

Resolving unpaid debt repayments through partial concessional financial⁹ support reduces the immediate outstanding loan balance, while concessional refinancing of the remaining debt at a lower interest rate and an extended tenor directly decreases annual debt service obligations from 2026 through the end of the loan. Both effects flow directly through to the capacity charge: the “principal repayment” and “interest charge” components of the tariff (refer to Table 7 above) would be proportionally reduced to reflect the restructured debt burden. Combined with a renegotiated reduction in the guaranteed ROE, total capacity payments will fall, substantially easing the fiscal pressure on CPPA-G and the Government of Pakistan. Figure 3 illustrates the early retirement costs under different refinancing instruments for Scenario 1.1.

⁹ This financial support is provided by China in terms of loan repayment arrears.

Figure 3: Cash Buyout for Early Retirement for Sahiwal for Select Scenarios



Source: Authors illustration.

The savings in debt repayment and capacity payments are driven primarily by Dimension 1 (treatment of missed debt repayments) and Dimension 3 (refinancing instrument). Dimension 2 (utilization rate) has a negligible effect on these outcomes. Figure 4 therefore presents results for S1.1 and S2.1 only (full scenario results for Sahiwal are in Annex 1).

In terms of near-term liquidity relief:

- All refinancing options reduce both capacity payments and debt repayment obligation in 2026 relative to the base case, providing near-term liquidity relief;
- Panda bond issuance delivers the largest capacity payments and debt repayment reduction near-term, but concentrates repayment risk in a substantial bullet payment at maturity;
- Refinancing at a lower interest rate while retaining the original tenor provides the least liquidity relief, even less than refinancing at the original interest rate but a longer tenor, and is therefore not the optimal option.

In terms of cost of cash buyout for early retirement:

- Buyout costs are significantly higher before debt is fully repaid than after, because post-repayment buyouts only need to compensate equity holders for foregone returns rather than both debt and equity cash flows.
- Resolving the 2023-2025 missed debt repayments through a collaborative burden-sharing mechanism instead of carrying forward reduces early retirement costs by approximately \$200 million if retirement occurs before the loan is fully repaid.

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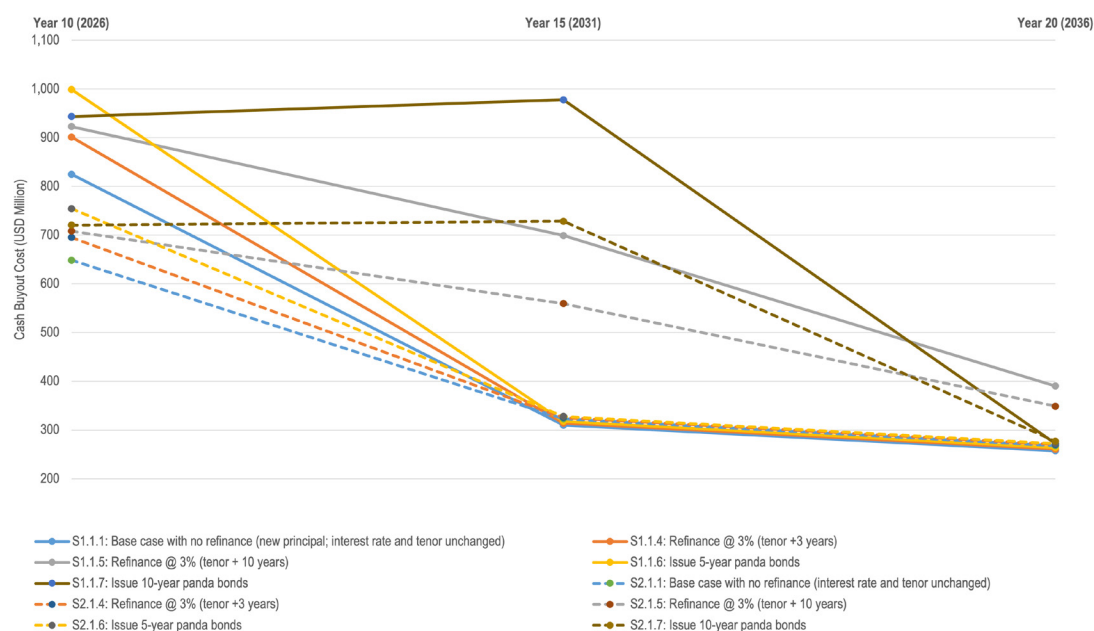
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Figure 4: Sahiwal's Cash Buyout Cost for Sahiwal Retiring at Different Year of Operation

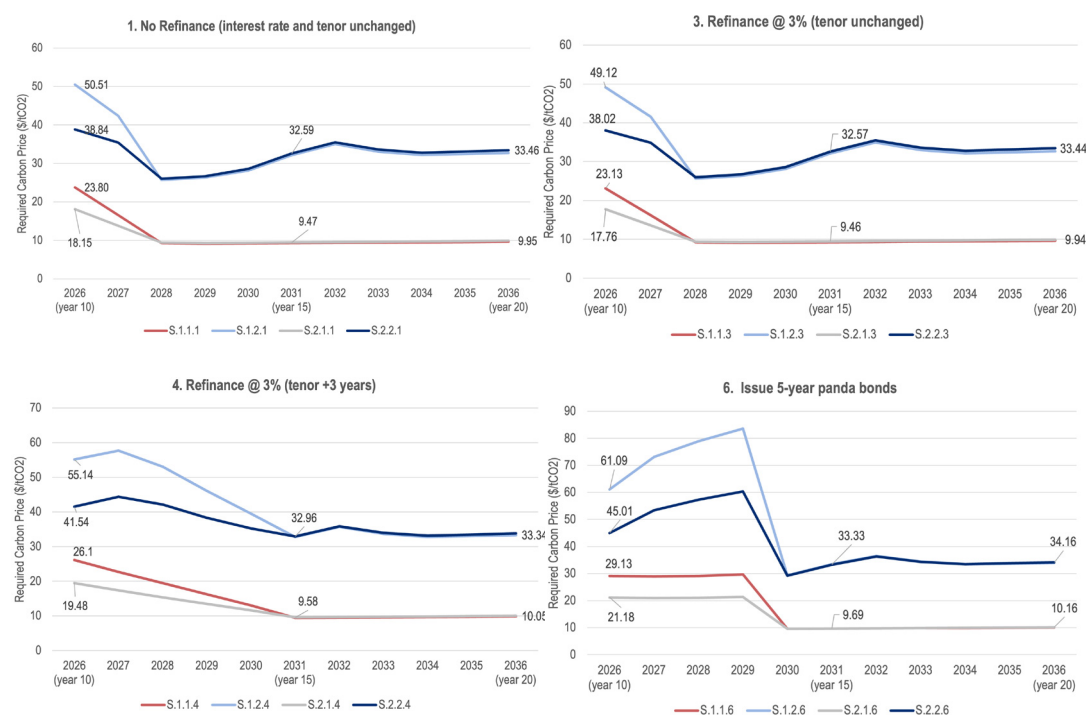
Source: Authors calculation.

Carbon Buyout After Concessional Refinancing

As an alternative to a cash buyout, early retirement can be financed by pricing future avoided emissions at a level sufficient to compensate the outstanding present value of both debt and equity cash flows (Clark et al. 2023). The required carbon price is shaped by all three scenario dimensions: the treatment of missed debt repayments, utilization rate projections, and refinancing instrument (Figure 5). Among these, the utilization rate has the largest impact. Lower utilization rates mean fewer avoided emissions are available, requiring a higher price per ton of CO₂ to cover the same foregone cash flows. Additionally, the required carbon price drops substantially once debt service is complete, as only foregone equity returns remain to be compensated.

Even under the lower-utilization scenario of the Indicative Generation Capacity Expansion Plan (IGCEP), a carbon price of \$30-\$35/tCO₂ is sufficient to finance early retirement, a level within the range of prevailing compliance and voluntary carbon markets. This suggests that carbon finance is a credible funding source rather than just a theoretical option.

Figure 5: Required Carbon Price for Early Retirement for Sahiwal for (Select) Different Scenarios



Source: Authors calculation.

A prominent framework for this approach is the Coal to Clean Credit Initiative (CCCI) led by the Rockefeller Foundation in collaboration with Verra and other partners. Central to this initiative is the Verra Methodology for Accelerated Retirement of Coal-Fired Power Plants Using Just Transition (VM0052), which provides a framework for quantifying greenhouse gas reductions from the early shutdown of coal plants and their replacement with renewable energy. VM0052 enables project developers to generate verified carbon units (VCUs) for the emissions avoided between the accelerated retirement date and the end of its baseline operating life. To ensure environmental integrity and social equity, the methodology requires strict eligibility rules, including a just transition plan, commitments against new coal expansion, and the deployment of renewable energy to replace at least part of the retired coal capacity.

A recent policy study applied the VM0052 framework to the 1,320-MW Sahiwal coal-fired power plant in Pakistan. While the plant met key eligibility criteria, including a long-term power purchase agreement and steady operational performance, the analysis also highlighted structural inefficiencies, such as declining dispatch and high capacity payments. Operating with an estimated emission factor of 617 kg CO₂/MWh, the early retirement of Sahiwal could avoid roughly 2.44 million tons of CO₂ annually. At a carbon price of \$25 per ton, this would generate around \$60.9 million per year, totaling \$1.22 billion over two decades. This revenue could offset transition costs and fund renewable replacements, positioning the Sahiwal plant as a pilot project for Pakistan's entry into carbon-market-supported coal retirement strategies (Waleed and Babar 2025).

However, CCCI-type carbon credits do not apply to all assets. Mine-mouth projects, particularly those using local coal in integrated mining-power configurations, often fail to meet eligibility criteria that prioritize fuel switching or reduced fuel imports. For these local-coal assets, alternative carbon-credit pathways may be viable, such as credits generated under China's voluntary carbon market or bilateral mechanisms under Article 6.2 of the Paris Agreement, both of which could potentially be structured to recognize verified emission reductions from early retirement and repurposing of mine-mouth plants.

Repurposing of Retired Coal Plant Sites

Retiring coal-fired power plants (CFPPs) opens up significant opportunities for site conversion. Repurposing allows developers to preserve the value of existing land, permits, transmission lines and grid connections. While all conversion pathways eliminate coal combustion, they differ in capital intensity, grid services provided, and dependence on enabling policy (Table 9).

Among these options, synchronous condensers (SynCon) is the most immediately viable. By retaining the existing generator and transmission infrastructure while eliminating fuel consumption, it can deliver voltage control, reactive power, and system inertia at relatively low capital cost and without the need for new off-take arrangements. This approach has already been implemented at retired coal sites in Australia, Denmark, and the United Kingdom (Uniper 2023; ABB 2023).

For other options, **Solar-plus-BESS (Battery Energy Storage Systems)** is a strong candidate for sites with favorable land and grid access, particularly the three coastal imported-coal plants. Existing high-voltage switchyards and transmission connections make these sites well suited to renewable parks and storage hubs.

BESS-only repurposing is a viable intermediate option, though highly dependent on the future design of ancillary service tariffs. **Industrial hubs** such as data centers or green hydrogen production base offer long-term value but require significant additional capital and supportive non-power sector policies. **Biomass co-firing or LNG conversion** are technically feasible, but severely constrained by biomass supply limits, boiler design requirements and fuel price volatility, making them a low priority for Pakistan.

Table 9: Repurposing Options and Feasibility

Option	Feasibility	Per Unit Capital Cost (\$/kW)*	Notes
SynCon conversion	High	23–61	Very low CAPEX; reuses generator & grid assets; technically easy, low cost, supports renewable energy transition
Solar + BESS hybrid repowering	High	340–630 (renewables + storage)	Uses land & grid; strong climate finance interest
BESS-only repurposing	Medium-High	110–265	Depending on ancillary service tariff design
Industrial SEZ/data center repurposing	Medium	75–380	Depending on non-power sector policies. Large variation by industrial model.
Biomass co-firing	Low-Medium	8–38	Restricted by biomass supply thus limited scale; small emissions benefits.
Gas/LNG conversion	Low	150–380	Requires new turbines; limited gas supply; fuel-price risks. high FX risk.
Hydrogen hub conversion	Long-term	225–530	Promising but depends on future markets

Source: Authors calculation.

Note: BESS = Battery Energy Storage Systems; LNG = liquefied natural gas; RE = Renewable Energy; SEZ = Special Economic Zone; SynCons = Synchronous Condensers. * Benchmarks derived from Isaad et al. (2025), ADB (2025) and Hakim et al. (2024). Adjusted for inflation, exchange rate movements, and changes in input prices over the project period).

Under optimistic utilization assumptions, retiring or repurposing a 1,320 MW imported-coal power plant 15 years early would avoid 40–70 MtCO₂, and roughly 100 MtCO₂ for a 1,320 MW local-coal plant (Table 10). Financially, early retirement yields about \$2 billion in avoided capacity payments per 1,320-MW plant compared to business-as-usual scenarios.

Table 10: Estimated Avoided Emissions from CFPP Early Retirement

		Avoid emissions (MtCO ₂) if retired at			
		Year 5 (25 years early)	Year 10 (20 years early)	Year 15 (15 years early)	Year 20 (10 years early)
Optimistic utilization projection					
1320 MW	Sahiwal	--	78.70	61.83	41.22
	Port Qasim	--	90.42	68.32	45.55
	China Power Hub	--	53.71	40.62	27.08
	SSRL Thar Block I	177.81	142.41	106.81	71.20
660MW	Engro PowerGen	112.75	91.06	68.33	45.55
330MW	Thar Energy Limited	48.29	38.63	28.97	19.32
	ThalNova	52.43	42.03	31.52	21.02
Conservative (IGCEP) utilization projection					
1320 MW	Sahiwal	--	31.43	18.63	12.64
	Port Qasim	--	14.25	10.62	7.27
	China Power Hub	--	28.50	18.70	12.59
	SSRL Thar Block I	127.24	88.08	66.94	44.63
660MW	Engro PowerGen	73.92	52.56	34.10	23.04
330MW	Thar Energy Limited	29.98	19.82	14.34	9.56
	ThalNova	31.20	20.27	15.47	10.31

Source: Authors calculation.

