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China coal exit: Opportunities for China-led financing of early phase down of coal-fired power plants in Pakistan and Vietnam

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About this Publication

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Cover picture: Engineer and construction site manager dealing with a coal power plant in the background. (Image: Shutterstock)

Acronyms and abbreviations

ACT	Accelerating Coal Transition
ADB	Asia Development Bank
ALLIES	Choosing your allies
BAU	Business as usual
CFB	Circulating Fluidised Bed
CFPP	Coal-fired power plant
CIF	Climate Investment Funds
CPPA	Central Power Purchasing
DE	Debt-to-equity
DISCO	Distribution companies
ETM	Energy Transition Mechanism
EV	Enterprise Value
EVN	Electricity of Vietnam
FCFE	Free cash flow to equity
FiT	Feed-in tariffs
FUTURE	Ministry of the Future
G7	Group of Seven: Canada, France, Italy, Germany, Japan, the United Kingdom and the United States of America and the European Union
GEM	Global Energy Monitor
GFANZ	Glasgow Alliance for Net Zero
IEA	International Energy Agency
IGCEP	Indicative Generation Capacity Expansion Plan
IPG	International partners group
JETP	Just Energy Transition Partnership
MAS	Monetary Authority of Singapore
MDB	Multilateral development bank
MEE	Ministry of Ecology and Environment
MOFA	Ministry of Foreign Affairs
MOFCOM	Ministry of Commerce
MOIT	Ministry of Industry and Trade
MPO	Managed coal phase-out
MW	Megawatt
NDRC	National Development and Reform Commission
NEPRA	National Electric Power Regulatory Authority, Pakistan
NPV	Net Present Value
OECD	Organisation for Economic Cooperation and Development
PC	Pulverised Coal
PDP8	8th Power Development Plan
RE	Renewable energy
SOEs	State-owned enterprises
SOFIs	State-owned financial institutions
US	United States of America
USD	US dollar
WEF	World Energy Forum

Contents

Executive summary

Prevalent literature assumes that coal-fired power plants (CFPP) in Asia are difficult to retire due to their relatively young age. This study evaluates how the financial values of six Chinese-sponsored coal-fired power plants (CFPP) in Pakistan and Vietnam are impacted through early plant retirement under different financing and economic scenarios. Contrary to common assumptions, the results indicate:

- For all six plants in Vietnam and Pakistan, our modelling showed an increase in enterprise value with Asset/Portfolio Refinancing through early retirement;
- When refinancing is bundled with renewable energy investments, the enterprise values would more than triple compared with the value of the original power purchasing agreement;
- Accordingly, investors could benefit financially from early CFPP retirement;
- Younger plants can shave more years off their commercial lifetime and be retired earlier due to higher relative debt burden and higher financing costs during the early years of operations;
- In Pakistan with its very young CFPPs, refinancing would allow the retirement of the three plants seven to nine years ahead of schedule—while improving enterprise value.

Based on the results, this study recommends that Chinese companies, financial institutions and other investors engaged in overseas CFPPs consider reducing their CFPP exposure by shifting to renewable energy investments. Enterprise value and feasibility of CFPP retirement bundled with renewable investment would further improve through concessional loans, credit enhancement mechanisms and innovative financing instruments such as debt-for-climate swaps involving Chinese CFPP sponsors.

Note: data were collected as of January 2023. The analyses and discussion section of the study was drafted in the third quarter of 2023 and first presented publicly during the World Energy Forum (WEF) in November 2023. Results and findings may change given new national policies, financial and economic conditions.

Floating Solar Energy Project in Vietnam. (Image: Asian Development Bank)

1. Introduction

Early phase-down of coal-fired power plants (CFPPs) is discussed in emerging and developed countries globally as a solution for reducing emissions faster.[1] Organisation for Economic Cooperation and Development (OECD) countries and the EU have taken the lead in phasing out coal and retiring existing CFPPs, with 56 per cent of operating capacity either closed already since 2010 or scheduled to close by 2030.[2]

In emerging economies, particularly across Asia, where most of the new additions of CFPPs have taken place over the past 15 years,[3] several initiatives have been launched to support the early phase-down of CFPPs:

- Energy Transition Mechanism (ETM) was launched in 2021 by the Asian Development Bank (ADB) as a public-private finance vehicle to expedite the retirement or repurposing of fossil fuel plants within the Asia and Pacific. In April 2023, ADB announced that "the priority for Pakistan is to transition away from oil- and diesel-fired power plants, although coal-fired power plants will likely be addressed as part of ETM's pre-feasibility study". ADB completed the pre-feasibility study last November 2023. In the same update, ADB mentioned that it "conducted a pre-feasibility study in 2021 and is in discussions with key ministries to initiate a full ETM feasibility study".

- Just Energy Transition Partnership (JETP) was launched in 2021 at COP26 in Glasgow with a goal to expand public and private financing for equitable energy transitions of emerging economies. JETP is financially supported mainly by the international partners group (IPG) comprising France, Germany, the European Union, the United Kingdom and Canada, and private financial institutions. To date, four countries have joined JETP: South Africa in 2021, Indonesia and Vietnam in 2022, and Senegal in 2023.

- Accelerating Coal Transition (ACT) launched in 2021 is a comprehensive program designed to assist countries in transitioning away from coal. ACT operates as a multi-multilateral development bank (MDB) financing platform under the Climate Investment Funds (CIF). The program has received substantial financial backing from the G7, who pledged up to USD 2 billion.

- The ASEAN Taxonomy for Sustainable Finance released in March 2023 includes coal phase-out activities in the Plus Standards framework. It categorises coal phase-out into "green" if the CFPPs achieve phase-out by 2040 and "amber" if the CFPPs achieve phase-out by 2050 (for more details please refer to the original document).[4]

- Glasgow Alliance for Net Zero (GFANZ) in June 2023 has published guidance for managed coal phase-out (MPO) in Asia-Pacific, which was developed in collaboration with local financial and policy stakeholders, as well as knowledge partners.[5]

- Monetary Authority of Singapore (MAS) in 2023 evaluates the investment in blended finance instruments to provide financing for accelerated phase-down of coal-fired power plants in the Asian region[6] and has introduced transition credits as a complementary financing mechanism "to accelerate and scale the early retirement of CFPPs".[7]

However, at this point, the early phase-down of CFPPs in emerging economies is still considered a challenge. First, many emerging economies have rapidly growing electricity needs: Emerging Asian economies' electricity needs are projected to grow about 3 to 5 percent per year due to population growth, economic growth, and the electrification of industry and transport.[8] This makes the retirement of existing power generation units more challenging as significant investments in renewables would be needed to grow the electricity sector to meet demand while simultaneously compensating for the generation capacity loss through CFPP retirement.

Second, there is a belief that "in general, the older a plant is, the cheaper it will be to retire because more of its initial investment has already been recouped".[1,9] As many CFPPs in emerging economies are relatively young (e.g., the average age in Vietnam is 6.7 years and 10.8 years in Indonesia, compared to more than 40 years in the US)[3], their early retirement is regarded as costly.

A third challenge is the role of China's state-owned enterprises (SOEs) and state-owned financial institutions (SOFIs), who have been among the top sponsors of CFPPs in emerging Asia but have not been included in any of the considerations in the region.[10,11]

This study addresses the three challenges by analysing the financial costs and opportunities of China-sponsored CFPPs in Vietnam and Pakistan and expands on previous studies that used representative model plants with generalised assumptions.[10]

We used financial and operational data of six operating coal-fired power plants (three in Pakistan, and three in Vietnam) to calculate their enterprise values with the discounted cash flow method.[12] We also built three future scenarios to model external risks on future cash flows of the CFPPs and potential early retirement options (for example, CFPP retirement only vs re-investment into renewable energy projects). Furthermore, instead of modelling retirement options that rely on finance from a hypothetical price for avoided carbon emissions, the study utilised achievable financing structures to establish retirement options. Finally, the results of the financial values and projections of the early CFPP retirement programs were supplemented by an additional scenario that factored in renewable energy (RE) alternatives.

The results show that investors could benefit financially from the early retirement of CFPPs. Contrary to previous belief, the feasibility of retiring younger plants is higher, as younger plants have a higher debt burden that leads to higher financing costs during the early years of operations. Once a plant becomes older and its debt is paid off, more of its revenues become profits, diminishing the potential gains of early retirement. Furthermore, the results show that when combining the retirement of CFPPs with investment into RE, enterprise values for investors would at least triple compared to completing the original PPA.

