Global Practices for Financing of Early Coal Retirement for Accelerated Green Energy Transition

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Executive Summary

Coal-fired power is recognized as a major driver of global climate change. To reduce emissions, a number of countries around the world have started phasing out coal power and agreed to stop building new coal-fired power plants at home and abroad. In addition to their climate change implications, coal-fired power plants have become uncompetitive due to the rapidly falling cost of alternative energies. Should electricity generation be locked into more expensive coal power, either the consumers or the governments (e.g., through subsidies) would need to pay for higher energy prices in order to keep the cash flows of coal-fired power plants positive.

In response, many global, regional and national initiatives have been announced to accelerate the clean transition of coal-fired power plants, especially in developing countries. These initiatives have different focuses but also support and complement each other. They also share similar aims such as mobilising private investors with public financing, improving policy setting and governance, enhancing partnership and ensuring a socially just transition, etc.

This report reviews global, regional and national initiatives for facilitating the early retirement of coal-fired power plants and draws lessons for financing a just transition and ensuring energy security. We start by providing an overview of global coal power fleets, including their current status and profitability, and then discuss existing and proposed approaches for early coal retirement, including:

- Global and regional initiatives, including Coal Asset Transition Accelerator (CATA), Accelerating Coal Transition (ACT), Energy Transition Mechanism (ETM), and EU Just Transition Mechanism;
- National initiatives, e.g., in Indonesia, Chile, South Africa, Germany, the US;
- Other proposals or approaches by think tanks and academia.

As financing is a key factor for facilitating coal retirement, we discuss globally applied and proposed financing options, including ratepayer-backed bond securitization, asset portfolio securitization, carbon retirement portfolios, and carbon avoidance bonuses.

From existing experience, we summarise several factors that should be considered when preparing for early coal retirement:

1. **Political buy-in:** as current coal retirement initiatives are driven by the public sector, an established policy environment and credible governance are almost always prerequisites for reducing uncertainty for investors and operators, securing multilateral concessional financing and mobilising private capital;
2. **Cooperation with operators:** for the retirement of coal assets, either by buying them out directly or repurposing them for renewable energy projects, engagement with operators (state-owned companies or private investors depending on different cases) of coal-fired power plants is critical for the successful retirement of coal-fired power plants;
3. **Devising a just transition plan for affected employees and communities:** to cushion adverse social impacts and to provide new opportunities to employees of to-be-retired coal-fired power plants and affected communities, a just transition plan needs to be made years before the actual transition is implemented;
4. **Finding the right financing options**: financing for early coal retirement can take various forms, e.g., refinancing, securitization, investment portfolios, carbon avoidance bonuses. These options could be applicable in different

countries and situations: commercial options might be more attractive to older assets in developed markets, while financing options provided by multilateral or national development banks are more accessible to developing countries for early feasibility studies, providing incentives to operators of coal plants and supporting affected employees and communities;

5. **Electricity and grid planning**: grid planning, especially in developing countries with limited power accessibility, is needed to compensate for any intermittences of green energies or long distances between the electricity source and demand in cities;
6. **Legal and institutional planning**: both the set-up of an official framework and the implementation and supervision during coal plant phase-out need legal and institutional planning in advance.

Finally, as China tightens regulations for coal plants at home and commits to stopping building new coal-fired power plants abroad, we offer policy recommendations for Chinese stakeholders engaged in overseas coal-fired power plants on the early retirement of coal assets:

1. **Understand the economics**: Evaluate the *net present value (NPV)* of existing Chinese-backed overseas coal-fired power plants in comparison to the NPV of alternative new energy installations (including relevant grid extensions and power storage facilities) on an asset level for select pilot countries. The pilot countries should be a country with relevant Chinese engagement in coal-fired power plants and a stated interest in reducing the share of fossil fuel energy in the power mix (e.g., Pakistan, Indonesia, Vietnam). In the calculations, relevant financing costs, as well as various scenarios for shadow carbon prices, fuel prices, price decreases in solar/wind energy and timeframes (e.g., retirement in 2025, 2030, 2035) should be included. Furthermore, evaluate the economics including *electricity prices*: alternative sources of electricity that can provide lower-cost electricity to consumers, including industrial consumers, could improve the overall economics of replacing the coal-fired power plant.
2. **Evaluate Chinese and host country policy goals:** Chinese policymakers have emphasized the relevance of green development at home and abroad, the relevance of the Paris Agreement to limit global warming domestically and for BRI development, and explicitly announced support for green energy development in BRI countries, in African countries and globally. With fossil-fueled power recognized as a non-Paris-aligned energy source, Chinese investors, developers, and fossil fuel owners can evaluate how to support publicly stated Chinese policy goals. At the same time, BRI host countries have explicitly stated goals to de-carbonize their economies, not least through their nationally-determined contributions (NDCs). Accordingly, supporting BRI countries to achieve these goals could take the form of supporting early coal retirement.
3. **Engage with pilot countries**: Engage pilot countries on a political level to discuss technical, legal, political, and financial cooperation on early coal-retirement of identified potential assets. This should help understand hidden costs and opportunities, as well as other legal and social risks of early coal retirement while ensuring political interest and support in the host country. Engage with local society to understand requirements and needs to reduce

coal reliance and possibilities to reduce electricity costs. This could also help local policymakers in their decisions and provide relevant policy frameworks for early retirement.