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The financial analysis reinforces these system benefits: indicative internal rates of return (IRRs) for repurposing options range from 15 to 27 percent (Table 11), with the highest values for Port Qasim and Thar Block-1 due to their strong grid-services value and large solar-plus-storage potential. Even other conservative cases deliver IRRs of 16 to 19 percent, comfortably above the typical renewable-energy hurdle rates in Pakistan.

These financial returns confirm that early action on the three imported-coal plants is both economically and fiscally compelling:

- **Sahiwal:** Well-suited for a pilot ETM/CCCI package integrating early retirement, SynCon conversion, and 500-800 MW of solar-plus-BESS facility;
- **Port Qasim:** Could become a stability and storage hub for the Karachi region, with longer-term hydrogen potential;
- **China Power Hub:** Its coastal land and strong solar resource make it ideal for conversion into a large renewable-energy park;
- **Thar lignite plants:** Because these plants are tied to domestic fuel linkages and mine-cost recovery, immediate retirement is less practical. However, their high emissions intensity and mounting transition risks require phased, medium-term diversification into solar, storage, and industrial uses. Repowering costs range from \$120-\$420 million for TEL, ThalNova, and Engro Powergen, and \$500-\$900 million for Thar Block-1.

Ultimately, the alignment of carbon mitigation, fiscal savings, and investor returns points toward a clear path forward: prioritize immediate repurposing for imported-coal plants while laying the groundwork for a phased transition across the Thar cluster.

Table 11: Repurposing Options

Plant	Capacity and fuel	Priority repurposing pathway*	Cost Estimate (\$ million)	Annual Earnings (\$ million)	IRR^	Notes
Flagship imported-coal plants						
Sahiwal (Punjab)	1,320 MW, imported	Early retirement; SynCon conversion with staged solar/BESS expansion	480-900	80-150	15.8%	Strong grid location; high solar potential
Port Qasim (Sindh)	1,320 MW, imported	Early retirement; SynCon and large-scale BESS deployment via port-adjacent grid	180-430	50-95	23.4%	Serves Karachi load pocket; ideal for storage-first pathway
China Power Hub (Balochistan)	1,320 MW, imported	Early retirement; conversion to solar/BESS park with limited SynCon services	450-830	80-175	19.3%	Excellent coastal solar resource; ample land
Thar lignite cluster (domestic coal)						
Engro PowerGen Thar	660 MW, Thar lignite	Maintain as mid-term baseload bridge; phase transition to solar/BESS post-2035	230-420	40-85	18.6%	Mine-mouth facility; repowering coordinated with mine asset recovery
SSRL Thar Block I	1,320 MW, Thar lignite	Medium-term retirement with post-mine payback; transition to solar/BESS and green hydrogen	500-900	120-255	26.5%	Vast site; long-term scalability for green hydrogen
Thar Energy Limited	330 MW, Thar lignite	Post-mine recovery transition to small-scale SynCon and modular BESS	120-210	21-41	18.1%	Smaller site; highly suited for modular, localized storage
ThalNova Thar	330 MW, Thar lignite	Post-mine recovery transition to small-scale SynCon and modular BESS	120-210	21-41	18.1%	Same as Thar Energy Limited; requires coordinated transmission planning

Source: Authors compiled based on ADB (2025), CPEC official website, Global Energy Monitor (2025) and Isaad et al. (2025).

Note: BESS = Battery Energy Storage Systems; IRR = Internal Rate of Return; SynCons = Synchronous Condensers; TEL = Thar Energy Limited. * Options: A. Early retirement; B. Early retirement + synchronous condenser; C. Early retirement + solar-plus-BESS repowering; D. Early retirement + BESS-only site; E. Partial measures. ^ Assumptions: Midpoint repurposing CAPEX; Midpoint annual earnings; 20-year operating life; Cashflow structure: Year 0 = -CAPEX; Years 1-15 = annual earnings

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Cost of a Just Transition

Managing the socioeconomic impact on workers and local communities is an indispensable part of a credible early retirement plan. The three imported-coal CFPPs (Sahiwal, Port Qasim, and China Power Hub) are significant local employers despite operating in more diversified regional economies. Sahiwal created 1,683 total jobs, including 1,033 local jobs (CPEC 2023). Port Qasim and China Power Hub report similar workforce sizes. Early retirement plans should therefore allocate resources for worker retraining, job-matching into renewables and grid service sectors, and transitional support for supply-chain small and medium enterprises (SMEs).

The stakes are substantially higher for local coal CFPPs, because these four mine-mouth plants anchor an integrated coal-linked regional economy in one of Pakistan's most underdeveloped areas, with dependencies extending well beyond direct employment. Thar Block-1 alone provides over 18,000 direct local jobs and funds critical social infrastructure, including schools, medical clinics, training centers and clean water supply schemes. A just transition in this region requires multi-year funding to sustain these essential services, alongside resources for mine closure, land rehabilitation, and structured alternative livelihood pathways.

Using Pakistan-adjusted cost parameters, the total just transition cost across all seven plants is estimated at \$1.2-2.1 billion (see Table 12 and Annex 3). These figures represent order-of-magnitude estimates intended to inform financing structure and stakeholder negotiations rather than precise project budgets.

Table 12: Just Transition Impacts

Plant	At-a-Glance Summary
Imported-Coal Plants	
Sahiwal	Jobs: 1,683 (1,033 local) • Dependence: Local SMEs, technical staff • Key JT Needs: Reskilling, SME support, CSR continuity • Cost: \$130-230 million
Port Qasim	Jobs: ~1,000 • Dependence: Port/logistics chain • Key JT Needs: Supplier transition, retraining, community services • Cost: \$130-230 million
China Hub	Jobs: ~1,700 • Dependence: CSR-funded education & health • Key JT Needs: Welfare funding, redeployment • Cost: \$130-230 million
Thar Lignite Plants	
Engro Thar Block II	Jobs: ~2,500 (1,800 local) • Dependence: Mine-plant ecosystem • Key JT Needs: Mine closure, CSR continuation, livelihood shift • Cost: \$200-350 million
TEL (Thar)	Jobs: ~800 (construction-heavy) • Dependence: Local SMEs, remote region • Key JT Needs: Retraining, SME/job creation • Cost: \$100-175 million
ThalNova (Thar)	Jobs: ~300 • Dependence: Remote jobs/services • Key JT Needs: Wage-bridging, diversification • Cost: \$100-175 million
Thar Block-1	Jobs: 18,000+ direct local • Dependence: Large CSR ecosystem (schools, clinics, water) • Key JT Needs: Multi-year CSR funding, mass redeployment, land rehab • Cost: \$400-700 million
Fleet Total (All Seven Plants)	\$1,175-2,060 million (≈ \$1.2-2.1 billion)

Source: Authors' compilation and estimates based on CPEC official website, Xinhua (2023), Ramay (2024), Daily Times (2023) and transition cost benchmarks.

Note: CSR = corporate social responsibility; JT = job transition; SME = small and medium enterprise.

Phased Financing Arrangement

The phased financing arrangement aligns the four phases set out at the start of this chapter with four complementary sources, each playing a distinct role:

- **China (banks and equity holders)** absorbs near-term costs by waiving a portion of accumulated arrears and accepting concessional refinancing terms, with recovery achieved over time through repurposing revenues.
- **Pakistan** prepays its share of arrears, potentially supported by multilateral development bank (MDB) lending, and benefits from reduced capacity payment obligations following refinancing and ROE renegotiation.
- **Carbon markets** provide the funding mechanism for buyout, monetizing avoided emissions to compensate equity holders for foregone returns.
- **Repurposing investments** generate sufficient returns to reimburse the amounts provided in terms of concessional finance by China and to cover just transition costs, while delivering ongoing grid and clean energy services.

Figure 6 illustrates this framework applies to the Sahiwal coal-fired power plant.

Phase 1 Arrears resolution and concessional refinancing (2026)

The preferred approach is to resolve and avoid adding the 2023-2025 arrears to future debt. China provides concessional financial support in terms of 50 percent of accumulated loan repayment arrears from 2023 to 2025 (\$141 million), with Pakistan prepaying the remainder (\$141 million). The outstanding loan principal stays at \$436 million, and the guaranteed return on equity (ROE) is reduced from 27 percent to 18 percent.

Phase 2 Concessional refinancing (2026)

The \$436 million balance is refinanced under one of two structures:

- **Loan extension:** Chinese lenders and MDB partners refinance the balance at 3% interest rate with a 3-year tenor extension (full repayment by 2031 instead of 2028), reducing annual debt service from \$264 million to \$80 million and annual capacity payments from \$413 million to \$218 million. The refinancing can be done in renminbi.
- **Panda bonds:** The balance is refinanced via a 5-year renminbi-denominated green Panda bonds¹⁰. This drastically drops near-term annual debt service to \$13 million, with a substantial bullet payment falling due at maturity (2030)

Phase 3 Early Retirement (2031)

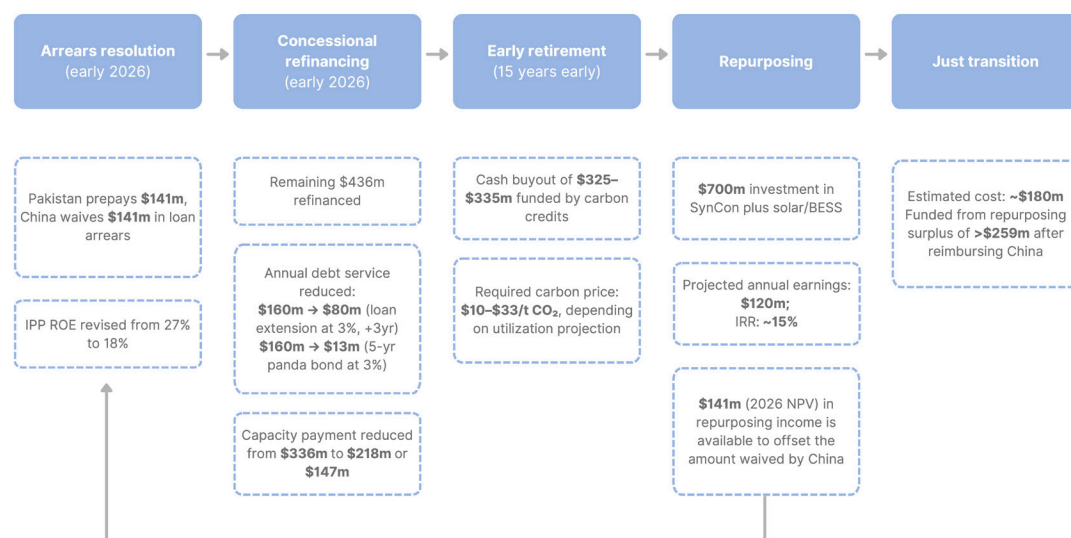
Early retirement of the Sahiwal plant in 2031 (15 years ahead of schedule) is financed through cash or carbon buyout, with an estimated buyout cost of about \$325-335 million, or a required carbon price of \$10-33 per tCO₂ depending on the utilization rate.

¹⁰ Green Panda Bonds are RMB-denominated green bonds issued by foreign governments, multilateral institutions, or overseas corporations in China's onshore bond market, with proceeds dedicated to environmentally sustainable projects such as renewable energy and energy efficiency. They combine the Panda bond format (foreign issuer raising RMB in China) with internationally recognized green bond standards.

Phase 4 Repurposing and just transition

The site is subsequently repurposed into a synchronous condenser with added solar and battery storage, requiring about \$700 million in investment but generating an IRR of around 15 percent. The resulting cash flows are sufficient to repay the amount that was provided in financial support by China, finance the repurposing itself, and still leave positive net cash flows.

Figure 6: Financing and Transition Plan: Sahiwal CFPP



Source: Authors illustration.

This structure is designed to be self-sustaining over time: China's upfront concessions are recovered through repurposing surpluses, Pakistan's prepayment is more than offset by capacity payment savings, and the buyout is externally funded through carbon markets rather than fiscal resources alone. In this framework, China could play a catalytic role by helping establish enabling policy and market conditions while anchoring a phased financing plan that aligns commercial recovery with climate objectives. Should China choose not to lead, the project remains financially viable and could attract support from MDBs such as the ADB, given its measurable emissions reductions, fiscal savings, and bankable cash-flow profile.

The loan restructuring negotiations could also consider incorporating a recapture clause, whereby part of the excess profits generated by the repurposed project, after satisfying all debt service and other contractual obligations, would be allocated to recover part or all of the debt arrears previously waived by the Chinese partners.

Table 13 sets out these arrangements for the three imported-coal CFPPs. Despite differences in commissioning years and loan sizes, they share broadly similar financial dynamics under a staged transition approach. Across the three plants, about half of accumulated arrears (\$429 million in total) are wrote-off by China and matched by Pakistan's prepayment, allowing the remaining \$1.6 billion in debt to be refinanced at 3 percent interest rate. This refinancing sharply reduces annual debt service and capacity payments compared with the non-refinancing baseline. Early retirement around 15 years ahead of schedule is financially enabled through carbon credit-financed buyouts, with required carbon prices varying by plant and financing structure.