Foundation wind energy in Pakistan. (Image: Asian Development Bank)

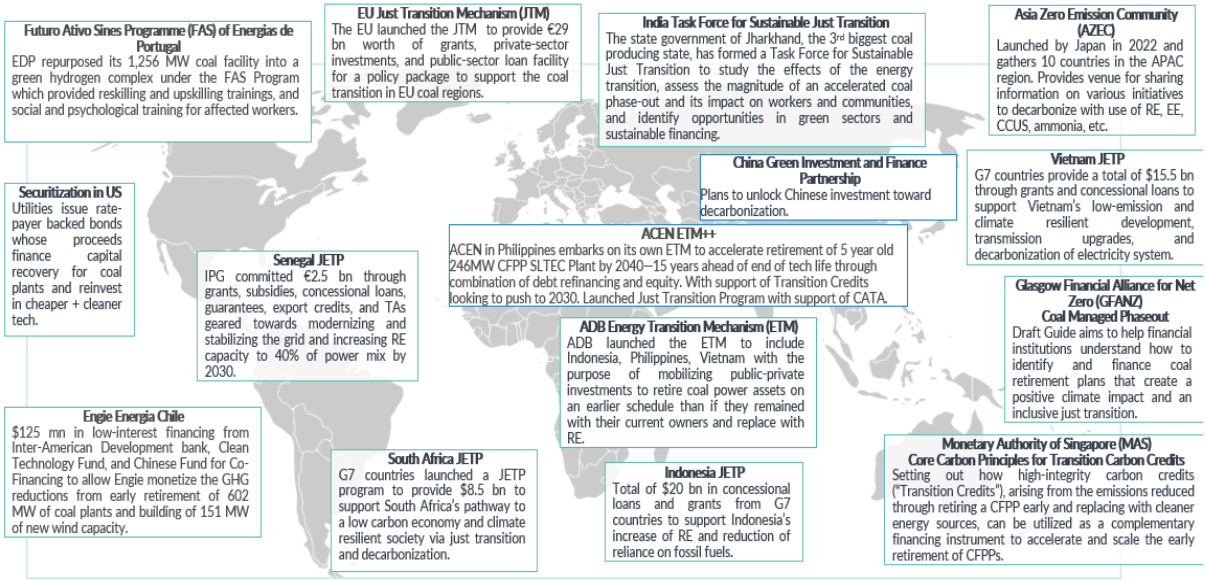
2. The context of coal power phase-down

2.1 Global energy transition and coal retirement trends

Energy transition in power generation includes the phase-down of fossil fuels, expansion of RE capacities, energy storage and grid infrastructure.

Many countries have pledged through joint initiatives or self-declaration to reduce dependence on coal power and increase financial support for RE (Figure 1).

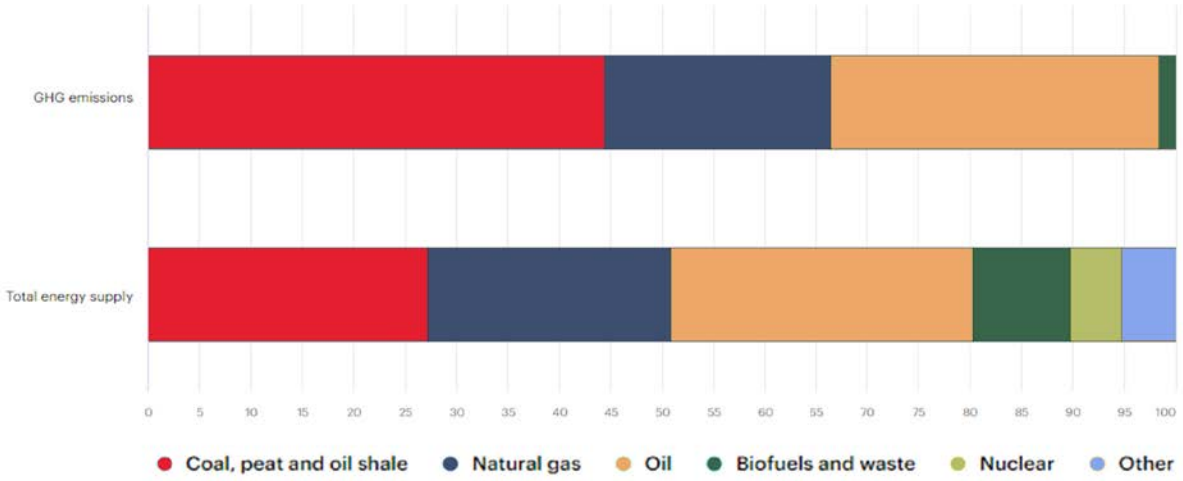
Figure 1: Energy Transition Initiatives Around the World



Source: Authors

Despite being the biggest source of greenhouse gases (see Figure 2) among thermal power generation sources, coal remains a major source of electricity in developing Asia (Figure 3) due to its low costs. As a consequence of the decreasing cost of alternative energies, operations of existing CFPPs have not only negative climate effects but also increased economic costs, given it is now cheaper to produce electricity via renewables compared to coal-fired power plants on a per kwh basis[13]. In addition, previous volatility of coal and other commodity prices globally made countries realise that high dependence on coal will not translate to savings in the long run.

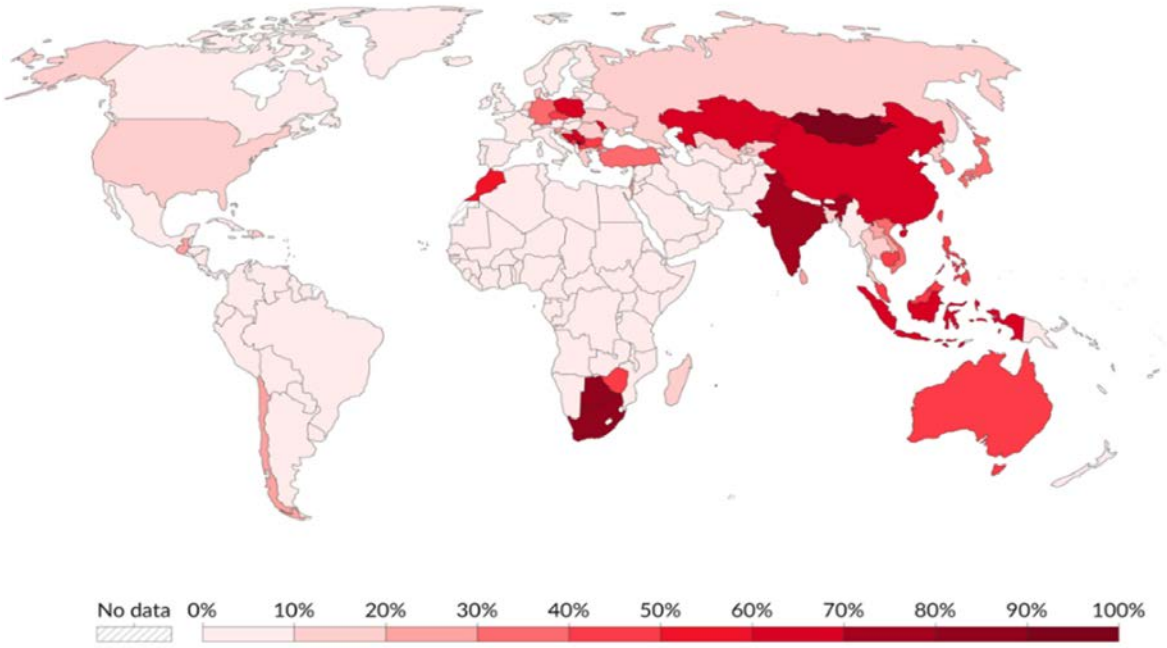
Figure 2: Share of GHG emissions and total energy supply by product, World, 2021



Source: International Energy Agency, 2021[14]

To reduce the volatility of energy costs and high climate emissions, interest in the "early retirement" of CFPPs has been increasing as seen in the rise in the number of various regional and global programs (see Figure 3). Nevertheless, global coal power capacity continues to maintain a net growth.

Figure 3: Share of electricity production from coal in 2022



Source: Our World in Data 2022[15]

Early retirement of CFPPs in developing Asia is even more of an uphill battle due to the relatively young age of existing fleets and the rapidly growing electricity demand for cheap and stable power.

Figure 4: Global coal power added vs retired

Source: Global Energy Monitor[3]

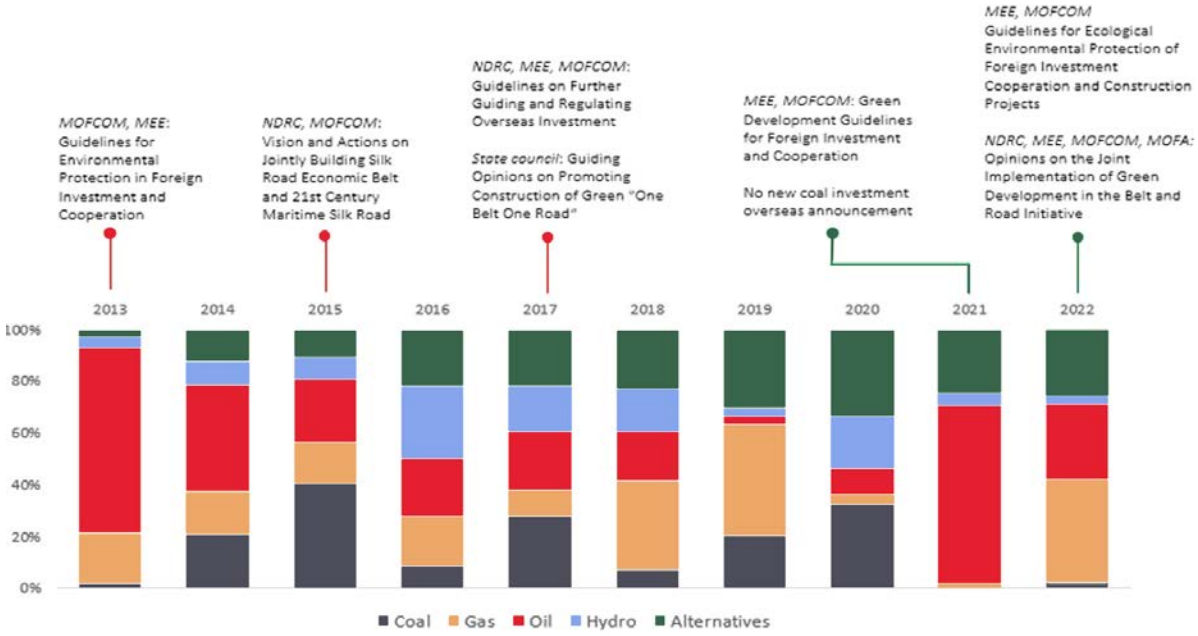
2.2 China's international coal policy

China has a dual role as the world's largest consumer and producer of coal, as well as a major public financier of CFPPs and exporter of coal-related technologies, such as boilers, turbines, and generators. It is home to half the world's operating coal capacity and 57 per cent of pre-construction coal power projects as of 2022.