4. **Develop and evaluate green energy scenarios with the pilot country**: Understand specific requirements of energy planning in the pilot country and simulate supply and demand in various scenarios of early coal retirement. Particularly as networks might not be available for supporting intermittent electricity supply or as energy storage might not be sufficiently developed, this energy planning should take a phased approach.
5. **Engage with existing asset owners**: Evaluate requirements and negotiation strategies with asset owners on early retirement. As each country and the coal-fired power plant might be owned and operated under different governance structures, competent negotiation partners could also provide existing asset owners relevant participation in new energy parks to improve willingness to engage.
6. **Financing mechanism**: Depending on the NPV calculations (e.g., NPV of existing coal-fired power plants is much/little lower/higher than NPV of alternative energy investment), evaluate different financing mechanisms that can include both domestic and international, as well as multilateral sources of finance:
   a) NPV of alternative energy is higher: evaluate commercial financing solutions;
   b) NPV of alternative energy is slightly lower: evaluate blended finance solutions;
   c) NPV of alternative energy is much lower: no action or secure philanthropic/public funding.

   As international commercial and development financial institutions are interested in supporting the expansion of green energy in their portfolios, more financing options for green energy investments, including financing retirement are available, some of which were mentioned above (e.g., ADB ETM).
7. **Support engagement with local communities and employer**s: although this step would also be the responsibility of the local government and asset owner, competent Chinese partners could provide guidance and share experience in job transition. For example, Chinese partners can provide relevant capacity building and job opportunities in energy transition by investing in local manufacturing of relevant equipment.

Despite early trials, early coal retirement is highly complex, and often requires evaluation of economics, legal and social considerations on the asset level to find specific solutions for each coal-fired power plant. In this regard, however, financing coal retirement is just as complex as financing any new coal project that requires project-specific evaluations.

加速绿色能源转型：提前退役煤炭的全球融资实践

执行摘要

燃煤发电被认为是推动全球气候变化的主要因素之一。为了减少排放，世界上越来越多的国家已经开始逐步淘汰煤电，并承诺在境内和境外停止新建燃煤电厂。除了对气候变化的影响，由于可替代能源的成本迅速下降，燃煤电厂在经济性方面也越来越缺乏竞争力。因此，如果一直采用更昂贵的燃煤电厂发电，为保证燃煤电厂的正现金流，消费者或政府（如通过补贴）将需要支付更高的能源价格，以保持燃煤电厂的现金流。

在此背景下，不少全球性、区域性和国家倡议开始致力于加速（特别是在发展中国家）燃煤电厂的清洁转型。这些倡议的重点各不相同，但也相互支持和补充。它们通常有类似的目标，如利用公共资金撬动私人资本，改善政策制定和治理，加强伙伴关系，确保能源转型中的社会公正等。

本报告研究了世界各地促进燃煤电厂提前退役的做法，并总结了为保证公平过渡提供资金和确保能源安全的经验教训。报告首先概述全球燃煤电厂的演变、现状和盈利情况，然后讨论了已推行和规划中的煤电提前退役机制，包括：

- 全球和地区倡议，如煤炭资产转型加速平台（CATA）、加速煤炭过渡（ACT）项目、能源过渡机制（ETM）、欧盟公平过渡机制等；
- 国家倡议，如印度尼西亚、智利、南非、德国、美国的实践；
- 其它智库和学界的提议。

由于融资是煤电提前退役的关键因素，报告还讨论了可采用的融资模式，包括纳税人支持的债券证券化、资产组合证券化、碳退役投资组合、减排奖金等。报告总结，在为早期煤炭退役做准备时，应至少考虑六个要素：

1. **政治意愿**：由于目前煤炭退役主要由公共部门推动，因此，成熟的政策环境和可信的治理是减少投资者和经营者面对的不确定性、确保多边优惠融资和调动私人资本的前提条件；
2. **与运营商合作**：针对煤炭资产的退役（不管是直接买下还是改为可再生能源项目），与燃煤电厂的运营商（取决于不同情况，可能是国有公司或私人投资者）接触，对于燃煤电厂的成功退役至关重要；
3. **为受影响的员工和社区制定公平过渡计划**：为了减轻不利的社会影响，并为即将退役的燃煤电厂的员工和受影响的社区提供新的机会，需要在退煤计划开始实施之前制定一个公正的过渡计划；

4. **选择合适的融资方案**：为提前退煤进行融资可以采取各种形式，如再融资、证券化、投资组合、减排奖金等。融资方案需要适用于不同国家的情况，例如商业性融资方案可能对发达市场的旧资产更有吸引力，而发展中国家更容易得到多边或国家开发银行提供的融资，用于早期的可行性研究，为煤电厂的经营者提供激励，支持受影响的员工和社区等；
5. **电力和电网规划**：特别是在电力可及性有限的发展中国家，电网规划对于解决退煤后绿色能源的间歇性问题、电力传输挑战等至关重要；
6. **法律和机构规划**：官方煤电退役框架的建立以及煤电厂淘汰过程中的实施和监督都需要提前规划。