Table 13: Sequential Financing Arrangement for CFPPs Utilizing Imported Coals (\$ millions unless otherwise indicated)

	Sahiwal	Port Qasim	China Hub	Total
Year of Commission	2017	2018	2019	-
Installed Capacity (MW)	1,320	1,320	1,320	3,960
2023-2025 arrears	282	288	288	858
Arrears resolution:				
Amount China wrote-off	141	144	144	429
Amount Pakistan prepays	141	144	144	429
Principal outstanding to be refinanced after arrears resolution	436	523	677	1,636
2026 debt repayment after refinancing:				
Option 4: Tenor extension of 3 years at 3% pa	80	96	108	284
Option 6: Panda Bond 5 years at 3% pa	13	16	20	49
Compared to without refinancing	160	192	192	544
2026 Capacity payment after refinancing and ROE reduction:				
Option 4: Tenor extension of 3 years at 3% pa	218	244	308	770
Option 6: Panda Bond 5 years at 3% pa	147	152	209	508
Compared to without refinancing and ROE reduction	336	386	448	1,170
Year of Early Retirement (15 years early)	2031	2032	2033	
Buyout cost and required carbon prices:				
Option 4: Tenor extension of 3 years at 3% pa				
Cost of Cash buyout	325	369	405	1,099
Required Carbon price (\$/tCO ₂) ^b	10 – 33	10 – 66	20 – 45	-
Option 6: Panda Bond 5 years at 3% pa				
Cost of Cash buyout	335	370	406	1,111
Required Carbon price (\$/tCO ₂) ^b	10 – 33	10 – 66	21 – 45	-
Repurposing:				
Repurposing Investment	700	300	650	1,650
Annual earning	120	70	130	320
IRR ^a	15.0%	22.2%	18.4%	
NPV (2026) ^a	400	297	458	1,155
Covering the amount wrote-off by China	141	144	144	429
Surplus	259	153	314	726
Cost of Just Transition	180	180	180	540

Source: Author's estimates.

Note: ^a Assuming 15 years of operation; ^b depending on utilization rate projection.

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Table 14 synthesizes the sequential financing outcomes for the four local-coal CFPPs. Total accumulated arrears across the four plants reach approximately \$492 million, again split evenly between China (\$247 million) and Pakistan (\$247 million). The remaining \$2.1 billion in debt is refinanced at roughly 3 percent, reducing aggregate annual repayments from \$390 million to \$252 million under loan extension, or to \$64 million under Panda bond financing. Capacity payments decline correspondingly, from \$766 million to \$603 million or \$380 million.

Early retirement at the 15-year horizon targets Engro Powergen in 2033 and the remaining three plants between 2036 and 2037. Required carbon prices are generally lower than for the imported-coal portfolio. Total cash buyout costs across the portfolio are estimated at \$757 million under either financing option. Retiring these CFPPs 20 years early (in year 10 of operation) raises upfront buyout costs to \$1.68 billion under loan extension and \$1.19 billion under Panda bonds, but the longer operating life of repurposed assets generates substantially higher NPVs (\$1.7 billion versus \$958 million). Under the 20-year scenario, the aggregate surplus reaches \$1.46 billion against just-transition costs of \$1.1 billion, compared with a \$711 million surplus under the 15-year scenario.

Table 14: Sequential Financing Arrangement for CFPPs Utilizing Local Coals (\$ millions unless otherwise indicated)

	Engro Powergen	Thar Energy Limited	ThalNova	Thar Block 1	Total
Year of Commission	2019	2022	2023	2023	-
Installed Capacity (MW)	660	330	330	1,320	2,640
2023-2025 arrears	150	75	75	192	492
Arrears resolution:					
Amount China wrote-off	75	38	38	96	247
Amount Pakistan prepays	75	38	38	96	247
Principal outstanding to be refinanced after arrears resolution	352	284	284	1,211	2,131
2026 debt repayment after refinancing:					
Option 4: Tenor extension of 3 years at 3% pa	56	33	33	130	252
Option 6: Panda Bond 5 years at 3% pa	10	9	9	36	64
Compared to without refinancing	100	49	49	192	390
2026 Capacity payment after refinancing and ROE reduction:					
Option 4: Tenor extension of 3 years at 3% pa	137	77	77	312	603
Option 6: Panda Bond 5 years at 3% pa	87	47	47	199	380
Compared to without refinancing and ROE reduction	210	109	110	442	766
Year of Early Retirement (15 years early)	2033	2036	2037	2037	-
Buyout cost and required carbon prices:					
Option 4: Tenor extension of 3 years at 3% pa					
Cost of Cash buyout	201	94	94	368	757
Required Carbon price (\$/tCO ₂)	6 - 12	5 - 13	5 - 11	6 - 10	-
Option 6: Panda Bond 5 years at 3% pa					

	Engro Powergen	Thar Energy Limited	ThalNova	Thar Block 1	Total
<i>Cost of Cash buyout</i>	202	94	94	367	757
<i>Required Carbon price (\$/tCO₂)</i>	6 – 12	5 – 13	5 – 11	6 – 10	-
Repurposing:					
Repurposing Investment ^a	325	165	165	700	1,355
Annual earning	60	30	30	180	300
IRR	16.6%	16.3%	16.3%	24.8%	
NPV (2026)	195	80	76	607	958
Covering the amount wrote-off by China	75	38	38	96	247
Surplus	120	42	38	511	711
Cost of Just Transition	275	135	135	550	1,095
Year of Early Retirement (20 years early)	2028	2031	2032	2032	
Buyout cost and required carbon prices:					
Option 4: Tenor extension of 3 years at 3% pa					
<i>Cost of Cash buyout</i>	418	196	196	867	1,677
<i>Required Carbon price (\$/tCO₂)</i>	10 – 16	9 – 19	9 – 19	13 – 21	-
Option 6: Panda Bond 5 years at 3% pa					
<i>Cost of Cash buyout</i>	558	108	108	419	1,193
<i>Required Carbon price (\$/tCO₂)</i>	14 – 21	5 – 11	5 – 11	6 – 10	-
Repurposing					
Repurposing Investment ^b	325	165	165	700	1,355
Annual earning	60	30	30	180	300
IRR	17.8%	17.5%	17.5%	25.4%	
NPV (2026)	360	149	141	1,049	1,699
Covering the amount wrote-off by China	75	38	38	96	247
Surplus	285	111	103	957	1,456
Cost of Just Transition ¹¹	275	135	135	550	1,095

^a Assuming 15 years of operation^b Assuming 20 years of operation

The key difference between the imported and local coal CFPP portfolios is not strategy but timing. As local-coal plants were commissioned several years after imported-coal plants, their retirement dates fall later in the calendar. This natural stagger provides a meaningful buffer for managing the system transition: it supports supply adequacy as new renewable capacity is phased in and allows repurposing and just transition measures to be sequenced carefully rather than implemented simultaneously across the full portfolio.

¹¹ Just transition costs are estimated by aggregating plant-specific labor, community, and environmental liabilities arising from coal phase-down. As shown in Annex 4, costs include worker income protection and retraining, continuation of CSR-provided social services, mine closure and land rehabilitation (where applicable), and investments in livelihood diversification for affected communities.

Table 15 compares capacity payment savings with transition costs under the phased financing arrangement, taking scenario S2.2.4 (burden-sharing of 2023–2025 arrears, concessional refinancing at 3 percent with a three-year tenor extension, ROE reduced to 18 percent) as the reference case. Compared with a baseline of no refinancing, ROE reduction, or early retirement, the arrangement saves \$3.1 billion in capacity payments across the three imported-coal CFPPs, nearly double the estimated transition cost if retired in year 15 of operation. The margin is smaller for local-coal CFPPs, but the arrangement still saves \$1.8 billion in capacity payments.¹²

Table 15: Capacity savings from the phased financing arrangement and early retirement of CFPPs

	Imported-Coal CFPPs				Local-Coal CFPPs				
	Sahiwal	Port Qasim	China Hub	Sub total	Engro Powergen	Thar Energy Limited	ThalNova	Thar Block-1	Subtotal
Capacity (MW)	1320	1320	1320	3960	660	330	330	1320	2640
Baseline									
PPA expiry year	2047	2048	2049		2049	2052	2053	2053	
PV of capacity payments at the end of 2025 (2026 to PPA expiry)	1665	1795	2439	5899	1112	667	670	2825	5274
Phased Financing Arrangement									
Retirement year	2031	2032	2033		2033	2036	2037	2037	
PV of capacity payments at the end of 2025 (2026 to retirement year)	897	435	1482	2814	655	443	453	1891	3442
Capacity payment savings	768	1360	957	3085	457	224	217	934	1832
Transition Cost									
Cash buyout cost at year 15 of operation	325	369	405	1099	201	94	94	368	757
Estimated just transition cost	180	180	180	540	275	135	135	550	1095
Total transition cost	505	549	585	1639	476	229	229	918	1852
Carbon Emissions Avoided (MtCO ₂)	18.6	10.6	18.7	48.0	34.1	14.3	15.5	66.9	131

Source: Authors calculation.

Notes: All monetary values in \$ million. Future payments discounted at 12% to reflect the borrowing cost of the Government of Pakistan. IGCEP's utilization projection (conservative) is used.

Baseline = each plant operates through the original 30-year PPA with no restructuring, no ROE reduction or early retirement. The early retirement pathway corresponds to the scenario S2.2.4: burden-sharing of 2023–2025 arrears, concessional refinancing at 3% with three-year tenor extension, ROE reduced to 18%.

¹² For comparison purposes only. Transition cost is funded by credit revenues from avoided emissions and income from repurposing investment, not from capacity payments savings



Peshawar, Pakistan. Photo by Adeel Shabir via Unsplash.

ENABLING COLLABORATIVE MECHANISMS FOR TRANSITION

Financial viability, as demonstrated in Chapter 4, is necessary but not sufficient for coal transition. Translating modeled scenarios into implementable programs requires three parallel tracks of institutional action: (1) bilateral China-Pakistan cooperation frameworks that align incentives, share risks, and coordinate financing; (2) Pakistan’s domestic policy reforms that create enabling conditions for transition; and (3) third-party engagement from MDBs, climate funds, and carbon markets that provide catalytic capital and technical support. This chapter examines how these mechanisms can be activated to move from technical feasibility to political implementation, organized around eight critical enablers that together constitute a comprehensive transition framework (Table 16).

Table 16: Policy Recommendations

Focus Area	China: Government & Stakeholders	Pakistan: Government & Stakeholders	Priority & Timing
Sense of Urgency	Recognize CFPP challenges; prioritize market-based, practical fixes.	Balance fiscal relief, early coal retirement, and clean-energy transition in PPA talks.	Essential (Immediate: 0-12 months)
Strategic Approach	Align with Green BRI and climate goals; pair renewables and grid upgrades with coal phase-down.	Create a national decarbonization roadmap linking CPEC energy cooperation with low-carbon growth reforms.	Enabling (1-3 years)
Prioritization (Financial Stabilization)	Stabilize overseas coal assets while maintaining investor confidence	Ease fiscal and FX stress via debt refinancing and tariff/PPA restructuring	Essential (Immediate: 0-12 months)
Institutional Collaboration	Form an inter-ministerial Energy Transition Cell (including Ministry of Climate Change, Ministry of Energy (Power Division), Ministry of Finance and Planning Division.	Engage ADB, AIIB, and global partners (e.g., Rockefeller, RMI) for technical and financial backing.	Enabling (1-2 years)
Just Transition	Integrate a just -transition plan: assess impacts, retrain workers, repurpose sites, and ensure inclusion.	Support community transition through local industry, skills, and social protection programs.	Enabling (Parallel to financing; 1-5 years)
Phased Financing	Lower repayment burden via early principal pay-downs and interest cuts (RMB loan terms).	Use MDB policy loans, blended finance (ETM, CCCI, debt-for-climate swaps, green bonds) panda bonds, to refinance coal debt.	Essential (Design in 0-12 months; implement 1-3 years)
Carbon Markets	Launch bilateral carbon-credit cooperation under Paris Art. 6.2; share China Certified Emission Reductions (CCER) standards. ¹³	Build MRV and registry systems; pilot cross-border credit trades; integrate with regional markets.	Enabling → Optional (Pilot 1-3 years; scale 3+ years)

¹³ China’s Certified Emission Reduction (CCER) program is the country’s voluntary carbon credit mechanism administered by the Ministry of Ecology and Environment, allowing projects such as renewable energy, methane capture, and energy efficiency to generate tradable emission reduction credits. Following its relaunch in 2024 with updated methodologies and stronger oversight, CCER could provide a potential institutional basis for Article 6.2 cooperation under the Paris Agreement, enabling bilateral carbon market arrangements—such as between China and Pakistan—through the transfer of mitigation outcomes consistent with international accounting rules and corresponding adjustments.

Focus Area	China: Government & Stakeholders	Pakistan: Government & Stakeholders	Priority & Timing
Catering to Public Goods	A public-goods approach aligns with Green BRI objectives and enables negotiated frameworks and financing instruments (including Panda bonds) to be scaled beyond imported-coal CFPPs.	A system-wide approach supports NDC implementation and power-sector reform, enabling both imported- and local-coal CFPPs to transition through sequenced pathways rather than exclusion.	Optional / Scaling (3+ years)
Monitoring	Apply Green BRI standards — use project traffic-light grading and green finance tools, and shared data platforms for emissions and tracking.	Require all new CPEC projects to disclose traffic-light ratings, environmental and loan details, and feed updates into a joint Green CPEC Tracker.	Enabling (1–3 years)

Source: Authors compilation.