China-funded CFPPs are heavily concentrated in South Asia and Southeast Asia, which account for 88 per cent of China's overseas coal investment as of 2022. As of 2020, the top five countries receiving this support (in billion USD) from the two largest overseas lenders, China Development Bank and China Export and Import Bank are Indonesia, Vietnam, South Africa, Pakistan, and Russia.[16]

As major financiers of China's overseas energy investment are state-owned enterprises and banks, the policies of the Chinese central government and ministries play a key role in guiding their practices. Since 2013, China's policies regarding environmental and social standards in BRI investment have become more stringent, suggesting companies follow stricter international or Chinese standards instead of host countries' principles and improving ESG reporting standards (Figure 5). In 2021, President Xi Jinping announced that China would not build new coal-fired power projects abroad.

Figure 5: China's overseas energy investment by technology and environmental governance policies



Note: Red dot means the policy follows host country principles; Green dot means the policy follows international/Chinese rules

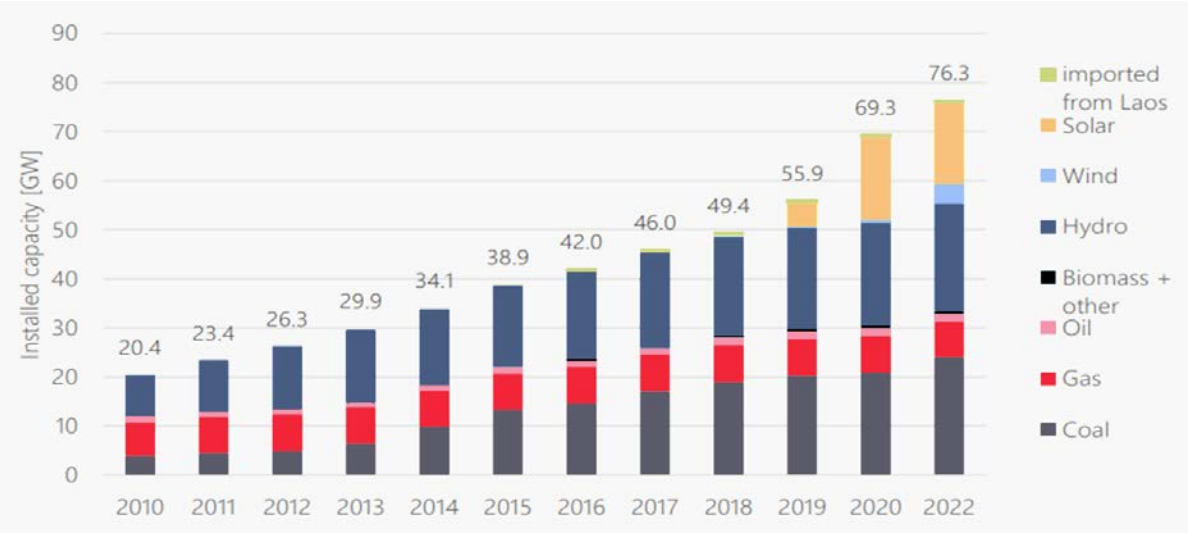
Source: Authors

2.3 Vietnam: Power sector context and policy

Vietnam's power industry is under the jurisdiction of the Ministry of Industry and Trade (MOIT). Under MOIT, the Electricity Regulatory Authority of Vietnam oversees sector regulation; several other branches oversee policy, research and planning.

Vietnam's power sector has a coal-dependent supply structure. In 2022, Vietnam's total installed capacity was 76 GW, dominated by coal, natural gas and hydropower; however, the share of coal has decreased slightly since 2019 as a result of growth in solar and wind installed capacity (Figure 6).[17]

Figure 6: Historical installed capacity for electricity generation in Vietnam



Source: Vietnam Electricity National Load Dispatch Centre, 2022[18]

According to Global Energy Monitor, about two-thirds of the operating and under-construction coal power units in Vietnam are state-owned, mostly by Electricity of Vietnam (EVN). EVN is also the largest buyer of electricity in Vietnam and holds a monopoly on transmission and distribution.[19]

Based on Global Coal Project Finance data in 2022, the total finance secured for Vietnam CFPPs is around USD 20 billion, the majority of which is backed by debt from Chinese banks and these CFPPs form 16 per cent of the country's total power supply (Table 1).

Table 1: Latest list of China-backed CFPPs in Vietnam

CFPP	Technology	Capacity (MW)	COD	Age (year)	Coal Supply
Mao Khe PS	CFB	440	2012	11	Local
An Khanh PS	CFB	115	2015	8	Local
Thang Long PS	CFB	600	2018	5	Local
Cao Ngan PS	Subcritical	115	2006	17	Local
Quang Ninh-1	Subcritical	600	2010	13	Local
Hai Phong TPS2	Subcritical	600	2013	10	Local
Duyen Hai 1	Subcritical	1,245	2015	8	Local
Mong Duong PS2	Subcritical	1,200	2015	8	Local
Vinh Tan PS1	Subcritical	1,200	2018	5	Imported
Duyen Hai 2	Subcritical	1,320	2021	2	Imported
Hai Duong TPP1	Subcritical	1,200	2021	2	Local
Vinh Tan PS2	Supercritical	1,245	2014	9	Imported
Thai Binh 2	Supercritical	1,200	2023	0	Local
Van Phong PS	Supercritical	1,320	2023	0	Local

Source: Authors

The government of Vietnam has been actively exploring energy transition policies.

- In November 2021, Vietnam announced a carbon-neutral target by 2050 and joined declarations of ending new coal investments during COP26.
- In December 2022, Vietnam became the third country reaching a Just Energy Transition Partnership with G7 countries following South Africa and Indonesia and will mobilise an initial $15 bn of public and private finance over 3 - 5 years to support Vietnam's green transition.
- In January 2023, more supporting policies for feed-in tariffs (FiT) and other tax reliefs with FiT extensions for solar and wind projects were announced.
- In May 2023, the 8th Power Development Plan (PDP8) was published. According to PDP8, Vietnam will not build new CFPPs after 2030. CFPP capacities will decrease, and a smart grid system will be built that can integrate and safely operate large-scale RE installations. In 2050, coal will not exit the power mix and solar power will become the dominant energy source.

However, complexity and challenges remain, illustrated by the many revisions of PDP8 and over two years of consultation with public and private stakeholders. The latest round of FiT for new solar is significantly lower than the last round and below market expectations, making the next set of RE programs still uncertain.

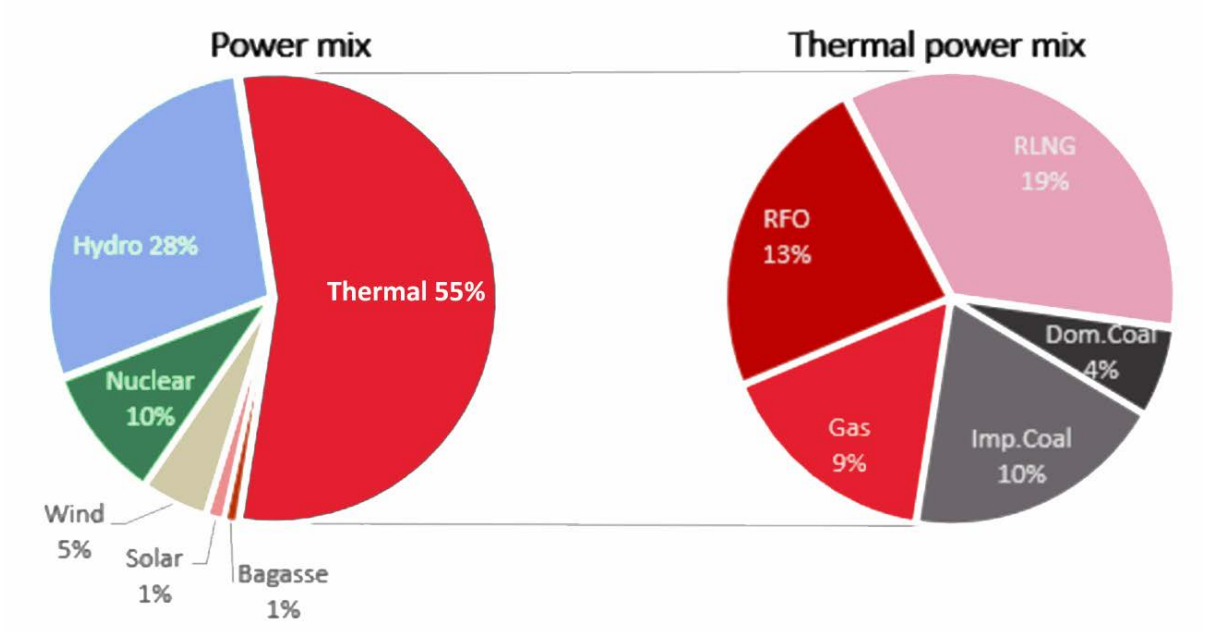
2.4 Pakistan: Power sector context and policy

As of June 2022, fossil fuels account for 55 per cent of the total installed generation capacity in Pakistan. Coal contributes 14 per cent of the total (Figure 7)[20].

In Pakistan, the government is the sole buyer of power through the Central Power Purchasing Agency (CPPA). Revenues are earned from electricity consumers, which fund the payments to suppliers, distributors, transmission companies, and generation companies.