最后，随着中国收紧对国内燃煤电厂的监管并承诺不再新建境外煤电项目，报告为中国利益相关者提出关于"一带一路"国家燃煤电厂提前退役的政策建议：

1. **了解现有燃煤电厂的盈利情况**：评估现存中国企业支持的海外燃煤电厂的净现值，并与可替代能源项目（包括配套电网和储能设施）在资产层面上进行比较。试点可以是中国企业参与燃煤电厂投建、并明确表示有兴趣降低化石能源在电力结构中的比例的国家（如巴基斯坦、印度尼西亚、越南）。在计算中，应包括相关的融资成本，以及碳排放影子价格、燃料价格、太阳能/风能的价格下降和时间框架（如 2025 年、2030 年、2035 年退役）的各种情景。 此外，评估包括电价在内的经济性：例如，替代性电力来源能否为消费者（包括工业消费者）提供更低成本的电力？如果是，这将提高替代燃煤电厂的整体经济可行性。
2. **评估中国和东道国的政策目标**：中国的政策制定者强调绿色发展在国内外的意义和《巴黎协定》对国内低碳转型、"一带一路"发展、遏止全球变暖的意义，并明确表示支持"一带一路"国家、非洲国家和全球的绿色能源发展。随着化石燃料被确认为与《巴黎协定》目标不一致的能源，中国的投资者、开发商和化石燃料资产所有者可以评估如何支持中国公开声明的政策目标。同时，一些"一带一路"国家已明确提出了经济去碳化的目标（特别是通过国家自主贡献）。支持煤电项目的提前淘汰可以成为支持这些国家实现目标的途径。
3. **与试点国家进行接触**：在政治层面上，就潜在煤电资产的提前退役在技术、法律、政治和财政方面的合作进行讨论。这有助于了解提前退煤的隐性成本和机会，法律和社会风险，同时确保东道国的政治兴趣和支持。此外，与当地社会接触，了解减少煤炭依赖的要求，以及降低电力成本的可能性。这也可以帮助当地政策制定者做出决定，并为提前退役提供相关的政策框架。
4. **与试点国家合作制定和评估绿色能源方案**：了解试点国家能源规划的具体要求，模拟各种提前淘汰煤炭的情景下的供应和需求。特别是在电网可能无法支持间歇性的电力供应，或者储能可能没有充分发展的情况下，能源规划应该采取分阶段的方法。
5. **与现有的资产所有者接触**：评估关于提前退役的要求和与资产所有者的谈判策略。由于每个国家和燃煤电厂可能在不同的治理结构下所有和运营，有能力的

谈判伙伴也可以向现资产所有者提供参与新能源园区的机会，以提高参与意愿。

6. **融资机制**：根据净现值的计算结果（例如，现有燃煤电厂的净现值比替代能源投资的净现值高/低得多/少），评估不同的融资机制，包括国内、国际以及多边资金来源：
   a) 替代能源的净现值较高：评估商业融资方案。
   b) 替代能源的净现值略低：评估混合融资方案。
   c) 替代能源的净现值要低得多：不采取行动或争取慈善和公共资金。
7. **支持与当地社区和雇主的接触**：虽然这一步是当地政府和资产所有者的责任，但有能力的中国合作伙伴可以提供指导，并分享就业转型的经验。例如，中国合作伙伴可以提供相关的能力建设，并通过投资当地相关设备的制造，提供支持能源转型的就业机会。

尽管有早期的试验，煤电厂提前退役仍然非常复杂，往往需要在资产层面对经济、法律和社会因素进行评估，为每个燃煤电厂找到具体的解决方案。从这个角度看，煤电项目退役融资就像为任何新的煤炭项目融资一样复杂，需要对项目进行具体评估。