Notes: ADB = Asian Development Bank; AIIB = Asian Infrastructure Investment Bank; BRI = Belt and Road Initiative; CCCI = Coal to Clean Credit Initiative; CCER = China Certified Emission Reductions; CFPP = Coal Fired Power Plant; CPEC = China-Pakistan Economic Corridor; ETM = Energy Transition Mechanism; MDB = multilateral development bank; MRV = Measurement, Reporting, and Verification; PPA = Power Purchase Agreement; RMI = Rocky Mountain Institute;

Sense of Urgency

Both China and Pakistan now face a narrow window of opportunity to address CFPP challenges through coordinated, market-based solutions. For China, urgency stems from its 2021 commitment to halt overseas coal financing and reposition itself as a leader in sustainable development finance. Following through requires practical, risk-managed approaches such as concessional refinancing, asset repurposing, and bilateral carbon credit mechanisms; inaction risks reputational and financial exposure across China's overseas coal portfolio. For Pakistan, urgency lies in balancing the fiscal burden of capacity payments, the need for early coal retirement, and clean energy transition targets. PPA restructuring, equity return reductions, and blended finance instruments such as ADB's Energy Transition Mechanism and the Rockefeller Foundation's Coal-to-Clean Credit Initiative are essential to ease fiscal stress while preserving energy security and social stability. Jointly, both countries share an interest in framing CFPP transition not as a liability to be managed but as a strategic opportunity to strengthen CPEC's long-term viability and position the bilateral relationship within the evolving global climate finance landscape.

Strategic Approach

China's strategic approach should focus on deeper integration of its Green BRI commitments with the decarbonization needs of partner countries, given the dominant role of Chinese-financed CFPPs Pakistan's power sector and its pressing fiscal, energy, and climate transition challenges. This means moving beyond project-by-project management toward a systemic transition model that couples coal phase-down with renewable energy deployment, smart grid upgrades, and energy storage expansion. China's comparative advantage in solar, wind, and battery manufacturing positions it to provide cost-competitive green technologies while financing mechanisms such as concessional refinancing, debt-for-climate swaps, and performance-based carbon credit schemes can support the transition. Institutional coordination among agencies such as National Development and Reform Commission (NDRC), Ministry of Finance (MOF), and China International Development Cooperation Agency (CIDCA) would be central to ensuring that overseas investment practices align with China's domestic green taxonomies and ESG standards, while Chinese banks and green funds pilot Green BRI transition finance instruments. Embedding Article 6.2-compatible carbon credit mechanisms

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into overseas projects could further monetize emissions reductions and enhance project bankability, linking climate ambition directly with economic returns.

For Pakistan, the strategic priority is to institutionalize a national decarbonization roadmap that ties together energy transition, fiscal reform, and low-carbon industrial upgrading under the CPEC framework. This roadmap should set clear milestones for coal retirement, renewable expansion, and grid modernization, supported by policy coherence across the Ministry of Energy, Finance, and Planning. Strengthening regulatory frameworks, including feed-in tariffs, competitive auctions for renewables, and incentives for local clean-tech manufacturing, can attract private and concessional capital. Linking CPEC cooperation to low-carbon industrial parks, battery manufacturing zones, and smart grid pilots would extend the energy transition into an engine for green industrial growth and job creation.

Pakistan should also work with partners like ADB, AIIB, Rockefeller Foundation, and RMI to mobilize blended finance and just transition support, ensuring affordability and social inclusion. By coupling CPEC's infrastructure platform with a clear policy roadmap and credible financing mechanisms, Pakistan can shift from managing chronic energy deficits toward building a more sustainable growth path.

Prioritization

For China, the immediate priority is to stabilize overseas coal assets through structured refinancing, portfolio risk management, and phased coal-to-renewable conversion to protect the value of existing investments and maintain investor confidence. For Pakistan, the focus should be on easing fiscal and foreign exchange pressures through debt restructuring and PPA renegotiation, ensuring repayment terms reflect actual plant utilization. A credible, publicly communicated policy direction, which links fiscal reforms with the clean energy transition, is essential to sustain investor trust, attract blended finance, and create the conditions for longer-term low-carbon transformation of the power sector.

A key enabler for financial viability is the development of an ancillary-services tariff framework by NEPRA, which would compensate plants for grid stability services that are currently not monetized in the market.

Institutional Collaboration

China and Pakistan should establish a China-Pakistan Green Energy Task Force under the CPEC framework to coordinate the coal-to-clean energy transition and facilitate mutually beneficial climate outcomes. Co-chaired by the CPEC Secretariat and supported by relevant ministries, the Task Force could coordinate financing models, project pipelines, and policy alignment between both governments. It should also integrate Chinese financial institutions like CDB, CHEXIM, ICBC and Sinosure with Pakistan's Ministry of Finance and Planning Commission to develop transition financing instruments, including concessional refinancing, debt-for-climate swaps, and carbon-credit pilots under Article 6.2. The Task Force could further serve as a primary platform for joint monitoring, applying Green BRI standards, ESG metrics, and traffic-light project ratings to track progress and ensure accountability.

On Pakistan's side, effective implementation depends on institutional coordination and policy alignment. The government should establish a Technical Working Group on Transition Finance and Grid Modernization that brings together the Ministry of Energy, Ministry of Planning, Development & Special Initiatives, Ministry of Finance, and the Ministry of Climate Change & Environmental Coordination to overcome fragmented mandates and delays in policy execution and ensure consistency between federal and provincial actions. Supported by partners such as ADB, AIIB,

Rockefeller Foundation, and RMI, this group would facilitate access to global best practices, technical assistance, and blended finance solutions. A cohesive institutional framework would enable Pakistan to move from ad hoc energy reforms to a strategic, whole-of-government approach, turning CPEC into a cornerstone for sustainable, climate-aligned economic growth.

Just Transition

A successful coal transition in China-Pakistan cooperation must embed social inclusion and regional stability alongside financial considerations. On China's side, this entails developing a structured just transition plan for overseas coal projects that systematically assesses employment and community impacts, provides retraining and job placement for affected workers, and supports the repurposing of decommissioned sites for renewable energy, logistics, or industrial reuse. Chinese institutions involved in the green overseas investment can integrate social safeguards and inclusion metrics into transition finance and project evaluation criteria, ensuring that the coal phase-down generates shared and people-centered benefits rather than displacement.

For Pakistan, embedding just transition principles means linking coal retirement with local economic revitalization, workforce reskilling, and social protection. Programs that support small and medium enterprise participation, vocational training in green industries, and regional development around former coal zones can transform potential job losses into opportunities for innovation and inclusion. Technical and financial support from ADB, AIIB, Rockefeller Foundation, and RMI can help design and implement community-centered transition measures, ensuring that the shift to clean energy contributes not only to decarbonization but also to equitable, resilient, and inclusive growth.

Phased Financing

Pakistan has access to multiple financial instruments to support the early retirement of CFPPs and the broader clean energy transition. These include (1) concessional refinancing tools such as policy-based and blended finance, panda bonds, debt-for-climate swaps, and state-contingent debt instruments; and (2) potential carbon finance options such as the CCCI, Paris Agreement Article 6.2 bilateral agreements, and China's CCER program. Effective use of these instruments requires accompanying technical and institutional support, strong result management, prudent asset repurposing, and well-designed just transition programs with adequate domestic co-financing.

For Chinese government agencies and financial institutions, the most practical entry point is a phased and flexible approach to support the managed transition of coal assets in Pakistan while balancing financial stability with decarbonization goals. Key instruments include early principal pay-downs, interest rate reductions, and loan tenor extensions under existing RMB-denominated arrangements, alongside performance-linked refinancing structured through DFIs such as CDB and CHEXIM and tied to measurable emissions reduction or renewable capacity milestones. By integrating Green BRI financing standards and drawing on concessional windows through policy banks such as CDB and CHEXIM, China can contain financial exposure, strengthen long-term portfolio resilience, and demonstrate leadership in transition finance for emerging-market partnerships.¹⁴ The phased financing model can also be linked to Article 6.2 carbon-credit monetization, where verified emission reductions from early coal retirement generate partial loan offsets, strengthening the fiscal sustainability of both borrower and lender.

¹⁴ As of October 2025, Zambia concluded bilateral debt-restructuring agreements with Chinese lenders, including the CEXIM, covering over \$4 billion in debt through extended maturities and a three-year grace period, easing short-term repayment pressures without immediate nominal haircuts (Bloomberg 2025). The Zambia case provides a relevant precedent for Pakistan's coal-plant early-retirement framework, suggesting that structured extensions, grace periods, and phased refinancing could align creditor and debtors with transition objectives.

For Pakistan, phased financing provides a strategic pathway to stabilize the power sector without undermining fiscal balance. The government should work with multilateral and bilateral partners to mobilize blended finance packages that combine concessional capital, policy-based loans, and private participation. A well-sequenced, results-based financing roadmap, anchored in transparent policy reforms, credible monitoring, and social safeguards, would allow Pakistan to move from short-term liquidity relief toward long-term energy security and low-carbon industrial growth. Annex 4 lists selected financing, market and institutional mechanisms for CFPP early retirement, organized by concessional and blended refinancing tools, performance and risk-based mechanisms, carbon credit and carbon market instruments, and third-party engagement options.

Carbon Credits and Carbon Markets

The Sahiwal Coal Power Plant case study under the Coal-to-Clean Credit Initiative demonstrates how Pakistan could apply Verra's VM0052 methodology to support the early CFPP retirement and a transition to renewable energy (Waleed and Babar 2025). VM0052, *Accelerated Retirement of Coal-Fired Power Plants Using a Just Transition*, released in May 2025, provides a framework through which project developers may generate verified carbon units by retiring CFPPs ahead of schedule and replacing lost generation with renewable energy (Verra 2025). Applied to Sahiwal, the analysis estimates annual emissions reductions of approximately 2.44 million tCO₂, potentially translating into roughly \$60 million per year in carbon-credit revenues. The methodology also incorporates mandatory just-transition provisions intended to address impacts on workers, contractors, households, and affected communities.

At the same time, the use of transition credits for CFPP retirement remains methodologically complex and subject to evolving international integrity standards. As discussed in Annex 5, neither VM0052 nor Gold Standard's JUST: Coal Decommissioning methodology has yet secured Core Carbon Principles (CCP) approval from the Integrity Council for the Voluntary Carbon Market (Integrity Council for the Voluntary Carbon Market 2024). Additionality remains the central integrity test, particularly in Pakistan where CFPPs operate under take-or-pay PPAs with sovereign-backed capacity payments. Weak counterfactual assumptions, inflated baselines, intra-fleet leakage, or cross-financed structures relying on unrelated carbon credits could undermine the environmental integrity and market credibility of resulting credits.

A broader integrity-based transition architecture would therefore be required. Pakistan should prioritize development of a National Coal Retirement Plan anchored in the IGCEP, with plant-by-plant retirement trajectories, renewable replacement planning, dispatch safeguards, and consistency with Pakistan's NDC and any future Article 6 authorization framework. Without such a system-level approach, isolated retirement transactions may reduce emissions at the project boundary while increasing emissions elsewhere in the power system, particularly if imported-coal generation is replaced by lower-efficiency Thar lignite plants.

Within this broader framework, bilateral carbon-market cooperation could still become an important component of China-Pakistan climate cooperation under CPEC. China's relaunch of the China Certified Emission Reduction program in 2024 provides a possible institutional foundation for future cooperation. Pakistan could engage with China and other interested partner countries, to explore CCER or CCER-like cooperation frameworks, including joint methodology development, MRV systems, registry interoperability, and pilot cross-border transition-credit arrangements. Carefully structured Article 6.2 cooperation could also support corresponding-adjustment-eligible transactions and sovereign-backed transition-finance arrangements, although Article 6.2 should not be viewed as an automatic solution to integrity concerns relating to transparency, monitoring, or additionality.

In the near term, the focus should be less on immediate large-scale credit issuance and more on enabling activities, including methodology development, institutional strengthening, MRV systems, registry management, and pilot cooperation arrangements. Pakistan, together with CCCI and relevant partners, should also encourage Verra to formally submit VM0052 for ICVCM CCP assessment, following the procedural pathway already taken by VMR0017 and ACM0008 (Integrity Council for the Voluntary Carbon Market 2026a; Verra 2026b). Without CCP recognition, the credibility, pricing potential, and market acceptance of transition credits are likely to remain structurally constrained (Integrity Council for the Voluntary Carbon Market 2024).

Catering to Public Goods

An important caveat in applying CCCI to Pakistan is the risk of emissions leakage at the system level. Retiring imported-coal plants is likely to increase dispatch from Thar coal-based generators, which already operate at high capacity factors and, given the lower calorific value, are roughly twice as emissions-intensive as imported coal. The planned Lahore North transmission expansion, which would improve power evacuation from the southern grid, is likely to accelerate this substitution effect. If unaddressed, this dynamic undermines the net mitigation claims and carbon-credit integrity of early retirement interventions.

More broadly, a policy framework focused on imported-coal CFPP retirement presents an incomplete and potentially misleading policy narrative, as it implicitly reinforces the dominant policy framing of Thar coal as an indigenous solution. A credible coal-transition strategy must explicitly incorporate Thar coal-based plants and the Jamshoro Power Plant into the analytical framework, enabling transparent comparison of economic, environmental, and system-level trade-offs. On a per-MW basis, several local-coal (mine-mouth) CFPPs have higher emissions intensity than imported-coal plants, and excluding them from early retirement pathways weakens both the climate effectiveness and the political credibility of the overall strategy.