CFPPs are relatively new but strong entrants since 2016 with Pakistan focusing on the indigenisation of the power mix (with local Thar coal). China's participation in funding Pakistan CFPPs is recent, but they have built nearly 7 GW of capacity within 5 years, becoming one of the largest financiers and owners in the country and forming 90 per cent of the country's total coal-fired capacity mix as of June 2023 (Table 2).

Figure 7: Share of installed capacity for electricity generation in Pakistan in 2022



Source: Authors using data from Indicative Generation Capacity Expansion Plan 2022-31

Table 2: Latest list of China-backed CFPPs in Pakistan as of June 2023

CFPP	Technology	Capacity (MW)	COD	Age (year)	Coal Supply
Sahiwal CFPP	Supercritical	1320 (660MW x 2)	2017	5	Imported
CFPP at Port Qasim Karachi	Supercritical	1320 (660MW x 2)	2018	4	Imported
China Hub Coal Power Project, Hub Balochistan	Supercritical	1320 (660MW x 2)	2019	3	Imported
Engro Thar CFPP	Sub-critical	660	2019	3	Local
SSRL Thar Coal Block-I 7.8 mtpa & Power Plant	Sub-critical	1320 (660MW x 2)	2022, 2023	0	Local
HUBCO Thar CFPP	Sub-critical	330	2022	0	Local
HUBCO ThalNova Thar CFPP	Sub-critical	330	2023	0	Local
CFPP at Gwadar	Supercritical	300	expected 2026	0	Imported

Pakistan has made some efforts to boost RE generation, but domestic coal-fired power is still the solution to provide its citizens with reliable electricity, as Pakistan plans to quadruple its domestic coal-fired capacity to replace gas.[21]

- Since 2006, Pakistan has issued several RE-supportive and decarbonisation policies, aiming for a more diverse and cleaner electricity mix.
- In August 2020, the Pakistan government formally approved the Alternative and Renewable Energy Policy 2019, which aims to boost the share of electricity generated from renewable sources from around 5 per cent to at least 20 per cent by 2025 and 30 per cent by 2030.
- According to Pakistan's power generation expansion plan, the Indicative Generation Capacity Expansion Plan (IGCEP) 2022-2031, there is another 1,290 MW (300 MW imported coal, 990 MW local coal) capacity planned before 2031.
    - In March 2023, Prime Minister Muhammad Shehbaz Sharif inaugurated two CFPPs with a capacity of 1,650 megawatts of electricity in Tharparkar using local Thar coal. The projects include the 1,320 MW Shanghai Electric power plant and the 330 MW Thal Nova power plant.
    - Fast Track Solar PV Initiatives 2022 aims to produce 10,000 megawatts (MW) of electricity through solar energy projects: i) substitution of expensive imported fossil fuels with solar PV ii) Solar PV generation on 11 VK feeders, and iii) solarisation of public buildings.

The biggest challenges in Pakistan's energy transition ambitions include a circular debt problem and constraints in RE development. Based on National Electric Power Regulatory Authority, Pakistan's (NEPRA) State of Industry Report of 2022, the distribution companies (DISCO) receivables climbed from Rs.1,398,194 million (USD 489 mn) to Rs.1,680,426 million (USD 587.1 mn), worsening the issue on the country's power sector circular debt. The payment delays in Pakistan's independent power plants have caused financial distress. Sinohydro, a Chinese CFPP owner, issued a default warning to the government in May 2023. Despite Pakistan's target RE in the energy mix, there's no clear roadmap or commercial support (e.g. FIT or auctions) to encourage more investments in RE. Additionally, investments in grid infrastructure are needed to accommodate variable RE.

3. Key objectives and methodology

This study was conducted with the following objectives:

- To provide a pathway for accelerating China's international transition from coal-based power generation to RE by leveraging China SOEs;
- To evaluate financial mechanisms that capitalise on the unique features of China SOEs to offer transition Finance; and
- To present findings to the public and China SOEs on the potential financial mechanisms to explore early CFPP retirement for Pakistan and Vietnam.

To meet these objectives, the study has undergone a plant-by-plant analysis followed by valuation and extended scenario, and financial analysis through the following approach (explained in detail in Sections 3.1, 3.2 and 3.3):

- Due diligence and policy review: Plant operating and financial data were collected while various potential scenarios and post-announcement structures were gathered along with country-level data for both Pakistan and Vietnam. Respective country policies for CFPP operations for Pakistan, Vietnam and China are also considered.
- Scenario development: Based on the review of energy policies and post-announcement structures of country-level data for Pakistan and Vietnam, scenarios were then developed to model through three financial structures (see Section 3.3).
- Criteria development and plant selection: Before undergoing evaluation through a financial model, plants were first assessed through certain criteria to determine which of the China-backed CFPPs were the most appropriate candidates for retirement.
- Financial analysis: After selecting the set of CFPPs based on the selected criteria, each candidate for early retirement or transition was then evaluated based on their Net Present Value (NPV).

Table 3 illustrates how CFPP values are analysed and compared. Results and findings of the study were completed third quarter of 2023 and first presented publicly during the World Energy Forum (WEF) last November 2023.

Table 3: List of scenarios and financial mechanisms used for analysis

	Scenarios		
Financial structures	BAU	ALLIES	FUTURE
Baseline (completing PPA)	Individual CFPP's values are calculated in each box for vertical and horizontal comparison.		
Asset/Portfolio Refinancing			
Re Bundling			

Source: Authors

3.1 Due diligence and scenarios development

To understand how different developments in the future impact CFPP values in Asia, this study developed three scenarios for the year 2035 based on expert interviews and published research. It is important to note that these scenarios serve only as an orientation of future energy development, but not as a prediction of the future. At the same time, the scenarios are generalisations that cannot detail developments for the diverse settings of CFPPs.

The scenarios assume fast developments in technology are paired with political and economic uncertainties, including:

1. Business as Usual (BAU): Countries prioritise energy security and maintain the status quo.
2. Choosing Your Allies (ALLIES): Regional blocs prioritise economic and political interests; coal and RE balanced.
3. Ministry of the Future (FUTURE): Global economy prioritises RE and climate action; coal out, RE in.

Table 4: Scenarios descriptions for the year 2035

Business As Usual (BAU)	• Continued operation of coal-fired power plant (CFPP) until the economic life • Subsidies for fossil fuels remain in place • Gradual roll-out of RE • International and private investors are invited to support RE development • The government promotes local manufacturing • Voluntary carbon markets (VCM) continue to be a promise yet will be implemented at least in 2035
Choosing Your Allies (ALLIES)	• More prevalent economic & political blocks and trade barriers; less global cooperation on high-tech products • International generous support for developing countries' green transition • CBAM charges 60-80 per cent of the EU ETS price for imported emissions • Policies still favour RE, while entrenched interests and economic realities back local economic development including mining, and require high local manufacturing content
Ministry of the Future (FUTURE)	• CFPPs are less used, translating to lower utilisation facing increasing operating costs due to scarcity of suppliers and higher fuel costs • RE is maximised, translating to lower cost of operations due to improved scale, but revenues are lower due to competition • Global funding and trade support for the energy transition have accelerated • Accelerated CBAM and 50 per cent of its revenues are used for emerging markets' energy transition • VCM price is set at 50 per cent of the EU ETM • Financing for non-RE has mostly dried up, with few investors reaping high benefits from still financing CFPPS • Green technologies are exempt from persisting trade barriers. • Higher localisation of RE and higher payment morale for the elect

Source: Authors

Each of these scenarios has specific implications for the cost structure of a CFPP by impacting their financial revenues and financial costs. For example, the ALLIES scenario would increase the price of a coal tariff but reduce the coal supply cost, and the FUTURE scenario would reduce the price of a coal tariff but increase the coal supply cost. Table 5 shows how the different scenarios would impact the financial assumptions for coal and RE.

Table 5: Scenario impact on financial assumptions

Key Financial Assumptions		Coal			Renewable Energy		
Category	Component	BAU	ALLIES	FUTURE	BAU	ALLIES	FUTURE
Revenues	Fixed Capacity tariff	100%	120%	80%	100%	100%	90%
	Fuel tariff	100%	120%	80%	-	-	-
	Fixed & Variable O&M	100%	120%	80%	100%	100%	90%
Cost	Fuel cost	100%	90%	150%	-	-	-
	Variable O&M cost	100%	110%	110%	-	-	-
	Fixed O&M cost	100%	110%	110%	100%	100%	90%
	Financing cost	100%	90%	120%	100%	100%	90%
	Insurance cost	100%	90%	120%	100%	100%	80%
Others	% of fees collected	100%	90%	100%	100%	90%	100%
	% utilisation/load	100%	110%	50%	100%	95%	100%
	Project cost*	-	-	-	100%	100%	95%*

Source: Authors
**Assumed 2025 and not 2035; cheaper cost per MW translates to more MW developed per total financing available.*

3.2 Criteria development and plant selection

The criteria for selecting the CFPPs for early retirement analysis include three principles:

1. CFPPs using Pulverised Coal (PC) or subcritical Circulating Fluidised Bed (CFB) are prioritised as shutting down plants with less efficient carbon intensity technologies creates the most carbon emissions reduction;

2. CFPPs of smaller sizes are prioritised as they simulate a more realistic CFPP transition without comprising a country's energy supply;

3. As CFPPs of various ages have distinct remaining operational lives at a single point in time, which can produce different financial results, CFPPs from "young, middle, and old" age brackets are prioritised to diversify the archetypes of CFPPs for early retirement.

Selecting specific CFPPs ensures that financial models are built as far as possible on fact (instead of on assumptions) by utilising information on these plants' PPAs and financial performance, as well as power sector reports. (Table 6). shows the six plants selected based on these principles.