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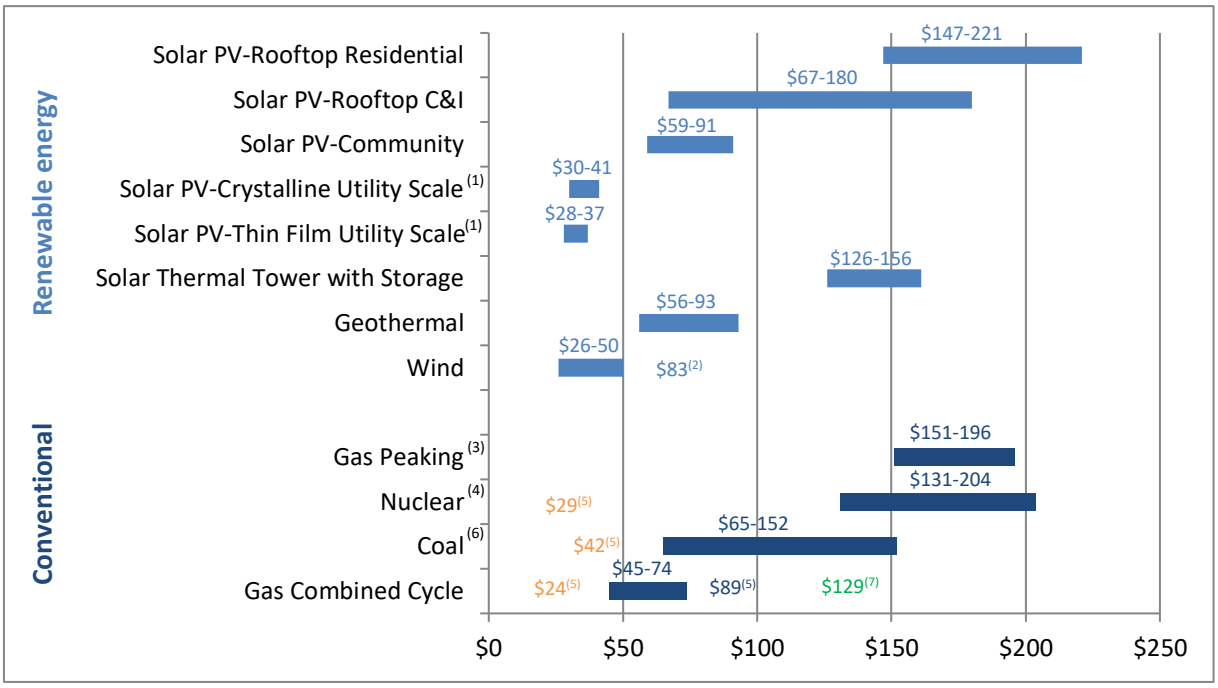
1. Introduction

Coal-fired power is recognized as a major driver of global climate change. To reduce climate emissions, an increasing number of countries around the world have started phasing out coal power and agreed to stop building new coal-fired power plants either at home or abroad. At the UN General Assembly in September 2021, China's President Xi announced that China would no longer build coal-fired power plants abroad.

An important driver for the energy transition is alternative energies, particularly solar and wind. Rapidly decreasing prices for the installation of wind and solar plants have led to the quickly decreasing cost of "green" energies that are often outcompeting the levelized cost of traditional energies, such as coal and gas (see Figure 1).

Figure 1: Levelized Cost of energy comparison without subsidies in 2021



Note: The calculation assumes 60% debt at an 8% interest rate and 40% equity at a 12% cost.
(1) The low case represents a single-axis tracking system and the high case represents a fixed-tilt system.
(2) Represents the estimated implied midpoint of the LCOE of offshore wind, assuming a capital cost range of approximately $2,500-$3,600/kW.
(3) The fuel cost assumption for Lazard's global unsubsidized analysis for gas-fired generation resources is $3.45/MMBTU.
(4) The analysis does not reflect decommissioning costs, ongoing maintenance-related capital expenditures or the potential economic impacts of federal loan guarantees or other subsidies.
(5) Represents the midpoint of the marginal cost of operating fully depreciated gas combined cycle, coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for decommissioned gas combined cycle or coal asset is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating gas combined cycle, coal and nuclear assets across the U.S. capacity factors, fuel, variable and fixed operating expenses are based on upper-and lover-quartile estimates derived from Lazard's research.
(6) High end incorporates 90% carbon capture and storage. Does not include cost of transportation and storage.
(7) Represents the LCOE of the observed high case gas combined cycle inputs using a 20% blend of "blue" hydrogen (i.e., hydrogen produced from a steam-methane reformer, using natural gas as a feedstock, and sequestering the resulting CO_2 in a nearby saline aquifer). No plant modifications are assumed beyond a 2% adjustment to the plant's heat rate. The corresponding fuel cost is $5.20/MMBTU, assuming $1.39/kg for blue hydrogen.

Source: Adapted from Lazard (2021)[1]

As a consequence of the decreasing cost of alternative energies, operations of existing coal-fired power plants have not only negative climate effects, but

also increase economic costs: given it is now cheaper to produce electricity via renewables compared to coal-fired power plants,[2] electricity prices should fall below the cost of coal-fired electricity. To compensate for operating coal-fired power plants, either the consumer or the government through subsidies needs to pay the higher cost to keep coal-fired power plants profitable.

To reduce energy costs and climate emissions, interest in the "early retirement" of coal-fired power plants has been increasing both in developed and developing countries, including Chile, Pakistan, Germany, and the US. Such early retirement, however, needs careful consideration of multiple factors:

- Stability of electricity supply
- Socially just transition of employees in the coal sector
- Legal considerations
- Financial considerations, particularly of capital expenditure