While easing the financial and foreign-exchange pressures is an important and pragmatic entry point for transition, it should not be confused with the ultimate objective of coal early retirement. The fundamental rationale for retiring coal-fired power plants lies in the provision of global public goods, most notably large-scale carbon emissions reduction in line with the Paris Agreement. From this perspective, both imported-coal and local-coal CFPPs are equally relevant targets for transition, and a policy framework that addresses only one category is neither logically consistent nor politically sustainable.

Beyond emissions reduction, early retirement and repurposing of CFPPs are closely linked to the provision of a broader set of enabling public goods: carbon-reduction policies, regulatory frameworks, and physical infrastructure such as smart grids, energy storage, and advanced dispatch systems. Such public goods take time, institutional learning, and sustained investment to develop, with their economic and system value maximized when applied across the entire power network. Similarly, the negotiations themselves also constitute policy public goods. They cover PPA restructuring, debt relief, refinancing terms, carbon finance arrangements, and just transition commitments, and may include refinancing packages involving Chinese lenders, MDBs, and partner institutions, as well as instruments such as green or transition-linked panda bonds. Once reached, these agreements establish precedents, institutional capacity, risk-sharing frameworks, and trust applicable to both imported-coal and local-coal CFPPs. Restricting such negotiated frameworks to a single category of plants would dilute their public goods value and reduce their effectiveness in enabling a coordinated, economy-wide transition.

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Accordingly, while near-term prioritization based on fiscal stress and foreign-exchange exposure is justified, the transition framework must ultimately be anchored in a public-goods perspective. This implies inclusive access to enabling policies, negotiated arrangements, carbon finance mechanisms, and system-level infrastructure for all CFPPs, with differentiation applied through sequencing, financing structures, and regional just-transition considerations rather than categorical exclusion.

Monitoring

To ensure transparency, accountability, and the credibility of green transition efforts, China and Pakistan should jointly adopt a robust monitoring and reporting system built on China's overseas investment principles and digital transparency tools. On China's side, government agencies and development financiers can apply Green BRI standards, incorporating traffic-light project grading, green finance taxonomies, and shared data platforms to monitor environmental and financial performance across CPEC energy projects. Linked to monitoring, reporting, and verification (MRV) frameworks, these mechanisms would track progress on emissions reduction, coal retirement, and renewable deployment, while supporting climate-linked refinancing arrangements and reinforcing China's role in global green finance.

For Pakistan, institutionalizing transparency means requiring all new CPEC energy-transition projects to publicly disclose traffic-light ratings, environmental impact data, and financing details, with all data integrated into a joint Green CPEC Tracker. Co-managed by both governments, the platform would consolidate project-level data on carbon intensity, financing arrangements, and social outcomes, enabling real-time verification and strengthening investor confidence in Pakistan's transition commitments.

Coordination and Communication

Successful transition finance requires coherent coordination among Pakistan's key institutions and a shared understanding of roles across government, regulators, and development partners. The Ministries of Energy, Finance, Planning, and Climate Change must operate under a unified framework that aligns policy objectives, investment priorities, and timelines. The Technical Working Group on Transition Finance and Grid Modernization proposed in Section 5.4 would serve this function, reducing duplication, shorten decision cycles, and enable more effective engagement with private investors and international financiers supporting early coal retirement and renewable energy integration.

Equally important is clear and consistent communication, both horizontally across ministries and vertically between federal, provincial, and local stakeholders. Transparent communication channels help ensure that policy shifts, financing mechanisms, and project updates are well understood and synchronized across institutions. Effective communication also builds trust among domestic and international partners, improving the credibility of Pakistan's transition plans and attracting concessional and climate finance. Regular information exchanges, public briefings, and stakeholder consultations can strengthen accountability and maintain momentum toward shared national goals for decarbonization and just transition.

Action Kickoff

Despite years of assessments and consultations, concrete action has been slow to materialize. Part of the reason is structural: so many preparatory conditions must align simultaneously, from securing concessional financing and technical assistance to sequencing policy and institutional reforms, which rarely happen in practice. Many financiers, especially those offering concessional terms, operate on long and unpredictable timelines. Another reason is the high level of uncertainty and risk inherent in the transition process: even well-prepared plans face policy, market, technical, social, environmental, and regulatory risks, alongside the simple “unknowns” that come with piloting new transition models in challenging policy environments. Yet the fiscal and climate urgency is real, and the longer the delay, the more costly the eventual transition becomes. Someone must take the first step.

A practical entry point would be a policy-based loan from a multilateral development bank, in the range of \$500 million to \$1 billion, to support policy and institutional reforms, technical groundwork, and partial prepayment of outstanding debt principal. This would ease near-term liquidity pressures, reduce future debt service, and create a more favorable environment for negotiations. Critically, it would also signal strong government commitment and anchor a broader framework combining policy reforms, renewable investment, and just transition measures. Such a framework would in turn attract partners offering concessional refinancing, carbon credit mechanisms, and technical assistance. Successful implementation would also signal to China that Pakistan is serious about reform, encouraging closer alignment of CPEC’s energy portfolio with low-carbon goals.

Another practical approach is to engage third-party asset management companies (AMCs) to lead or co-finance coal transition efforts. This model reduces sovereign exposure, which is crucial given Pakistan’s participation in an International Monetary Fund (IMF) program and limited fiscal space, while drawing on global technical and financial expertise. AMCs experienced in managing non-performing or distressed assets can accelerate early CFPP retirement by applying debt restructuring and asset repurposing techniques that complement government-led efforts. Policy measures could include encouraging AMCs to integrate coal plant retirement into distressed debt-for-climate swaps, with public-sector entities providing limited financial support, technical assistance, and oversight.

China-based AMCs could participate in this process where Chinese policy and commercial banks have direct exposure to Pakistan’s coal-fired power assets, and Pakistan could consider forming joint ventures with Chinese AMCs to facilitate this engagement. MDBs could also establish AMC subsidiaries dedicated to energy transition that partner with local AMCs to implement coal retirement and site repurposing plans.

International precedents illustrate the model’s feasibility. In the United States, Starwood Energy Group retired two New Jersey coal plants ahead of schedule and is repurposing the sites for large-scale battery storage. Atlas Holdings, through Granite Shore Power, is converting two New Hampshire coal plants into a renewable energy park with battery storage. These cases show how asset managers can drive early coal retirement and clean energy repurposing, and offer relevant lessons for Pakistan’s transition pathway.

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This study examines the feasibility of early retirement of Chinese-financed coal-fired power plants (CFPPs) in Pakistan, treating early retirement not as a single-sector climate measure but as a multi-objective reform instrument that combines emissions reduction with power-sector and fiscal restructuring. The analytical framework links plant-level financial modeling with decarbonization, power-sector reform, and social transition objectives, sequencing arrears resolution, concessional refinancing, asset repurposing, and just transition measures.

The central constraint on early retirement is institutional rather than technical. Most CFPPs are viable retirement candidates in engineering and operational terms, and repurposing options such as synchronous condenser conversion or solar-plus-storage redevelopment are technically feasible at most sites. What blocks action is contractual rigidity, fragmented governance, and the absence of coordinated just transition planning, compounded by the regional dependencies that anchor local-coal plants in the Thar mining ecosystem.

Imported-coal CFPPs carry the largest foreign-exchange exposure, the lowest dispatch, and the highest capacity-payment burden, making them the strongest candidates for prioritized early retirement. Local-coal plants follow the same retirement logic, but their later commissioning dates push retirement into later calendar years, providing a buffer that allows electricity supply, storage, and grid investments to be phased in without compromising system stability. The delivery of coal transition requires coordination across power-sector regulation, climate policy, public finance, and regional development planning.

A phased financing plan is central to making early retirement credible and implementable. Concessional debt refinancing and ROE reduction cut near-term debt service and capacity payments. Compared with inaction, retiring the three imported-coal plants between 2031 and 2033 yields capacity payment savings of \$3.1 billion (present value at end-2025); retiring the four local-coal plants between 2033 and 2037 yields \$1.8 billion. Transition costs of \$1.6 billion (imported) and \$1.9 billion (local), covering cash buyout and just transition, are fundable through carbon-linked instruments that monetize avoided emissions. Repurposing itself creates value: projected returns support long-term system needs such as grid stability, renewable integration, and storage, and earlier retirement extends the operating life of repurposed assets while strengthening long-term outcomes.

A key limitation of applying the CCCI in Pakistan is the risk of system-level emissions leakage as retiring imported-coal plants may increase dispatch from emissions-intensive Thar lignite. A credible transition must therefore deliver system-wide emissions reduction, encompassing both imported- and domestic-coal plants, with differentiation by sequencing rather than fuel origin, even where near-term fiscal and foreign-exchange considerations justify initial prioritization.

Taken together, early retirement of Chinese-financed CFPPs in Pakistan is feasible at portfolio scale, provided it is pursued as a phased and financially engineered process. By combining qualitative readiness assessment with quantitative financial analysis, the study lays the technical and analytical foundation for the political dialogue and bilateral cooperation needed to implement it.

Bahrain, Pakistan. Photo by Ahmed Yanaal via Unsplash.



REFERENCES

- ABB. 2023. "ABB's Synchronous Condensers Go Live in Liverpool to Stabilize the UK's Power Grid." ABB, March 28. <https://new.abb.com/news/detail/101299/abb-synchronous-condensers-go-live-in-liverpool-to-stabilize-the-uks-power-grid>.
- Abbas, Yasir, and Rana Ammar Aslam. 2023. "Potential of Untapped Renewable Energy Resources in Pakistan: Current Status and Future Prospects." *Engineering Proceedings* 56 (1): 108. <https://doi.org/10.3390/ASEC2023-15274>.
- ADB. 2025. "Energy Transition Mechanism (ETM)." Asian Development Bank. Accessed April 6, 2026. <https://www.adb.org/what-we-do/energy-transition-mechanism-etm>.
- Alam, Kazim. 2023. "Chinese IPP Serves Notice of Payment Default on CPPA." Business. DAWN, May 31. <https://www.dawn.com/news/1757015>.
- Babar, Zainab, and Khalid Waleed. 2024. *Transitioning Away from Coal: An Orderly Retirement of Coal Power Plants in Pakistan*. Sustainable Development Policy Institute (SDPI). <https://sdpi.org/assets/lib/uploads/Report%20-%20Transitioning%20away%20from%20coal.pdf>.
- Bhandary, Rishikesh Ram, and Kelly Sims Gallagher. 2022. "What Drives Pakistan's Coal-Fired Power Plant Construction Boom? Understanding the China-Pakistan Economic Corridor's Energy Portfolio." *World Development Perspectives* 25 (March): 100396. <https://doi.org/10.1016/j.wdp.2022.100396>.
- Brautigam, Deborah, and Yinxuan Wang. 2021. "Global Debt Relief Dashboard: Tracking Chinese Debt Relief in the COVID-19 Era." *China Africa Research Initiative (CARI)*, January. <https://www.sais-cari.org/debt-relief>.
- Clark, Alex, Abhinav Jindal, Gireesh Shrimali, Cecilia Springer, and Ryan Rafaty. 2023. *Early Retirement Options for China-Financed Coal Plants in Southeast Asia and Beyond*. GCI Working Paper 030. Boston University Global Development Policy Center. https://www.bu.edu/gdp/files/2023/03/GCI_WP_030_CLARK_FIN.pdf.
- CPEC. 2023. "China-Pakistan Economic Corridor." <https://cpec.gov.pk>.
- Daily Times. 2023. *Thar Block II Generates over 17,000 Jobs for Locals*. October 26. <https://dailytimes.com.pk/1143102/thar-block-ii-generates-over-17000-jobs-for-locals/>.
- Dilawar, Ismail. 2025. "Pakistan Targets January Launch of First-Ever Panda Bond." *Arab News*, December 19. <https://arab.news/v9xkx>.
- Global Energy Monitor. 2025. "Global Coal Plant Tracker." <https://globalenergymonitor.org/projects/global-coal-plant-tracker/>.
- Gold Standard. 2026a. *Joined-Up Sustainable Transition (JUST): Coal Decommissioning*. Geneva: Gold Standard Foundation.
- Gold Standard. 2026b. "First Methodology to Support Just Transition Away from Fossil Fuel Generators Launched." March 24, 2026.
- Government of Pakistan. 2024. "Pakistan Economic Survey 2023-24." https://www.finance.gov.pk/survey_2024.html.
- Hakim, Diego Angel, Selena Key Galeos, and Tyler Matsuo. 2024. "Finding (Re)Purpose: How Planners Can Make Effective Coal Repurposing Decisions." *RMI*, October 21. <https://rmi.org/finding-repurpose-how-planners-can-make-effective-coal-repurposing-decisions/>.
- Hill, Matthew. 2025. "Zambia Signs Deals with Chinese Lender to Revamp Some Loans." *Bloomberg*, October 13. <https://www.bloomberg.com/news/articles/2025-10-13/zambia-signs-deals-with-chinese-lenders-to-revamp-some-loans>.

ICVCM. 2023. "The Core Carbon Principles, Assessment Framework and Assessment Procedure." Integrity Council for the Voluntary Carbon Market, March. <https://icvcm.org/the-core-carbon-principles/>.

International Carbon Action Partnership. 2024. *Emissions Trading Worldwide: Status Report 2024*. <https://icapcarbonaction.com/en/publications/emissions-trading-worldwide-2024-icap-status-report>.

International Carbon Action Partnership. 2025. "China Issues Landmark Guidelines to Transition to Absolute Cap and Expand Scope in National ETS." September 29. <https://icapcarbonaction.com/en/news/china-issues-landmark-guidelines-transition-absolute-cap-and-expand-scope-national-ets>.