Note that in Pakistan, despite the larger sizes (1320MW) of SSRL Thar and Sahiwal, they both consist of two units, making it manageable for phased shutdown (e.g., shutdown of one unit first). While the criteria specify less efficient technology, most of the CFPPs adopting less efficient technology in Pakistan are funded by China and are relatively new. As such, a supercritical plant (Sahiwal) was selected to capture a relatively older operational plant.

Table 6: Selected CFPPs in Vietnam and Pakistan for early retirement analysis

Country	Plants	Technology	Capacity (MW)	Age
Vietnam		CFB	600	5
	Quang Ninh-1	Subcritical	600	13
	Hai Phong TPS2	Subcritical	600	10
Pakistan	Engro Thar CFPP	Sub-critical	660	3
	SSRL Thar CFPP	Sub-critical	1320 (660 x2)	0
	Sahiwal CFPP	Supercritical	1320 (660 x2)	6

Thang Long thermal power plant. (Image: VietnamNet)

Table 7 provides basic assumptions for CFPPs in Vietnam and Pakistan. For the three CFPPs in Vietnam, the financial model was based on plant-specific data available online, the financials of sample plant Mong Duong 2[22] and assumptions from Vietnam Technology Catalogue.[23] For CFPPs in Pakistan, the financial model was based on formulas from the PPAs published on Pakistan's government website[24] and industry and plant-specific data available online. All data collected and analysed were as of November 2022.

Table 7: Basic assumptions for Vietnam's CFPPs financial models

		Vietnam	Pakistan
Operations	Net capacity factor	Net capacity factor based on available data online	
	Capacity charge	Assumes a 12% target return	Consists of fixed O&M, working capital, insurance, debt repayment, and ROE
	O&M fees	Based on the Vietnam technology catalogue	Variable O&M and fuel are pass-through
	Fuel costs	Pass-through fuel charge is derived from sample plants	Pass-through fuel charge is derived from sample plants
	Cost of services	Cost of services is based on sample plants	Cost of services is based on sample plants
	EBITDA	ranges from 36%-45%	About 75% in the first 10 years and lowers to 30% when the debt is paid and the corresponding debt component tariff drops
	Inflation/Growth	Follows historical trends derived from sample plants	Follows macroeconomic trends
Working capital	Accounts Receivable	Assumptions are based on Mong Duong FS notes;	Days receivable assumes 500 days;
	Accounts Payable	AR assumes 65 days, inventory 20, and AP 90 days	Fuel and AP are 30 and 90 days
Debt	Debt amount	Debt amount assumes 13-year sculpted repayments to match the CFPP's estimated operating cash flows	Existing 10Y debt is based on a 75:25 DE ratio
	Interest rate	7% PPA Interest assumes a 10Y US treasury bond rate plus a 2.5% project finance spread rounded up	Interest rate assumes KIBOR at the time of construction and spread of 3.5%
Capex	Capex	est. $1.0-$1.3 per MW	$1.5-$1.7 per MW plus a 50% cash buffer
	Depreciation	Depreciation is over 25 years	Depreciation is over 25 years

3.3 Financial analysis

This study focuses on three financing structures: baseline, Asset/Portfolio Refinancing and RE Bundling. Another potential financing structure, "debt-for-climate" or "coal-for-RE" swap, incorporates haircuts of outstanding debt to facilitate CFPP retirement, but debt forgiveness can appear as a bailout or can be a credit negative in the short term, tarnishing the track record of the borrower for future debt issuances. Therefore, to minimise potential credit rating risks, it is not included in the analysis.

Table 8: Financing structures

Baseline	• CFPP operates up to its end-of-life
Asset/Portfolio Refinancing	• CFPP raises refinancing now and realises value but does not guarantee the use of net proceeds for RE development. • CFPP is retired on the last payment year of its refinanced debt.
RE Bundling (combining coal and RE in a transaction) *No debt forgiveness*	• CFPP raises refinances on how and reinvests net proceeds into RE. • CFPP is retired on the last payment year of its refinanced debt.

Sustainable resources on a sunny day, Phuoc Dinh, Ninh Phuoc, Ninh Thuan, Vietnam (Image: Shutterstock)

Assumptions for Vietnam's CFPPs and solar power are summarised in Table 9.

Table 9: Assumptions for CFPP and solar (under RE bundling) in Vietnam

	Assumption	Financial mechanism	Thang Long	Hai Phong	Quang Ninh
CFPP assumptions	Installed Capacity	All	620 MW	600 MW	600 MW
	COD	All	2018	2013	2010
	Economic Life	PPA	25 years	25 years	25 years
		With Refinancing	17 years	22 years	25 years
	Retirement Year	PPA	2042	2037	2034
		With Refi	2034	2034	2034
	Existing Debt (2024)	All	$384	$8.1	-
	Interest Rate	PPA	7.00%	7.00%	-
	Refinanced Debt[1]	With Refi	$597	$460	$269
	Interest Rate	With Refi	6.00%	6.00%	6.00%
	Tenor of Refinanced debt	With Refi	10 years	10 years	10 years
	WACC debt-to-equity (DE) Ratio	PPA	50:50	50:50	50:50
		With Refi	80:20	80:20	80:20
	WACC Risk adjustment	PPA	5%	5%	5%
		With Refi	3%	3%	3%
	Cost of Equity	All	9.62%	9.62%	9.62%
	WACC	PPA	12.61%	12.61%	12.61%
		With Refi	7.76%	7.76%	7.76%
Solar projects assumptions	New money raised	Refinance with RE Bundling	$213	$452	$269
	DE Ratio		80:20	80:20	80:20
	Available funds		$1,063	$2,260	$1,344
	Project cost/ MW		$ 0.93 /MW	$ 0.93 /MW	$ 0.93 /MW
			$ 0.88 /MW[2]	$ 0.88 /MW[2]	$ 0.88 /MW[2]
	Installed Capacity		1,143 MW	2,374 MW	1,445 MW
			1,203 MW[2]	2,558 MW[2]	1,421 MW[2]
	Economic Life		20 years	20 years	20 years
	COD		2025	2025	2025
	Retirement Year		2044	2044	2044
	Equity		$213	$452	$269
	Debt		$850	$1,808	$1,075
	Tenor		15 years	15 years	15 years
	Interest rate		5.80%	5.80%	5.80%
	WACC DE ratio		80:20	80:20	80:20
	Risk adjustment		0.00%	0.00%	0.00%
	Cost of Equity		12.00%	12.00%	12.00%
	WACC		10.66%	10.66%	10.66%

[1]*Refinanced amount maximises the 80:20 DE ratio and DSCR stays above 1.20x*

[2]*RE technology is more developed and affordable under the Ministry of the Future -- with the same amount of available funds, more RE can be developed.*

Similarly, Pakistan's CFPP and solar assumptions are summarised in Table 10.

Table 10: Assumptions for CFPP and solar (under RE bundling) in Pakistan

	Assumption	Financial mechanism	SSRL	Engro	Sahiwal
CFPP assumptions	Installed Capacity	All	1,320 MW	600 MW	1,320 MW
	COD	All	2023	2019	2017
	Economic Life	PPA	25 years	25 years	25 years
		With Refi	12 years	16 years	18 years
	Retirement Year	PPA	2047	2043	2036
		With Refi	2034	2034	2034
	Existing Debt as of 2024	All	$1,946	$448	$486
	Interest Rate	PPA	17.99%[1]	15.41%	9.63%
	Additional Debt[2]	With Refi	$232	$162	$530
	Interest Rate[3]	With Refi	17.50%	17.50%	17.50%
	Tenor of refinanced debt	With Refi	10 years	10 years	10 years
	WACC DE Ratio	PPA	50:50	50:50	50:50
		With Refi	80:20	80:20	80:20
	WACC Risk adjustment	PPA	5%	5%	5%
		With Refi	3%	3%	3%
	Cost of Equity[4]	PPA	28.5%	28.5%	28.5%
		With Refi	23.5%	23.5%	23.5%
	WACC	PPA	28.25%	28.25%	28.25%
Solar projects assumptions	New money raised	Refinance with RE Bundling	$232	$162	$530
	DE Ratio		80:20	80:20	80:20
	Available funds		$1,162	$810	$2,651
	Project cost/MW[5]		$ 0.93 /MW	$ 0.93 /MW	$ 0.93 /MW
			$ 0.88 /MW	$ 0.88 /MW	$ 0.88 /MW
			1,250 MW	871 MW	2,851 MW
			1,316 MW	917 MW	3,001 MW
	Economic Life		20 years	20 years	20 years
	COD		2025	2025	2025
	Retirement Year		2044	2044	2044
	Equity		$232	$162	$530
	Debt		$930	$648	$2,121
	Tenor		15 years	15 years	15 years
	Interest rate		5.80%	5.80%	5.80%
	WACC DE ratio		80:20	80:20	80:20
	Risk adjustment		0.00%	0.00%	0.00%
	Cost of Equity		12.00%	12.00%	12.00%
	WACC		10.66%	10.66%	10.66%

[1] *Based on prevailing market rates at the time of financial close for SSRL, Engro Thar, and Sahiwal respectively*

[2] *As the CFPPs are all relatively young, an existing debt is not refinanced but maximised by raising additional debt (DE ratio of 80:20 cannot be achieved and a minimum 1.20x DSCR is targeted instead)*

[3] *Blended rates based on an average market rate of 20 per cent+3.5 per cent spread and concessional rate of 11.5 per cent*

[4] *Cost of equity assumes higher risk in PPA due to circular debt and overall country risk*

[5] *RE technology is more developed and affordable under the Ministry of the Future -- with the same amount of available funds, more RE can be developed.*

4. Results

Quantitative results of individual plant cash flows, enterprise value and equity value are reported for Vietnam and Pakistan separately. For all six plants, our modelling showed an increase in enterprise value under all scenarios. If the refinancing were bundled with RE investments, the enterprise values would more than triple even in the "worst case" business-as-usual scenario. In Pakistan, refinancing would allow the retirement of the three plants seven to nine years ahead of schedule – while maintaining profitability.