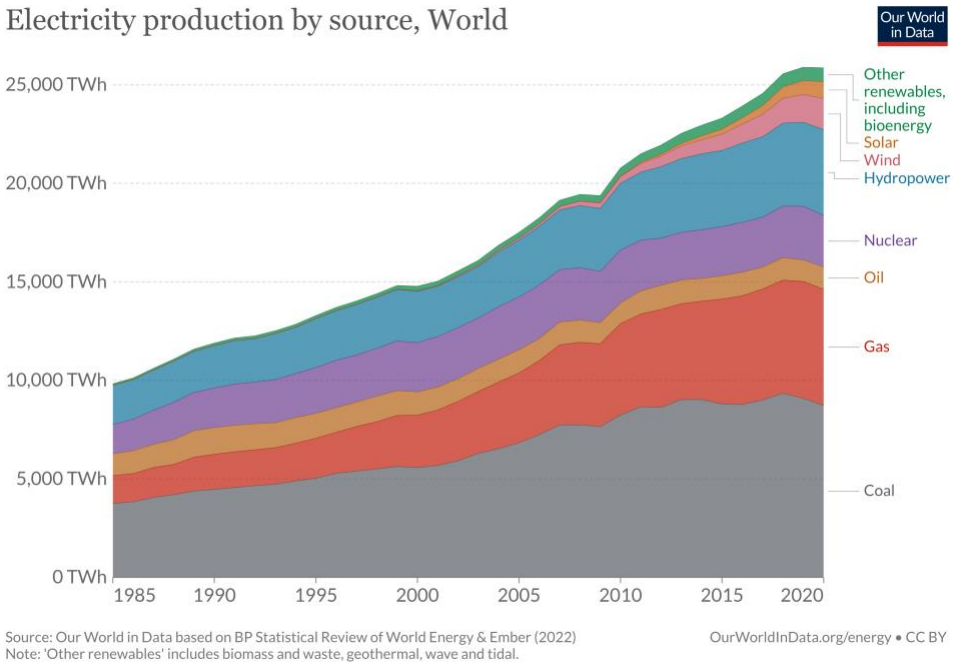
In this report, we look at options for financing early coal retirement and provide insights on applying them to overseas coal projects. The report starts by looking at the background of global coal power fleets and then analyses existing and applied approaches and initiatives for early coal retirement. It further analyses financial approaches to support early coal retirement to draw lessons before providing a summary and policy recommendations.

2. Background – The End of Coal?

2.1 Coal-Fired Power Generation in the World and Its Climate Impact

Since 2015, there has been a noticeable drop in the share of global electricity production from coal and an increase in the shares of renewables. In 2020, however, with 9,440 TWh of generated electricity,[3] coal still remains the largest source of the global electricity mix with a share of 34%, compared with approximately 23% from gas, 17% from hydropower, 10% from nuclear, 6% from wind and 3% from solar (Figure 2).[4]

Figure 2: Global electricity generation by source, 1985 to 2020

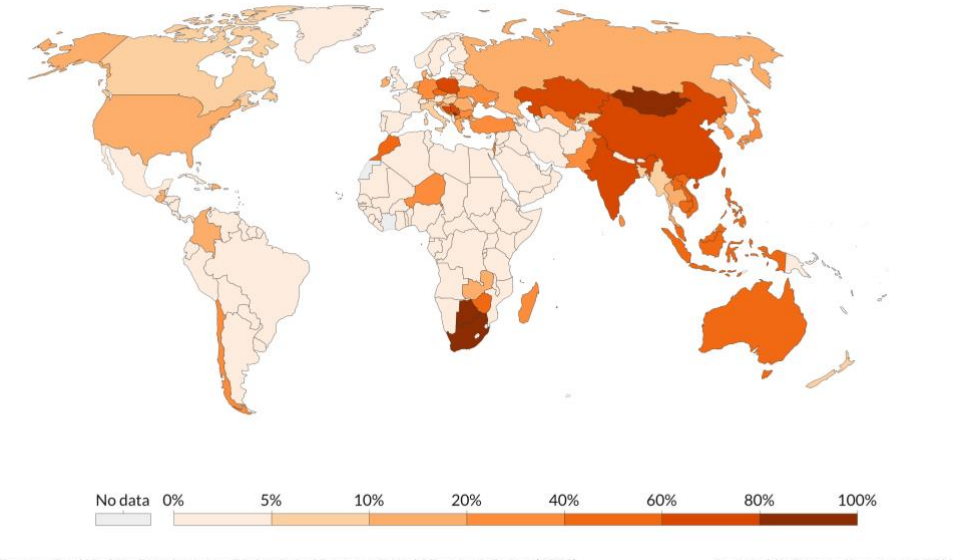


Source: Our World in Data (2022)[4]

The role of coal in electricity generation in some countries is more important than in others (

Figure 3):[4] in 2020, over 80% of electricity is generated from coal in South Africa, Mongolia, Botswana, and Kosovo. Besides, most countries of the Asia Pacific region, including Australia, China, India, Japan, Kazakhstan, Vietnam, and Indonesia, see over half of their electricity generated from coal, compared with 19% in the US[5], 13% in the EU[6] and (close to) 0% in many countries in Africa, Middle East and South America.

Figure 3: Share of electricity production from coal in 2021



Source: Our World in Data (2021)[4]

Similarly, the number of units and the total capacity of coal-fired power plants in operation vary across regions (

Table 1). Most coal-fired power plants in operation are situated in East, Southeast and South Asia, and coal-fired power plants in China, the US and India total around three-quarters of global capacity.