Integrity Council for the Voluntary Carbon Market. 2026a. "Integrity Council Announces New Batch of Assessment Decisions." May 11, 2026.

Integrity Council for the Voluntary Carbon Market. 2026b. "New Report Explores Integrity Requirements for Transition Credits." April 7, 2026.

Integrity Council for the Voluntary Carbon Market. 2024. *Core Carbon Principles, Assessment Framework and Assessment Procedure*. London: ICVCM.

Isaad, Haneea, Mustafa Hyder Sayed, Ahtasam Ahmad, and Umar Farooq. 2025. *Repurposing Pakistan's Coal-Based Assets: A Practical Case Study for the Early Retirement of Coal Assets in Pakistan*. Institute for Energy Economics and Financial Analysis. <https://ieefa.org/resources/repurposing-pakistans-coal-based-assets>.

Ministry of Ecology and Environment of China. 2024. *Progress Report of China's National Carbon Market (2024)*. Beijing. <https://www.mee.gov.cn/ywdt/xwfb/202407/W020240722528850763859.pdf>.

Miriri, Duncan. 2025. "Kenya Converts \$3.5 Billion Loans from China into Yuan to Cut Interest." *Africa. Reuters*, October 8. <https://www.reuters.com/world/africa/kenya-converts-railway-loan-china-into-yuan-save-interest-2025-10-07/>.

Nedopil, Christoph, Lawrence Ang, Matt Carpio, and Mengdi Yue. 2024. "Can Investors Benefit from the Early Retirement of Coal Plants: A Plant-Level Analysis of Chinese-Sponsored Coal Stations in Vietnam and Pakistan." *Energy Policy* 193 (October): 114291. <https://doi.org/10.1016/j.enpol.2024.114291>.

NEPRA. 2023. "State of Industry Report 2023." <https://nepra.org.pk/publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202023.pdf>.

NEPRA. 2024. "State of Industry Report 2024." <https://www.nepa.org.pk/publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202024.pdf>.

NEPRA. 2025. "State of Industry Report 2025." <https://nepra.org.pk/publications/State%20of%20Industry%20Reports/State%20of%20Industry%20Report%202025.pdf>.

Öko-Institut. 2025. *Assessment of VCS Methodology VM0052 on Accelerated Retirement of Coal-Fired Power Plants Using a Just Transition and Its Associated Modules VMD0060 and VMD0061*. Berlin: Öko-Institut.

Patel, Anika, and Simon Evans. 2025. "Q&A: What Does China's New Paris Agreement Pledge Mean for Climate Action?" *Carbon Brief*, September 25. <https://www.carbonbrief.org/qa-what-does-chinas-new-paris-agreement-pledge-mean-for-climate-action/>.

Ramay, Shakeel Ahmad. 2024. "Debunking Misconceptions about CPEC Energy Projects." *Express Tribune*, August 26. <https://tribune.com.pk/story/2491022/debunking-misconceptions-about-cpec-energy-projects>.

Schneider, Lambert, and Stephanie La Hoz Theuer. 2019. "Environmental Integrity of International Carbon Market Mechanisms under the Paris Agreement." *Climate Policy* 19 (3): 386–400. <https://doi.org/10.1080/14693062.2018.1521332>.

Song, Ziyi, Christoph Nedopil, Haneea Isaad, and Muhammad Basit Ghauri. 2023. *Sunrise and Sunset – Accelerating Coal Phase down and Green Energy Deployment in Pakistan: An Analysis of the Political Economy*.

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Green Finance and Development Center & IEEFA. https://greenfdc.org/wp-content/uploads/2023/08/Song-et-al-2023_Pakistan-Sunrise-Sunset-Renewables-Coal-retirement.pdf.

State Bank of Pakistan. 2022. Annual Report 2021-22: *The State of Pakistan's Economy*. Karachi. <https://www.sbp.org.pk/reports/annual/aarFY22/Anul-index-eng-22.htm>.

The Express Tribune. 2025. "Govt Clears Rs100b Chinese Debt before PM's Visit." The Express Tribune, August 26. <https://tribune.com.pk/story/2563260/govt-clears-rs100b-chinese-debt-before-pms-visit>.

Uniper. 2023. "Custom Built Synchronous Condenser Units Now in Operation at Uniper's Grain Power Station Site Helping to Deliver a Low Carbon Electricity System." UNIPER, April 6. <https://www.uniper.energy/united-kingdom/news/custom-built-synchronous-condenser-units-now-in-operation-at-unipers-grain-power-station-site-helping-to-deliver-a-low-carbon-electricity-system/>.

Verra. 2026a. "Consultation on Revision to Coal Plant Retirement Methodology." March 27, 2026.

Verra. 2026b. "Verra Secures ICVCM Approval for Renewable Energy and Mine Methane Methodologies." May 10, 2026.

Verra. 2025. VM0052: Accelerated Retirement of Coal-Fired Power Plants Using a Just Transition, v1.0. Washington, DC: Verra.

Waleed, Khalid, and Zainab Babar. 2025. *Coal to Clean Credit Initiative: A Case for Early Retirement of Coal Power Plant Using the VM0052 Methodology and Estimation of the Carbon Credit Revenue*. Sustainable Development Policy Institute. https://sdpi.org/assets/lib/uploads/Report%20-%20Coal%20to%20Clean%20Credit%20Initiative_compressed.pdf.

Xinhua. 2023. "Coal Power Plant under CPEC Boosts Socio-Economic Development in Pakistan." XinhuaNet, April 2. <https://english.news.cn/20230402/09e576643bf24475a6d782892802785e/c.html>.

ANNEX 1: SCENARIO ANALYSIS FOR SAHIWAL COAL POWER PLANT

Sahiwal Coal Power Plant			Capacity payment	Loan payment (P + I)	NPV			Year 10 (20 years early)		Year 15 (15 years early)		Year 20 (10 years early)	
					Debt	Total	Equity	Cash buyout (\$ million)	Carbon price (\$/tCO2)	Cash buyout (\$ million)	Carbon price (\$/tCO2)	Cash buyout (\$ million)	Carbon price (\$/tCO2)
			2026		End of 2025			2026		2031		2036	
S1: Missed debt repayment for 2023-2025 are not resolved	S1.1: Optimistic Utilization Projection	S1.1.1: Base case with no refinance (new principal; interest rate and tenor unchanged)	413	264	704	1,090	386	825	24	310	9	257	10
		S1.1.2: Refinance at original interest rate (tenor +3 years)	286	143	706	1,116	411	954	28	314	10	261	10
		S1.1.3: Refinance at 3% (tenor unchanged)	400	251	672	1,056	385	802	23	310	9	257	10
		S1.1.4: Refinance at 3% (tenor +3 years)	273	131	646	1,053	408	902	26	314	9	260	10
		S1.1.5: Refinance at 3% (tenor + 10 years)	205	67	593	1,040	447	923	27	699	21	390	15
		S1.1.6: Issue 5-year panda bonds	156	22*	628	1,057	429	999	29	318	10	264	10
		S1.1.7: Issue 10-year panda bonds	156	22*	560	1,036	476	944	27	978	30	272	11
	S1.2: IGCEP Utilization Projection	S1.2.1: Base case with no refinance (new principal; interest rate and tenor unchanged)	413	264	704	1,117	412	833	51	318	32	263	33
		S1.2.2: Refinance at original interest rate (tenor +3 years)	286	143	706	1,143	437	962	58	322	33	267	33
		S1.2.3: Refinance at 3% (tenor unchanged)	400	251	672	1,083	411	811	49	317	32	263	33
		S1.2.4: Refinance at 3% (tenor +3 years)	273	131	646	1,080	434	910	55	321	33	267	33
		S1.2.5: Refinance at 3% (tenor + 10 years)	205	67	593	1,067	474	931	56	707	73	396	50
		S1.2.6: Issue 5-year panda bonds	156	22*	628	1,083	456	1,007	61	325	34	270	34
		S1.2.7: Issue 10-year panda bonds	156	22*	560	1,063	503	952	57	985	102	278	35
S2: Missing debt repayment for 2023-2025 are resolved	S2.1: Optimistic Utilization Projection	S2.1.1: Base case with no refinance (interest rate and tenor unchanged)	303	160	428	871	444	649	18	323	9	268	10
		S2.1.2: Refinance at original interest rate (tenor +3 years)	242	87	428	887	459	727	20	326	10	270	10
		S2.1.3: Refinance at 3% (tenor unchanged)	296	153	408	851	443	635	18	323	9	268	10
		S2.1.4: Refinance at 3% (tenor +3 years)	218	80	392	849	457	695	19	325	10	270	10
		S2.1.5: Refinance at 3% (tenor + 10 years)	177	41	360	841	481	708	20	559	16	349	13
		S2.1.6: Issue 5-year panda bonds	147	13**	381	851	470	755	21	328	10	272	10
		S2.1.7: Issue 10-year panda bonds	147	13**	340	838	498	721	20	729	22	277	10
	S2.2: IGCEP Utilization Projection	S2.2.1: Base case with no refinance (interest rate and tenor unchanged)	303	160	428	897	470	657	39	330	33	274	33
		S2.2.2: Refinance at original interest rate (tenor +3 years)	226	87	428	913	485	735	43	333	33	276	34
		S2.2.3: Refinance at 3% (tenor unchanged)	296	153	408	877	469	643	38	330	33	274	33
		S2.2.4: Refinance at 3% (tenor +3 years)	218	80	392	875	483	703	42	333	33	276	34
		S2.2.5: Refinance at 3% (tenor + 10 years)	177	41	360	867	507	716	42	567	56	355	44
		S2.2.6: Issue 5-year panda bonds	147	13**	381	877	496	762	45	335	33	278	34
		S2.2.7: Issue 10-year panda bonds	147	13**	340	865	525	728	43	736	73	283	35

Source: Authors calculation.

Notes: * Bullet payment of \$740 million at maturity (converted from RMB to \$ using projected forex rate)

** Bullet payment of \$449 million at maturity (converted from RMB to \$ using projected forex rate)

ANNEX 2: COAL RETIREMENT AND REPURPOSING OPTIONS: KEY ISSUES AND CONSIDERATIONS

Option	Technical change	Example services after repurposing	Illustrative emissions impact (15-yr horizon, per 1,320 MW)	Illustrative coal capacity-payment savings vs BAU (15-yr horizon, per 1,320 MW)	Key requirements / issues	Pakistan-specific priority
A. Early retirement (cold shutdown + de-commissioning)	Shut coal units; dismantle or mothball; site reused later	None in short term (grid connection can be reused later)	Imported: avoid ~62 MtCO ₂ ; Thar: avoid ~76 MtCO ₂	Imported: avoid ~PKR 880 bn; Thar: avoid ~PKR 1,280 bn in coal CPP (before financing compensation)	Needs lump-sum compensation & debt reprofiling (ETM/CCCI-type facility); labor & just-transition support	High for Sahiwal, Port Qasim, Hub; medium for Thar plants (phase-out later)
B. Early retirement + synchronous condenser (SynCon)	Stop coal firing; convert turbine-generator to SynCon providing inertia, reactive power & fault level	Grid stability, voltage support, higher RE penetration	Same as Option A (no coal generation): ~62-76 MtCO ₂ avoided	Coal CPP can be cut by 70-90%; small residual payment for grid-service contract. For Sahiwal-type plant, IEEFA suggests SynCon CAPEX <\$100m vs ~\$5bn CPP to 2046 (i.e. very large net savings). IEEFA	Requires new ancillary-services tariff and contract structure; moderate CAPEX and outage time for conversion	Very high near major load centers: Sahiwal, Port Qasim, Hub
C. Early retirement + solar-plus-BESS repowering	Replace boilers/turbines with utility-scale PV & batteries; retain switchyard and transmission	Clean energy, firm capacity with storage, reduced fuel imports	Coal emissions avoided as in A/B; new solar/BESS has near-zero operational CO ₂	Coal CPP avoided equal to Option A; part of this replaced by fixed charges for renewables. Net CPP savings likely 40-60% vs coal, depending on financing	Needs land layout, solar resource, concessional climate finance, and Article-6/green crediting structures	High at sites with good solar & land: Hub, Sahiwal, Thar sites
D. Early retirement + BESS-only site	Shut coal units; add grid-scale batteries using existing substation	Frequency response, peak shaving, RE firming	Same coal-side emissions reduction as A/B	Coal CPP avoided as in A; some portion replaced by BESS capacity/ancillary payments	Needs ancillary-services market and storage tariff; battery import costs in FX	Medium-high around Karachi & Lahore load pockets
E. Partial measures (biomass co-firing, efficiency upgrades)	Co-fire 5-20% biomass; minor retrofits to improve heat rate	Slightly lower CO ₂ per MWh	Emissions cut typically <10-15%; no change in over-capacity	CPP essentially unchanged; only fuel cost & emissions reduced	Needs biomass supply chain; limited scale in Pakistan	Low priority vs large-impact options above

Source: Asian Development Bank. 2023. Energy Transition Mechanism: Policy and Technical Pathways for Coal Asset Transformation. Manila: Asian Development Bank; Gibbins, Jon, and Hannah Chalmers. 2020. "Repurposing Coal Power Stations as Synchronous Condensers." Energy Policy 144: 111-125; Global Energy Monitor. 2023. Global Coal Plant Tracker. San Francisco: Global Energy Monitor; Institute for Energy Economics and Financial Analysis. 2024. Pakistan's Coal Power Outlook and Transition Pathways. Cleveland, OH: Institute for Energy Economics and Financial Analysis; Rocky Mountain Institute. 2022. Coal Asset Transformation: Global Repurposing Strategies. Boulder, CO: Rocky Mountain Institute. IEEFA, Haneesa Isaad and Mustafa Hyder Sayed and Ahtasam Ahmad and Umar Farooq, "Repurposing Pakistan's coal-based assets", Institute for Energy Economics and Financial Analysis, 2025

Notes: BAU = business as usual; BESS = battery energy storage system; CAPEX = Capital Expenditure; CCCI = Coal to Clean Credits Initiative; CPP = capacity payment; ETM = Energy Transition Mechanism; FX = foreign exchange; IEEFA = Institute for Energy Economics and Financial Analysis; PKR = Pakistan Rupee; PV = photovoltaic; RE = renewable energy; SynCon = synchronous condenser

ANNEX 3: JUST TRANSITION COSTS BY COAL PLANT

Methodology for Estimating Jobs and Just Transition (JT) Costs

The job estimates are derived by triangulating reported plant-level employment figures (direct and local hires) with project disclosures and secondary sources, including China-Pakistan Economic Corridor (CPEC) project profiles, company announcements, and news reporting. For Thar-based mine-mouth projects, employment estimates also incorporate mine-linked jobs using ecosystem multipliers (mine + plant + local services), cross-checked against regional development reporting and corporate social responsibility (CSR) disclosures. Where only construction employment was available, conservative scaling factors were applied to approximate steady-state operational jobs, ensuring consistency across plants.