4.1 Vietnam

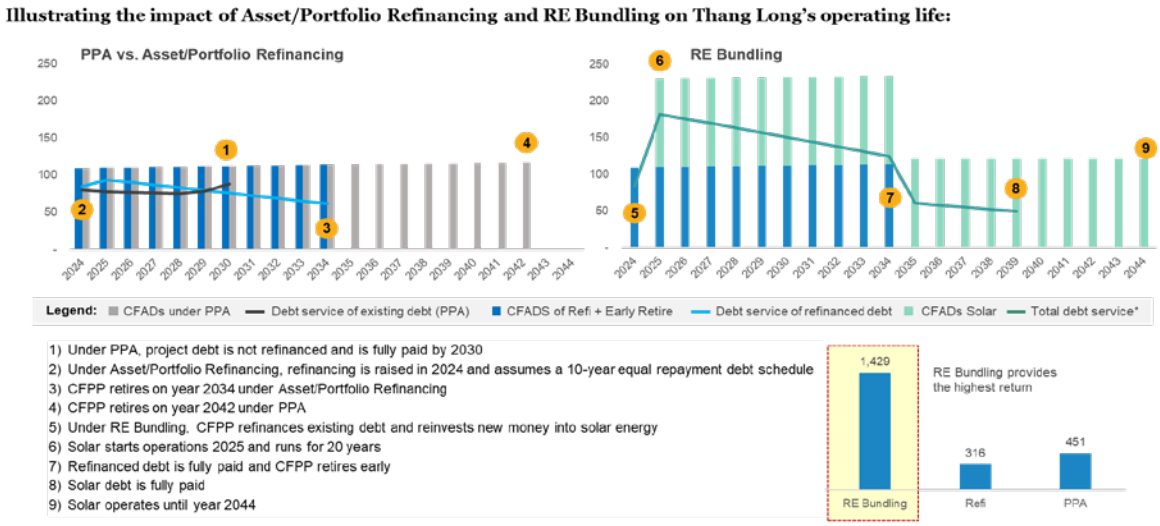
Sample cash flows for Thang Long

The sample cash flows of Thang Long's operating life are mapped under the original PPA and with asset/portfolio refinancing and RE bundling applied (Figure 8). Compared with completing the PPA (retiring in the year 2042), refinancing allows Thang Long to retire 8 years earlier while generating positive CFADs. It would not generate a higher return as the existing sculpted debt provides a better cash profile for free cash flow to equity (FCFE) than refinancing. When bundled with solar investment, however, Thang Long could still retire 8 years earlier and generate a higher return with cash flows from solar projects.

Enterprise values

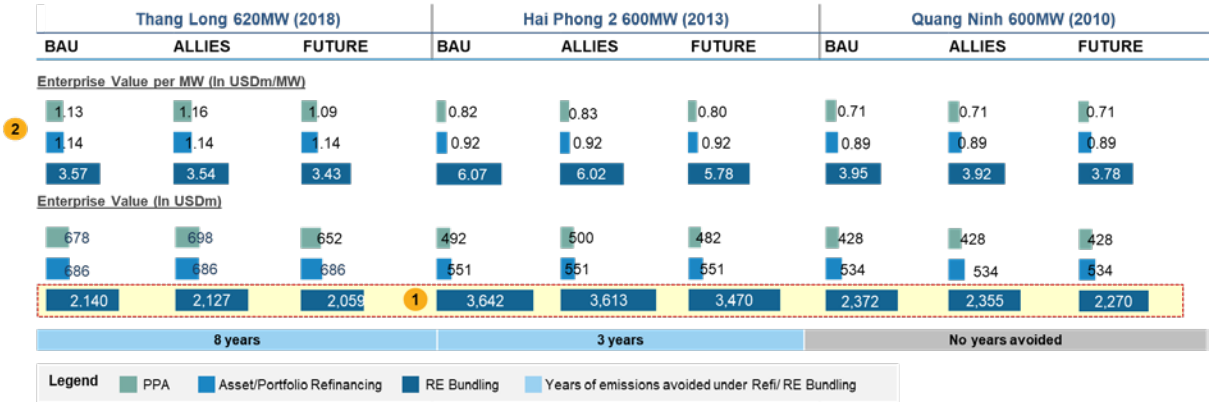
For all three CFPPs in Vietnam, RE Bundling produces the highest valuation in any scenario, especially for Hai Phong as its age and debt capacity are the most optimal for maximising refinancing and generating new money for RE. Under PPA and Refinancing, Thang Long's enterprise valuation is highest as it has more operational years than the two older CFPPs.

Figure 8: Sample cash flows of Vietnam's Thang Long CFPP



Source: Authors

Figure 9: Enterprise values for CFPPs in Vietnam



Source: Authors

Despite earlier retirement under refinancing, Asset/Portfolio Refinancing valuations are higher than PPA due to lower WACC from refinancing, which leverages a cheaper cost of capital and an optimal capital structure.

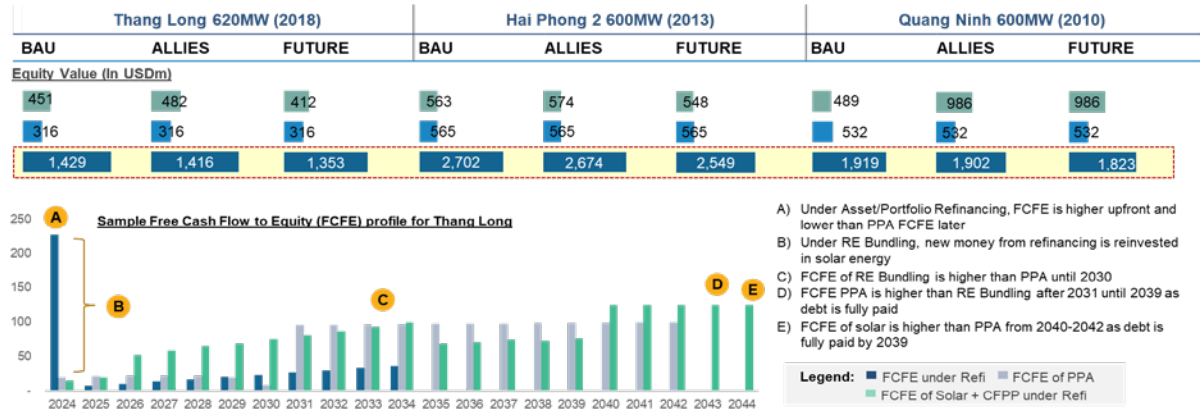
Valuations under Choose Your Allies (ALLIES) are higher than BAU for Thang Long and Hai Phong because of the increase in tariffs and utilisation. Valuations under the Ministry of Future (FUTURE) are lower than BAU due to a decrease in tariffs, an increase in costs, and lower coal energy utilisation.

Equity values

Figure 10 shows that the equity values are highest under RE Bundling for all three CFPPs in Vietnam, but overall equity values are higher for the older plants (Quang Ninh and Hai Phong) as their debts have been fully paid. Compared with Quang Ninh, Hai Phong's equity value is higher as Hai Phang is younger and has more operating years.

Equity values under RE Bundling are lower in the FUTURE scenario than ALLIES and BAU scenarios, because despite an increase in MWs developed, existing tariffs on a global level are already very tight (10–12 per cent) given increasing competition with previous CFPP contracts.

Figure 10: Equity values for CFPPs in Vietnam



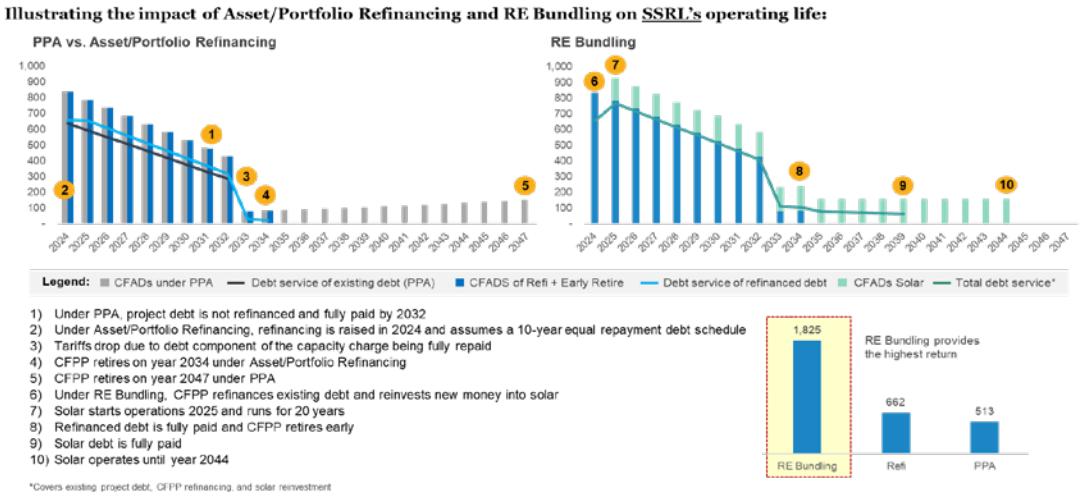
Source: Authors

4.2 Pakistan

Sample cash flows for SSRL

The sample cash flows of Thang Long's operating life are mapped under the original PPA and with asset/portfolio refinancing and RE bundling applied (Figure 11). Compared with completing the PPA (retiring in the year 2047), SSRL pays off the debt in the year 2032 and retires 13 years earlier (in the year 2034) under Asset/Portfolio Refinancing. If bundled with solar investment, refinanced debt is paid off in the year 2039 and solar projects continue to generate cash flows until 2044. Among the three, RE bundling generates the highest return.