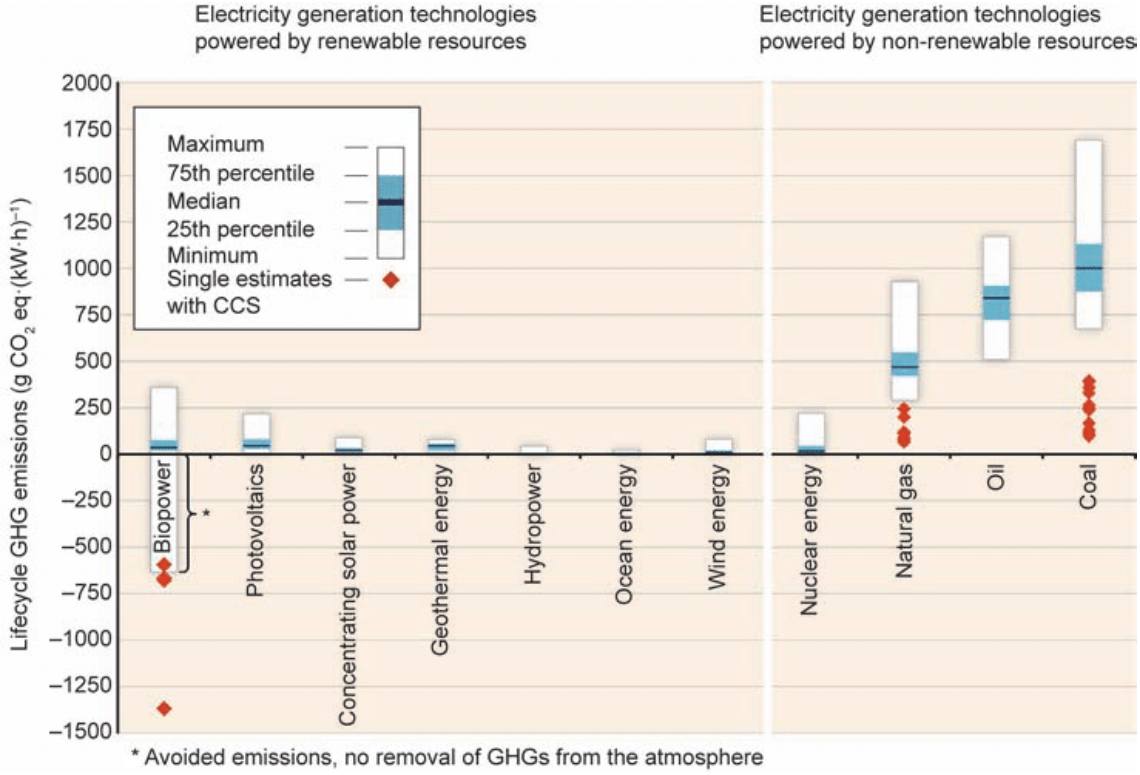
Table 1: Number of coal-power plants and capacity in operation by region

Region/country	Units in operation (July 2021)	Capacity in operation in MW (July 2021)	Share of Global total capacity
Africa and Middle East	158	55,508	2.7%
Australia/NZ	62	25,607	1.2%
Canada/US	525	240,294	11.6%
US	*498*	*232,772*	*11.3%*
East Asia	3,341	1,161,729	56.2%
China	*2990*	*1,046,893*	*50.6%*
EU27	476	117,749	5.7%
Eurasia	436	59,966	2.9%
Latin America and the Caribbean	100	18,340	0.9%
non-EU Europe	237	57,364	2.8%
SE Asia	382	90,396	4.4%
South Asia	876	240,760	11.6%
India	*855*	*233,077*	*11.3%*

Source: Compiled by authors based on Global Energy Monitor (2021)[7]

In recent years, electricity generation from coal has been viewed as one of the biggest threats to the fight against climate change due to its high levels of greenhouse gas emissions. As Figure 4 shows, the lifecycle GHG emissions of electricity powered by coal without Carbon Capture and Storage is the highest among non-renewable resources.

Figure 4: Lifecycle greenhouse gas (GHG) emissions of electricity generation technologies powered by renewable and non-renewable resources



Source: IPCC (2011)[8]

In 2020, the annual production-based emissions of carbon dioxide (CO_2) from coal are 14 billion tons, accounting for almost 40% of the global total, compared with 33% from gas and 20% from oil[9].

2.2 Status of Global Coal-fired Power Plants

The pipeline of coal-fired power plants includes several statuses: *announced*, *pre-permit*, *permitted*, *construction*, *operating*, *retired* in a normal lifecycle, Figure 5):

- There has been an increase in the capacity of coal-fired power plants being **retired**, driven by multiple factors such as flattened electricity demand growth, increased competition from natural gas and renewables[10], or a commitment to curbing global warming[11];
- In 2019 and 2020, the annual addition of capacity from started and resumed construction has seen a significant drop from

and sometimes *shelved*, *mothballed* or *cancelled* if plans are changed.