JT cost estimates are built bottom-up across four categories—worker support, CSR continuation, mine rehabilitation, and livelihood diversification—using unit cost assumptions grounded in international benchmarks and Pakistan-specific evidence. Worker-related costs (income protection and retraining) apply per-worker estimates informed by global just transition studies scaled to reported employment levels. CSR continuation costs are based on observed annual spending levels in Thar and other regions (e.g., education, health, water), projected over 10–12 years using project disclosures and media reporting. Mine closure and land rehabilitation costs are applied only to mine-mouth plants, using per-hectare benchmarks consistent with international practice and adapted to Thar site conditions. Livelihood diversification costs reflect district-level program envelopes (e.g., SME grants, women-focused employment, agriculture support), calibrated to local economic vulnerability and informed by development partner experience.

Example: Sahiwal Coal Power Plant (Punjab)

The methodology combines verified employment data, local wage proxies, and standardized just transition (JT) cost modules. Reported employment of 1,683 workers (including 1,033 local) provides the baseline, based on official project disclosures from the China-Pakistan Economic Corridor and corroborated by independent reporting (“During the operational phase, the plant employs 1,683 people”) (Government of Pakistan 2023; IEEFA 2025).

Worker transition costs (income support and reskilling) are estimated using per-worker cost benchmarks calibrated to local wages and informed by guidance from the United Nations Framework Convention on Climate Change on just transition planning, typically assuming 1–3 years of income support combined with retraining (UNFCCC 2022). Applied to Sahiwal, this yields an estimated range of \$55–95 million. CSR continuation costs are derived from observed project-level social investments (e.g., education, health, and training programs) reported in project and media sources (Arab News 2022), and projected over a 10–12 year transition horizon, resulting in \$35–55 million. Livelihood diversification costs—reflecting SME linkages and local economic dependence—are informed by regional development studies and energy sector analyses (IEEFA 2025) and are estimated at \$40–80 million.

As an imported-coal plant, Sahiwal does not incur mine closure costs, unlike Thar-based mine-mouth projects where land rehabilitation is a major component. Combining all components, the total JT cost is estimated at \$130–230 million, with ranges applied to reflect uncertainty and ensure transparency.

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Plant	Reported Employment	Key Community Dependence	Main Cost Categories	Workers (Income protection, retraining)	CSR Continuation (schools, clinics, water, training)	Mine Closure & Land Rehabilitation	Livelihood Diversification (women, SMEs, agriculture)	Total JT Cost Range
Sahiwal	1,683 jobs (including 1,033 local jobs)	Local SMEs; technical staff	Worker reskilling; income bridging; SME grants; CSR-service continuity	55-95	35-55	(no mine-mouth operations)	40-80	130-230
Port Qasim	~1,000 operations	Port/rail-linked livelihood chain	Retraining; supplier transition; port/logistics retraining; community services	45-80	30-50	—	40-70	130-230
China Hub	~1,700 jobs	Education/health CSR programs	Community welfare funding; job redeployment; regional infrastructure support	55-95	35-55	—	40-80	130-230
Engro Powergen	~2,500 jobs (1,800 local)	Mine-plant ecosystem	Mine-closure planning; alternate livelihoods; CSR funding	75-120	40-70	40-80	45-80	200-350
Thar Energy Limited	~800 construction jobs	Local SME dependence	Retraining; small enterprise support; remote-region job creation	35-60	20-35	15-30	30-50	100-175
ThalNova	~300 construction jobs	Remote region employment	Wage-bridging; remote-region service support; diversification funding	35-60	20-35	15-30	30-50	100-175
Thar Block 1	18,000+ direct employment opportunities	Extensive CSR network (schools, clinics, water)	Multi-year CSR service funding; large-scale job redeployment; land-rehab; women-targeted programs	150-250	100-150	60-120	90-180	400-700
TOTAL	—	—	—	450-760	280-450	130-260	315-590	1,175-2,060 (≈ \$1.2-2.1 billion)

Source: Arab News. 2022.. China-Pakistan Economic Corridor. 2023; Institute for Energy Economics and Financial Analysis. 2025; United Nations Framework Convention on Climate Change 2022.

CSR = Corporate Social Responsibility; JT = Just Transition; SME = Small-and-Medium-Sized Enterprise

Note on assumptions: Workers: Based on Pakistan-appropriate per-worker job total costs, scaled by plant size and workforce estimates ; CSR continuation: 10-12 years of sustaining existing CSR-funded public-goods at \$10-25m per year per region in Thar; lower in Punjab and Hub/Karachi; Mine closure & land rehabilitation: Only applicable to Thar Block I and II; estimated at \$10,000-20,000 per hectare for 2,500-3,500 ha disturbed land; Livelihood diversification: SME grants, women's employment programs, agriculture & grazing restoration, and local enterprise development at \$50-100m per district depending on economic vulnerability.

ANNEX 4: SELECTED FINANCING, MARKET AND INSTITUTIONAL MECHANISMS FOR COAL FIRED POWER PLANT EARLY RETIREMENT

Mechanism	Description	Financing Sources	Status of Implementation
Concessional and Blended Refinancing Tools			
Bilateral and Multilateral Policy-Based Loans for Coal Phaseout	Governments can access policy-based loans from MDBs to finance early coal retirement and energy transition reforms. These loans provide budget support linked to decommissioning, renewable investment, and just transition measures.	Concessional and regular loans from ADB, World Bank, and AIIB, disbursed upon completing policy actions such as regulatory reforms and creation of transition funds.	Several MDB policy loans have addressed energy sector reforms, but these efforts have been fragmented; more focused program targeting coal phaseout could be developed.
Just Energy Transition Partnership (JETP)	Multilateral funding agreements between donor countries and EMDE governments to accelerate coal phaseout, linked to national decommissioning commitments.	Blended finance combining concessional public funds and commercial investment to retire coal assets and expand renewables.	Implemented in South Africa, Indonesia, Vietnam, and Senegal.
Energy Transition Accelerator Financing Platform (ETAF)	A global platform launched by IRENA at COP26 to accelerate renewable energy and just transitions in developing countries by mobilizing concessional and market-based finance.	Blended finance from sovereign donors, MDBs, and private investors. Anchor funding of \$1 billion from ADFD, with partners including AIIB, IDB Invest, and the OPEC Fund. Target: \$10 billion by 2030.	Operational: 25+ projects approved in 20+ countries, supporting renewables and grid upgrades across Africa, Latin America, and Asia, with continued expansion.
ADB Energy Transition Mechanism (ETM)	It uses blended finance to refinance or acquire coal plants for early retirement, generating savings from lower financing costs and avoided emissions. These savings are reinvested in renewable energy and just transition initiatives to support Asia's decarbonization goals.	Blended finance through ETM Trust Fund: concessional and commercial financing covering difference between full-lifespan value and early-retirement value of coal plants.	Planning: Manila (Philippines), Cirebon 1 (Indonesia), Vietnam.
Performance and risk-based refinancing mechanisms			
IDB Compensation scheme (asset level financing)	Aims to accelerate retirement timeline of specific coal assets by reimbursing the owner's lost profitability through monetization of emissions displacement. Lump-sum payout replaces future coal revenues, incentivizing early closure.	Blended finance: concessional debt/equity from public sources to compensate emissions reduction; commercial financing for replacement renewables (public/private debt or equity).	Implemented: IDB Invest / Engie decarbonization instrument in Tocopilla, Chile.
Carbon-for-Climate Swaps	A debt conversion mechanism that exchanges part of a country's sovereign debt for commitments to finance climate actions such as coal retirement and renewable energy, easing debt burdens and creating fiscal space.	Blended finance combining debt relief from creditors, MDB guarantees, and concessional funds, with potential integration of carbon credits to attract private investors.	Emerging: Applied in Belize and Ecuador for conservation; being explored for energy transition and coal phaseout.
State-Contingent Debt Instruments (SCDIs)	SCDIs enhance debt sustainability by linking debt service to real-world variables such as GDP and commodity prices. Their countercyclical structure automatically adjusts payments based on fiscal capacity, reducing the risk of default and easing repayment burden during downturns.	Primarily raised from global capital markets, with MDBs and bilateral partners providing credit enhancement, guarantees, or technical support to attract investors and ensure market credibility.	SCDIs such as GDP-, commodity-, and revenue-linked bonds have been applied across several countries, showing how tying debt service to real variables enhances fiscal flexibility.
Green, Sustainability, and Sustainability-Linked Bonds (GSS+ Bonds)	GSS+ bonds mobilize capital for clean energy and coal phaseout projects, with SLBs linking interest rates to targets such as early coal retirement or renewable capacity growth.	Issued by governments or firms in global markets, with MDBs and bilateral partners offering guarantees or anchor investments.	Over \$4 trillion issued globally; adopted by Indonesia, Chile, and China. Pakistan could use GSS+ bonds to refinance coal assets and fund renewable transition.

Mechanism	Description	Financing Sources	Status of Implementation
Issuance of Panda Bonds for Coal Transition Refinancing	RMB-denominated bonds issued by foreign entities in China's domestic market to refinance coal-related debt or fund clean energy projects at lower cost while hedging currency risks and leveraging trade ties with China.	Raised in Chinese onshore markets with participation from domestic investors and policy banks; MDBs such as ADB and AIIB can offer credit enhancement or co-financing.	Emerging: Issued by countries like the Philippines, Egypt, and Hungary; BRI members such as Pakistan could use Panda bonds to refinance high-cost debt and support energy transition.

Carbon Credit and Carbon Market

Coal to Clean Credit Initiative (CCCI)	Developed by the Rockefeller Foundation and partners, CCCI converts emissions reductions from early coal retirements into high-integrity carbon credits to finance clean energy and just transition efforts.	Blended finance combining concessional, philanthropic, and private capital, with carbon credit revenues reinvested in clean energy.	Pilot phase: Projects underway in Indonesia, the Philippines, and Pakistan, with plans to expand across Asia and Africa.
Paris Agreement Article 6 Bilateral Carbon Credit Program	A bilateral mechanism under Article 6 that allows countries to trade carbon credits to meet emission targets through authorized international mitigation outcomes (ITMOs), ensuring no double counting and directing revenues to verified mitigation and community projects.	Public and private financing through bilateral agreements, with revenues from credit purchases funding renewable and climate projects in host countries.	Implemented: Dozens agreements signed since 2023, including by Singapore with multiple partner countries.
Regional Carbon Market Cooperation and China Certified Emission Reduction (CCER) Linkage	China's CCER program can support regional carbon market cooperation by enabling cross-border crediting and investment in low-carbon projects, including linking China's Voluntary Carbon Market with verified carbon credit from Pakistan.	Driven by private and bilateral investments through voluntary carbon markets, supported by Chinese regulators and MDBs; CCER revenues can fund renewable and just transition projects.	Emerging: CCER relaunched in 2023 with stricter standards; cooperation under Green BRI and South-South frameworks is exploring regional linkages in Asia.
Long-Term Forward Carbon Credits	A long-term (10–20 year) offtake structure where buyers commit today to purchase future verified carbon credits generated from the early retirement of Pakistan's coal plants. Staged or upfront prepayments provide cash flow to offset foregone capacity charges and fund clean-energy replacement. Credits would be issued annually under a VCS/Verra-aligned coal-to-clean transition methodology, quantifying avoided emissions from accelerated closure and renewable repowering.	Corporate net-zero buyers (airlines, tech, industrials); same sovereign or sub-sovereign buyers under Article 6.2	

Third Party Engagement

Asset Management Company (AMC) Mechanism for Coal-Fired Power Plant Early Retirement	AMCs acquire and manage distressed coal assets, restructuring loans and PPAs to execute early retirement and site repurposing plans. They apply expertise from handling non-performing assets to facilitate market-driven, financially viable coal transition strategies.	Blended finance combining concessional MDB funding with commercial and private capital through debt-to-equity and climate-debt swaps. MDBs provide technical assistance, co-financing, and governance support.	Implemented in pilot cases such as ARCIL (India), Cerberus (Germany), Brookfield (Australia), and private asset managers like Starwood and Atlas in the U.S.; ADB's International Public AMC Forum is advancing regional replication across Asia.
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Source: Authors' compilation.