Figure 11: Sample cash flows of Pakistan's SSRL CFPP



Source: Authors

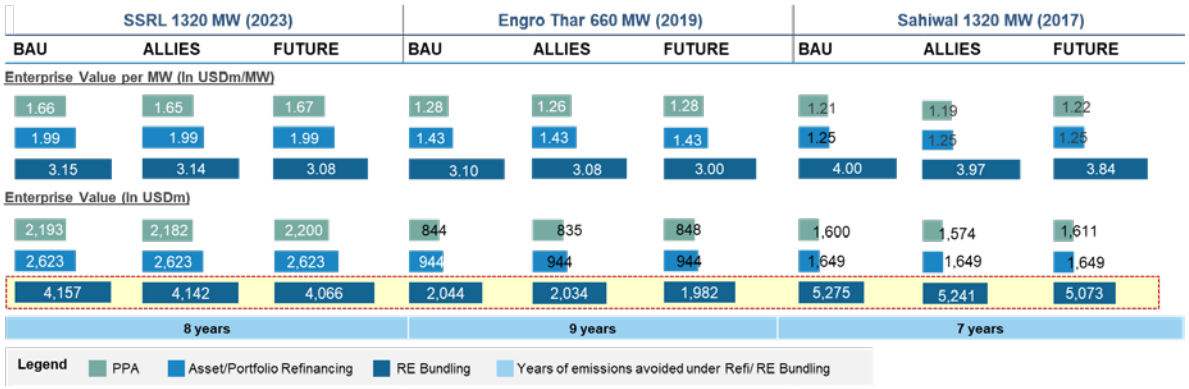
Enterprise values

For the three CFPPs in Pakistan, RE Bundling produces the highest enterprise values for all plants in any scenario (Figure 12). Among three CFPPs, Sahiwal's enterprise value per MW is highest under RE Bundling because it is more advanced in its debt payments, allowing a higher amount of net proceeds to be raised from refinancing for RE reinvestment. Under PPA and Asset/Portfolio refinancing, SSRL has the highest enterprise value per MW as it has more operational years left than the two older plants.

Enterprise values of Pakistan's CFPPs under ALLIES are lower than BAU due to circular debt concerns. Enterprise values are higher in FUTURE from positive working capital cash flows in the year 2035 when the assumption of lower utilisation reduces the stress on AR collections.

Compared with completing PPA, enterprise values are higher under Asset/Portfolio Refinancing due to WACC from refinancing, which leverages cheaper cost of capital and an optimal capital structure.

Figure 12: Enterprise values for CFPPs in Pakistan



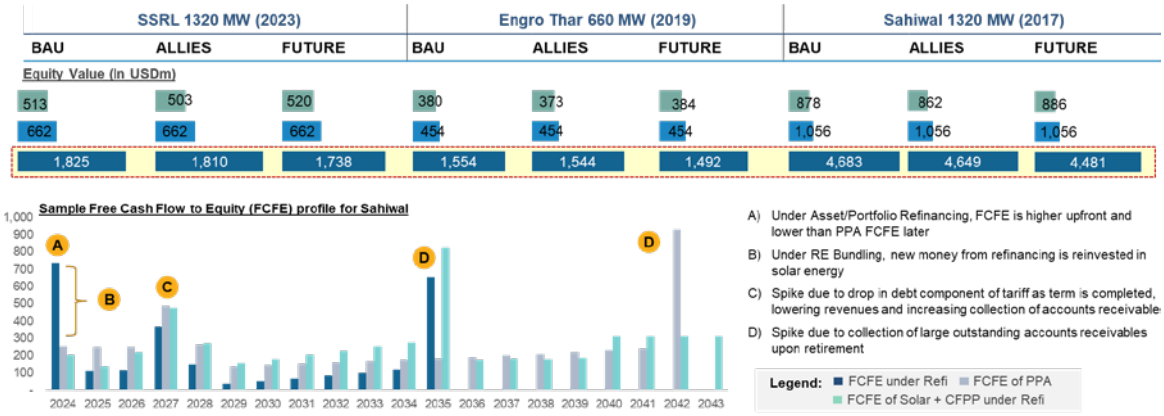
Source: Authors

Equity values

Among the three CFPPs, Sahiwal's equity value is higher than SSRL's because it is most advanced on its debt payment schedule, generating more free cash flows to equity.

Valuations with RE Bundling are lower in FUTURE than ALLIES/BAU scenarios because, despite an increase in MWs developed, the tariff formula uses the project cost as a basis for returns, which assumes no change in IRR but decreases the NPV (Figure 13. Similar to Vietnam, all scenarios with refinancing (Asset/Portfolio Refinancing, RE Bundling) provide new money that can uplift NPVs – with this being improved once an RE project is bundled as part scenario.

Figure 13: Equity values for CFPPs in Pakistan



Source: Authors

5. Discussion and recommendations

In both Pakistan and Vietnam, CFPPs are contractually designed to provide significant value for their owners, particularly due to high-capacity/ capital recovery charges and fuel charges in exchange for previously perceived country-level risk and high capex costs. The quantitative results based on the listed assumptions of this study shed light on which financial mechanism is a better option under different future scenarios:

- Under ALLIES and FUTURE scenarios, given higher risk considerations for the future operation of CFPPs, the early retirement through "Asset/Portfolio Refinancing" and "RE Bundling" mechanisms provide possible "hedges" that allow investors to retain asset value, compared with the business-as-usual scenario;

- In the FUTURE scenario where CFPPs are less prioritised for power generation, the "Asset/Portfolio Refinancing" and "RE Bundling" mechanisms still provide an advantage, BUT increasing competition in RE will dampen long-term profitability;

- Concessional financing can be channelled through debt swap structures (e.g. pure refinancing or potential partial or full forgiveness) to make accelerated phase-down of CFPPs and replacement with RE more feasible in both Pakistan and Vietnam

Specifically for Pakistan, circular debt and payment issues make any phase-down financially feasible IF subject to the availability of cash for payment of remaining/ future receivables and locally available RE investments.

Specifically for Vietnam, PDP8 offers clear energy deployment ambitions with trajectories for CFPP repurposing and possibly retiring however new FIT rates are not as competitive as expected.

Based on these findings, we propose four recommendations for Chinese companies, financial institutions and other investors.

1. First, Despite the world returning to "normal" in 2024 as compared to when this study was completed, there is still a big push for early CFPP retirement in emerging markets like Pakistan and Vietnam. This was reinforced following the results of the last COP28 held in Dubai last December 2023, where more international and multilateral organisations showed strong support for accelerated energy transition mechanisms including early CFPP retirement.

2. Second, China SOEs can still minimise their exposure in CFPPs by accelerating plans shifting to RE through refinancing, ideally with concessional financing similar to ADB's ETM.

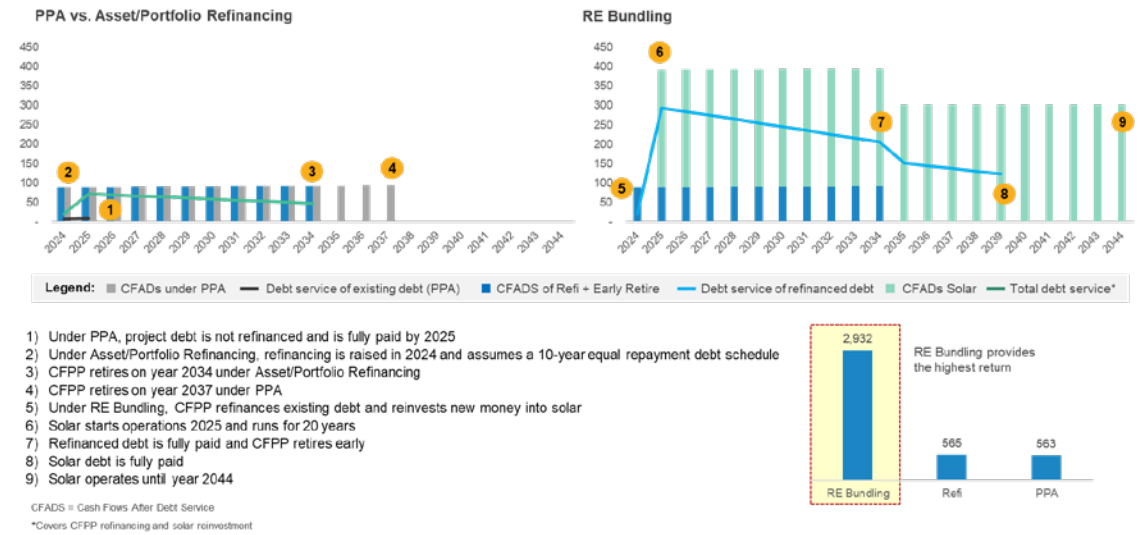
3. Third, Chinese financial institutions (e.g., EXIM, Sinosure) should evaluate the provision of credit enhancement mechanisms for political risk insurance focused on green energy or accelerated phase-down.

4. Fourth, Chinese investors can accelerate the use of innovative financing instruments, such as blended finance, including grants (e.g., provided through philanthropic organisations or development finance institutions).