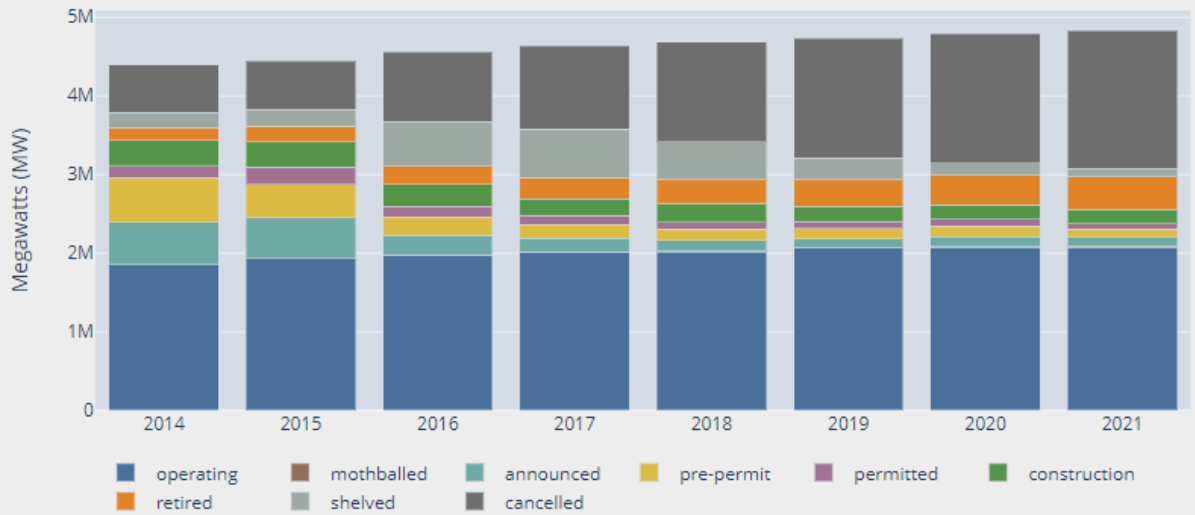
Data from Global Energy Monitor[7] shows the evolvement of the global coal-fired power plants pipeline since 2014 (

2015, but is still similar to/slightly higher than the annual retired capacity;
- Since 2014, the steep increase in **cancelled** capacity has been promising, coupled with major progress in several countries in 2020: The US retired 11.3 GW of coal plants, the EU retired 10.1 GW, and Indonesia, Vietnam, Bangladesh and the Philippines cancelled several major projects;[12]
- Commissioning of **new plants** fell to 50.3 GW in 2020, a decline

of 34% from 2019. China accounted for 76% of the new coal plants in 2020 (38.4 GW);[12]

- The flattened pattern in total capacity in operation and under development from 2019 to 2021 might result from the slow-down of global electricity demand due to COVID-19 instead of a permanent pattern.

Figure 5: Current total capacity of global coal-fired power plants by status, 2014 to 2021

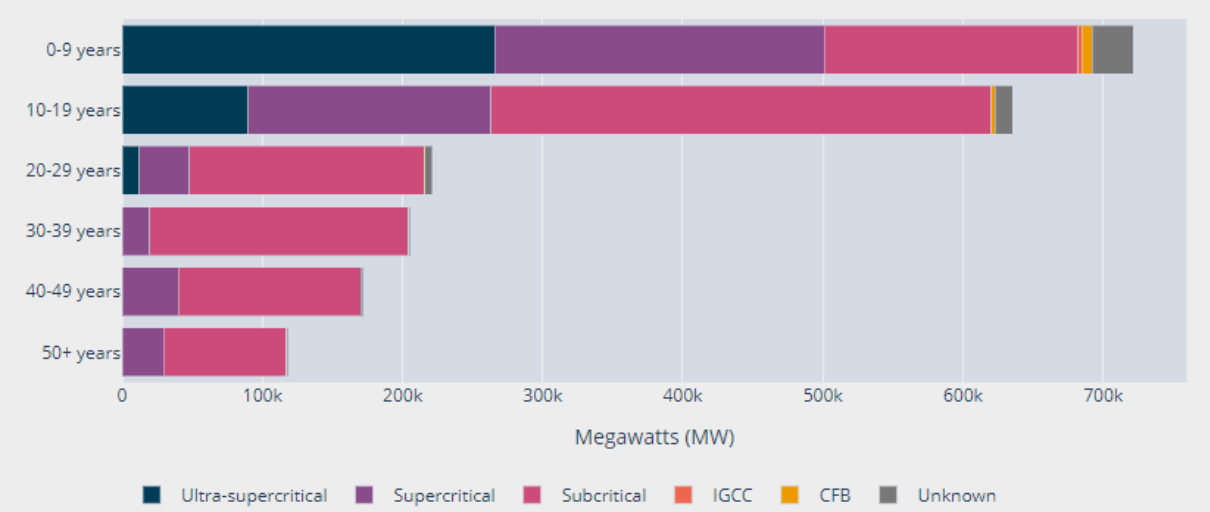


Source: Global Energy Monitor (2022)[7]

Of the over 6,500 coal-fired power plants in operation worldwide, their average ages vary across regions. Coal-fired power plants in Asia are relatively young, e.g., 7 years old in Vietnam, 12 years old in Indonesia, the Philippines and China.[13] In comparison, in advanced economies, the average age of coal plants is 40 years (in the US) and 35 years (in the EU).[14]

As is shown in Figure 6, even about 25% of the younger coal-fired power plants, however, are "subcritical" with lower efficiency than the super-critical and ultra-supercritical types, meaning lower efficiency and even more climate emissions and air pollution per unit of electricity.