Notes: ADB = Asian Development Bank; ADFD = Abu Dhabi Fund for Development; AIIB = Asian Infrastructure Investment Bank; BRI = Belt and Road Initiative; CCCI = Coal to Clean Credit Initiative; COP26 = Conference of the Parties – The UN Climate Change Conference in Glasgow; EMDE = Emerging Markets and Developing Economies; ETAF = Energy Transition Accelerator Financing Platform; GSS+ = Green, Sustainability, and Sustainability-Linked Bond; IDB = Inter-American Development Bank; IRENA = International Renewable Energy Agency; ITMO = International Mitigation Outcome; JETP = Just Energy Transition Partnership; MDB = Multilateral Development Bank; OPEC = Organization of the Petroleum Exporting Countries; SLB = Sustainability-Linked Bond; VCM = voluntary carbon market; VCS = Verified Carbon Standard.

ANNEX 5: CARBON-CREDITING PATHWAYS AND INTEGRITY SAFEGUARDS FOR CFPP EARLY RETIREMENT IN PAKISTAN

Purpose and Framing. Carbon-crediting instruments could potentially support the early retirement of coal-fired power plants (CFPPs) in Pakistan, but they should be treated as evolving and conditional instruments rather than mature or guaranteed sources of finance, particularly because credibility of carbon credits depends on additionality, leakage control, robust quantification, no double counting, and alignment with emerging high-integrity standards (Integrity Council for the Voluntary Carbon Market 2024).

The key policy question is therefore not whether carbon credits should be accepted or rejected in principle, but how Pakistan could shape a pathway that progressively strengthens environmental integrity, market credibility, and practical feasibility. This would require careful sequencing: debt and contractual restructuring first; development of national coal-retirement planning and measurement, reporting, and verification (MRV) systems next; and only thereafter any credit issuance based on verified emissions reductions.

Main Carbon-Crediting Schemes Relevant to CFPP Early Retirement. Table X.1 summarizes the principal carbon-crediting pathways currently relevant to discussions on CFPP early retirement in Pakistan. The table illustrates that while several mechanisms are emerging internationally, none can yet be considered fully mature or risk-free instruments for large-scale transition financing. Each pathway presents a different balance between innovation potential, institutional readiness, integrity concerns, and market credibility.

Two methodologies currently anchor the emerging transition-credit space. The first is Verra's VM0052, *Accelerated Retirement of Coal-Fired Power Plants Using a Just Transition*, released in May 2025 (Verra 2025). Verra states that VM0052 must be used together with just-transition requirements to address impacts on workers, households, contractors, and communities. The second is Gold Standard's JUST: Coal Decommissioning methodology, published in March 2026, which supports paired early closure of coal plants and installation of renewable energy in a way that maintains energy access and supports a fair transition (Gold Standard 2026a). However, both methodologies remain at relatively early stages of development and have not yet secured CCP approval from the Integrity Council for the Voluntary Carbon Market (ICVCM) (Integrity Council for the Voluntary Carbon Market 2024). As a result, their future market acceptance, pricing potential, and integrity standing remain uncertain.

Both methodologies share a similar core premise: early coal retirement should be paired with renewable replacement capacity, broadly reflecting a 1:1 MWh coal-to-renewables substitution logic. This design helps address the risk that emissions reductions are merely displaced elsewhere in the power system. However, neither VM0052 nor Gold Standard JUST: Coal Decommissioning has yet received Integrity Council for the Voluntary Carbon Market (ICVCM) Core Carbon Principles (CCP) approval. This matters because ICVCM's CCP label is increasingly becoming a market benchmark for credit quality and could materially affect price, buyer confidence, and reputational acceptability.

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The May 2026 conditional ICVCM approvals of Verra’s VMR0017¹⁵ and ACM0008¹⁶ provide an important procedural benchmark. ICVCM conditionally approved VMR0017 and ACM0008, while requiring updated tools and methodological safeguards (Integrity Council for the Voluntary Carbon Market 2026a; Verra 2026b). This suggests that VM0052 would also need to pass a similar independent assessment process before coal-retirement credits could plausibly command a high-integrity premium (Öko-Institut 2025).

The table also highlights that China Certified Emission Reduction or CCER-like arrangements may become increasingly important given China’s major involvement in Pakistan’s power sector. Nevertheless, substantial uncertainties remain regarding methodology development, cross-border applicability, and compatibility with evolving international integrity standards. In this regard, the paper treats CCER primarily as a potential future cooperation platform rather than an immediately operational mechanism for coal retirement.

Similarly, while Article 6.2 arrangements under the Paris Agreement could eventually facilitate sovereign-backed transition cooperation, the table emphasizes that such arrangements should not be viewed as automatic solutions to integrity concerns. Transparency, monitoring, corresponding adjustments, and methodology approval remain significant challenges. Accordingly, Article 6.2 is discussed more as a complementary enabling framework than as a standalone financing mechanism.

Overall, the table reinforces the paper’s broader argument that Pakistan should approach transition-credit mechanisms cautiously and incrementally. Pilot activities, methodology development, institutional strengthening, and integrity safeguards are likely to be more important in the near term than immediate large-scale credit issuance.

¹⁵ VMR0017 is Verra’s revised methodology and additionality framework for grid-connected renewable electricity projects under the Verified Carbon Standard (VCS) Program. It received conditional CCP approval from the Integrity Council for the Voluntary Carbon Market (VCM) in May 2026 and serves as a procedural benchmark for how methodologies such as VM0052 may eventually seek CCP recognition.

¹⁶ ACM0008 is a methane-abatement methodology under the VCS Program covering methane capture and destruction from coal mining activities. It received conditional CCP approval from the Integrity Council for the VCM in May 2026, subject to application of updated baseline and additionality requirements.

Table 5.1. Comparative Overview of Relevant Carbon-Crediting Pathways

Scheme	Potential relevance to Pakistan CFPP retirement	Potential strength	Main constraint	Practical implication
Verra VM0052	Dedicated methodology for early CFPP retirement with just-transition requirements	First structured coal-retirement crediting framework	Not yet ICVCM CCP-approved; additionality and baseline risks remain	Pakistan/CCCI should encourage formal ICVCM assessment
Gold Standard JUST: Coal Decommissioning	Supports paired coal closure and renewable replacement with just-transition framing	Strong safeguards and social-transition orientation	New and untested; no CCP approval yet	Useful comparator and possible alternative methodology
CCER / CCER-like scheme	Could be explored through Pakistan-China cooperation given Chinese role in Pakistan's power sector	Potential bilateral relevance and buyer alignment	No clear early retirement category; international recognition uncertain	Pakistan and China could jointly develop methodology, MRV, and registry arrangements
Article 6.2	Could support sovereign bilateral cooperation and corresponding adjustments	Provides official Paris Agreement framework	Transparency, monitoring, and methodology risks remain	Should not be used to cross-finance coal retirement from unrelated credits
Voluntary market transition credits	Could mobilize private or blended transition finance	May attract climate-finance interest if integrity is strong	Market demand and price remain uncertain	Should be piloted cautiously, not assumed as core financing

Source: Authors compilation.

Integrity Risks and Required Safeguards. The transition-credit mechanisms discussed above remain subject to integrity, market, and implementation risks. As summarized in Table X.2, these risks do not necessarily invalidate the potential use of carbon-credit instruments for CFPP early retirement, but they do imply that any future transaction would require robust safeguards, conservative assumptions, and careful sequencing.

Additionality remains the central integrity test. Pakistan's CFPPs operate under take-or-pay PPAs with sovereign-backed capacity payments, meaning that the financial counterfactual must be rigorously specified. If early retirement is perceived as being driven primarily by fiscal stress, circular-debt arrears, low utilization rates, or fuel-market pressures, carbon revenues may not be considered decisive, and the additionality claim could fail (Integrity Council for the Voluntary Carbon Market 2024). Conservative PPA-based counterfactuals, independent financial viability tests, and transparent disclosure of assumptions would therefore be essential safeguards against weak additionality and inflated baseline risks.

The paper also cautions against cross-subsidization or "cross-financed coal retirement" structures. Using revenues generated from unrelated afforestation, renewable-energy, or industrial decarbonization credits to finance coal-plant buyouts could weaken the additionality chain at both ends. The original project may no longer demonstrate that carbon revenues were necessary, while the coal-retirement activity itself would rely on emissions reductions already accounted for elsewhere. Such arrangements could create double-counting and greenwashing concerns (Integrity Council for

the Voluntary Carbon Market 2024) and should therefore be excluded ex ante unless supported by a highly robust accounting framework.

Similarly, Article 6.2 should not be treated as an automatic workaround for these integrity challenges. While Article 6.2 may eventually support sovereign-backed transition cooperation and corresponding-adjustment-eligible transactions, it does not by itself resolve questions relating to additionality, transparency, monitoring, or methodology approval. Any future use of Article 6.2 should therefore remain limited to clearly authorized transactions operating under transparent registries, robust MRV systems, and internationally credible methodologies (Integrity Council for the Voluntary Carbon Market 2024).

Pakistan also faces a specific “false-solution” risk associated with intra-fleet leakage. Retiring imported-coal plants such as Sahiwal in isolation may not reduce national power-sector emissions if generation shifts toward lower-efficiency Thar lignite plants. This is precisely the type of lock-in and leakage risk that the Integrity Council for the Voluntary Carbon Market integrity framework is intended to detect (Integrity Council for the Voluntary Carbon Market 2024). A broader National Coal Retirement Plan anchored in the IGCEP, incorporating plant-by-plant retirement trajectories, renewable replacement planning, and dispatch safeguards, would therefore be necessary to mitigate this risk.

Finally, the long-term market demand for transition credits remains uncertain. Even if methodologies eventually secure CCP alignment, market acceptance, pricing, and liquidity may take time to develop. For this reason, pilot-scale implementation, gradual scaling, and integration with broader blended-finance and just-transition mechanisms may be more realistic near-term approaches than immediate reliance on large-scale carbon-credit revenues (Gold Standard 2026b).

Table 5.2. Key Risks and Mitigation Pathways

Risk	Why it matters	Proposed safeguard
Weak additionality	Credits may be issued for retirements that would have happened anyway	Use conservative PPA-based counterfactuals and independent financial viability tests
Inflated baselines	Over-crediting could undermine market confidence	Link assumptions to IGCEP projections and verified historical dispatch data
Intra-fleet leakage	Imported coal retirement could shift dispatch to Thar lignite	Adopt a National Coal Retirement Plan with dispatch safeguards
Double counting	Same emissions reduction could be claimed by multiple parties	Use transparent registries and corresponding adjustments where applicable
Cross-subsidization	Credits from unrelated projects may not validly finance coal buyouts	Exclude cross-financed structures ex ante
Weak market demand	Credits may not command sufficient price or buyer confidence	Pilot gradually and seek CCP alignment before scaling
Social-transition risk	Early retirement may harm workers and communities	Require just-transition planning and revenue recycling for clean energy and affected communities

Source: Authors compilation.

Role of CCER and Pakistan-China Cooperation, CCER or CCER-like mechanisms deserve separate treatment because China is deeply involved in Pakistan's coal-power portfolio and may be a natural partner in any bilateral transition-finance structure. At present, however, CCER does not appear to have a clearly established early coal-retirement methodology, and CCER credits are not currently recognized wholesale as ICVCM-approved high-integrity credits (Integrity Council for the Voluntary Carbon Market 2024). This creates uncertainty over eligibility, pricing, buyers, cross-border use, and compatibility with Article 6.2.

The constructive way forward is not to assume that CCER can immediately finance coal retirement, but to frame CCER cooperation as a potential joint-development pathway. Pakistan and China could explore the development of CCER or CCER-like methodologies for coal transition, including MRV systems, registry interoperability, emissions-accounting rules, renewable replacement requirements, and just-transition safeguards. This would turn the current uncertainty into a practical cooperation agenda.

The suggested 1-3 year timeframe should therefore be understood as an enabling and pilot phase, not a credit-issuance period. During this phase, Pakistan and China could build institutions, clarify rules, test MRV systems, and explore pilot transactions. Actual issuance of credits would only occur later, after verified emissions reductions from plant retirement have materialized.

Recommendations and Preconditions for an Integrity-Based Transition Framework. Pakistan should adopt an integrity-first approach toward any future CFPP transition-credit transaction. A National Coal Retirement Plan should precede any project-level transaction and be anchored in the IGCEP, with clearly defined plant-by-plant retirement trajectories, verified renewable replacement requirements, dispatch safeguards, and consistency with Pakistan's NDC and any future Article 6 authorization framework. Without such a system-level framework, isolated transactions may be technically valid at the project boundary but counterproductive at the national emissions boundary (Integrity Council for the Voluntary Carbon Market 2026b).

At the same time, Pakistan, together with CCCI and relevant partners, should formally encourage Verra to submit VM0052 for Integrity Council for the Voluntary Carbon Market CCP assessment, following the procedural pathway already taken by VMR0017 and ACM0008 (Integrity Council for the Voluntary Carbon Market 2026a; Verra 2026b). Without CCP recognition, credibility, market acceptance, and pricing potential of transition credits are likely to remain structurally constrained (Integrity Council for the Voluntary Carbon Market 2024).

Pakistan should also proactively engage with China, and potentially other interested partner countries, to explore the development of China Certified Emission Reduction or CCER-like cooperation frameworks, including joint methodology development, MRV systems, registry interoperability, and pilot cross-border transition-credit arrangements. Similarly, Pakistan should continue exploring carefully structured Article 6.2 cooperation opportunities as part of a broader transition architecture emphasizing transparency, robust MRV systems, corresponding adjustments, additionality, leakage prevention, and environmental integrity. Gold Standard methodologies and other emerging integrity-aligned approaches should also remain under review as international standards and market practices continue to evolve.

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