Particularly in Pakistan, Chinese SOEs and investors (including banks) should evaluate the utilisation of innovative debt-for-climate swaps to reduce Pakistan's debt burden and financing cost, while ensuring getting minimum payment for existing plants. Also, Chinese stakeholders can utilise their excellent relations with Pakistan's stakeholders to negotiate the design of the "win-win-win" situations of coal phase-down, renewables deployment, and debt reduction. Furthermore, greening CPEC is a core ambition of Pakistan and China to scale experiences abroad. Financing accelerated energy transition should be used as a role model for other BRI countries.

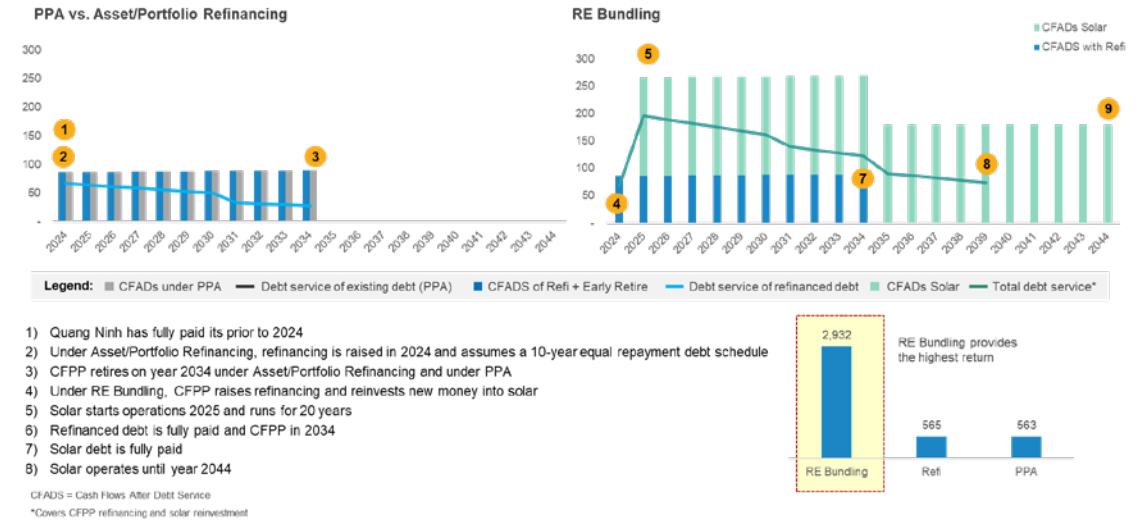
Appendix 1: Sample cash flows for Vietnam's Hai Phong and Quang Ninh CFPPs

Illustrating the impact of Asset/Portfolio Refinancing and RE Bundling on Hai Phong's operating life:



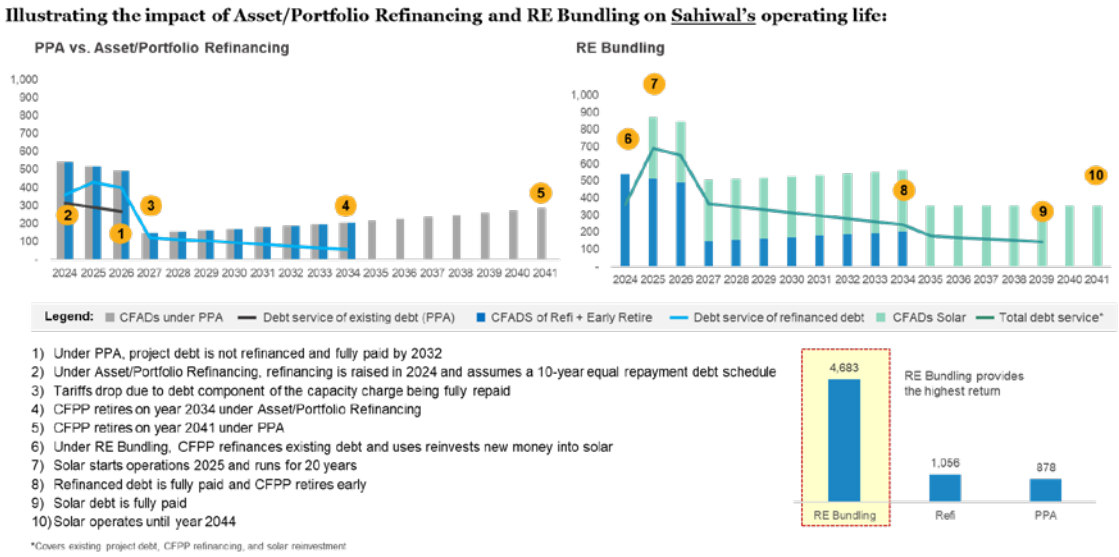
Source: Authors

Illustrating the impact of Asset/Portfolio Refinancing and RE Bundling on Quang Ninh's operating life:

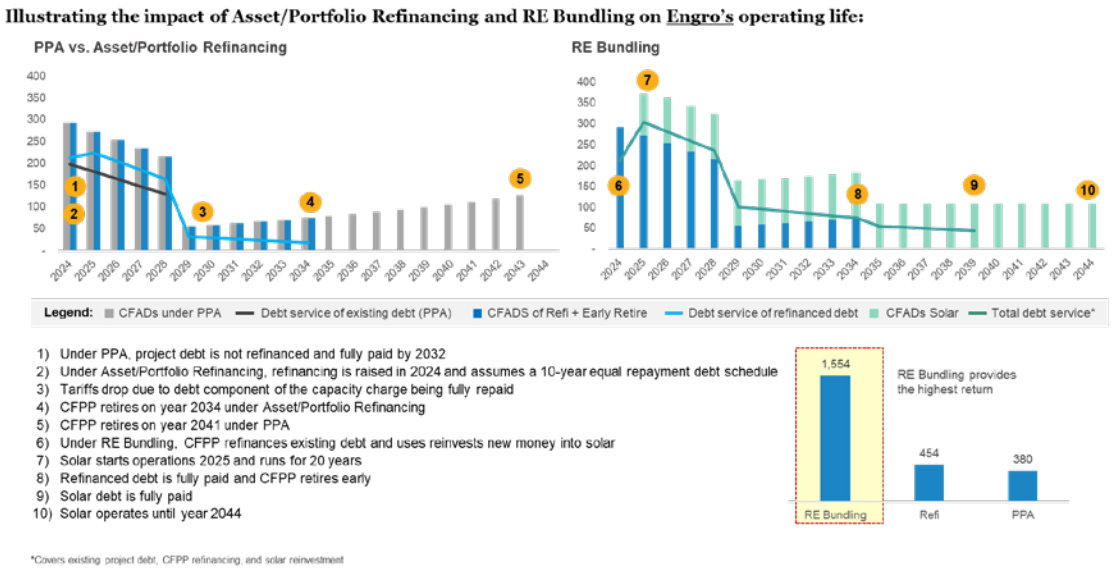


Source: Authors

Appendix 2: Sample cash flows for Pakistan's Sahiwal and Engro CFPPs



Source: Authors



Source: Authors

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About Griffith Asia Institute

Griffith Asia Institute (GAI) at Griffith University, Brisbane, Australia, is an internationally recognised institute providing knowledge, and solutions for sustainable development in Asia-Pacific. With a history of over 20 years, GAI has forged strong partnerships with key decision-makers in business, policy and with research institutions across the region. With over 80 faculty members and 50 adjunct members, GAI works in multidisciplinary teams and draws on a wide range of technical expertise in energy, finance, policy, and economics as well as in regional studies including a strong China component.

GAI is led by Professor Christoph Nedopil Wang and is organised through knowledge and regional hubs:

The Green Transition and Sustainable Development Hub addresses major challenges and opportunities for Asian and Pacific economies in addressing SDGs related to climate, life on land, life in the sea, partnerships, infrastructure and energy.

The Governance and Diplomacy Hub addresses major challenges and opportunities in the region for peaceful co-existence, diplomacy, inclusive governance, policymaking and institution building.

The Inclusive Growth and Rural Development Hub addresses major challenges and opportunities in the region regarding currently underserved communities (e.g., women, indigenous, youth, rural, or people with disabilities).

The four regional hubs address major regional and country-specific challenges and opportunities in (1) Southeast Asia, (2) South Asia, (3) Pacific and (4) China and the Region, each with their own hub lead.

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About the Green Finance & Development Center

The Green Finance & Development Center (GFDC) is a leading research center that provides advisory, research and capacity building for financial institutions and regulators for green and sustainable finance in China and internationally.

The GFDC works at the intersection of finance, policy, and industry to accelerate the development and use of green and sustainable finance instruments to address the climate and biodiversity crisis, as well as contribute to better social development opportunities.

The topics of our work at the Green Finance & Development Center respond to the needs and developments of the financial markets and related policies in China and internationally, while we also aim to provide evidence-based advisory and research for future policies and strategies to accelerate the greening of finance in policy and practice.

The Green Finance & Development Center was founded in 2021 by Christoph Nedopil Wang. It is associated with the Fanhai International School of Finance (FISF) at Fudan University in Shanghai, PR China.

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About Climate Smart Ventures

Climate Smart Ventures (CSV) is a proven leader in harnessing capital market driven solutions to retire fossil fuel-fired power plants and replace them with renewables to deliver a just and managed transition suited for Asia's growth.

CSV provides transition advice via robust technical and strategic advice to integrate transition as a value-creating platform for growth. CSV also offers transaction advice through the best-in-class financial advice and deal execution focused on transition goals and strategies.

CSV has local presence in five market and active engagements in 12 countries with partners, CSV operates across diverse social, economic and political contexts to unlock the power of finance for achieving decarbonisation goals.

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