Figure 6: Operating Coal Power by Plant Age and Type[1]



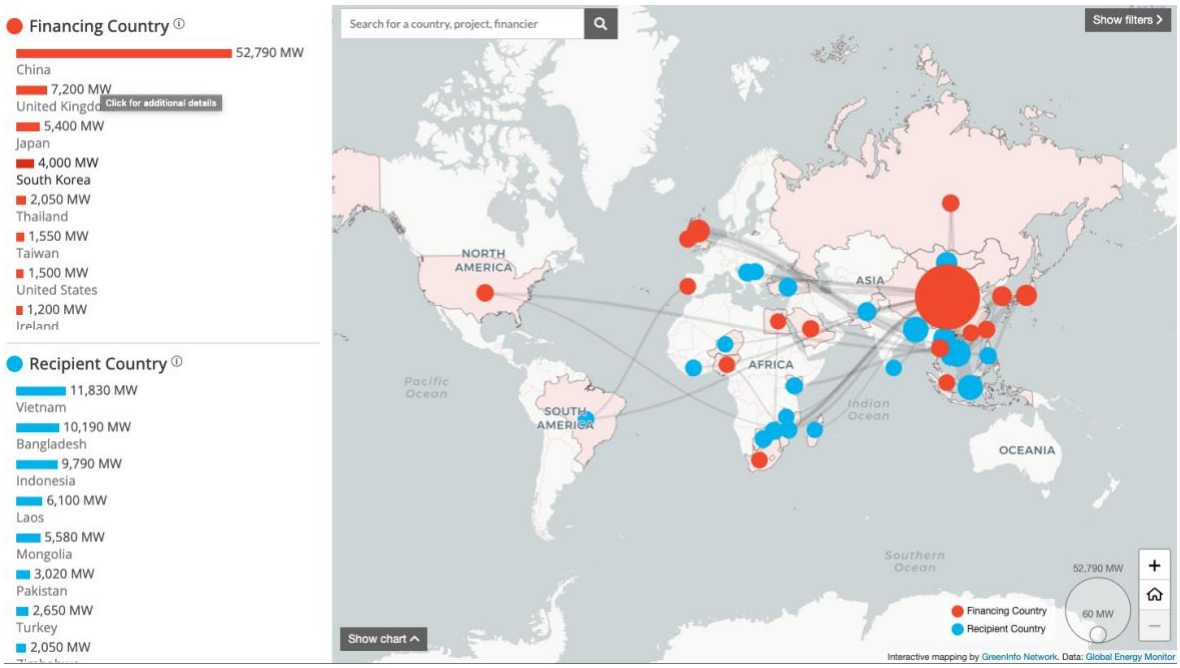
Source: Global Energy Monitor (2022)[7]

2.3 Status of Chinese-funded Overseas Coal-fired Power Plants

Chinese companies and financial institutions are said to currently finance about 52.8 GW of coal-fired power with about USD50 billion (including both public and private finance). The next largest coal-financing countries are the UK (7.2 GW) and Japan (5.4 GW) (see Figure 7). However, when analysing the state of coal-fired power plants announced or under construction, data show that many Chinese overseas coal investments have been stopped, with possibly more coal-fired power plants under construction being delayed or cancelled.

[1] The difference between **subcritical**, **supercritical**, and **ultra-supercritical** versions of pulverized coal combustion technology has to do with the steam pressure within the boiler. In a **subcritical plant,** steam pressure is below 200 bar and temperature is below 550 degrees Celsius. Subcritical units have efficiencies of between 33% and 37% (i.e. between 33% and 37% of the energy in the coal is converted into electricity). In **supercritical units**, the pressure of the boiler is about 243 bar and temperatures are 565 degrees Celsius. Efficiency ratings for supercritical coal plants range from 37% to 40%. In **ultra-supercritical units**, pressures are at 320 bar and temperatures at 600-610 degrees Celsius. (Source: Global Energy Monitor)[15]

Figure 7: Global Overseas Coal Financing



Source: Global Energy Monitor (2022)[16]

As an analysis by Nedopil (2021)[6] on the state of Chinese overseas coal-financing shows[1], 52 coal-fired power projects with Chinese financial participation outside of China had been announced between the second half of 2014 and the end of 2020. Of these announced projects, only one has gone into operation: the 1.3 GW Payra Patuakhali Figure 8), coal investments moving forward (that is coal-fired project whose status has changed to announced, permitted, started construction or going into operation) saw their peak in 2015 and 2016. By 2020, the value of projects moving forward was reduced to less than USD2 billion. At the same time, the value of projects moving backwards

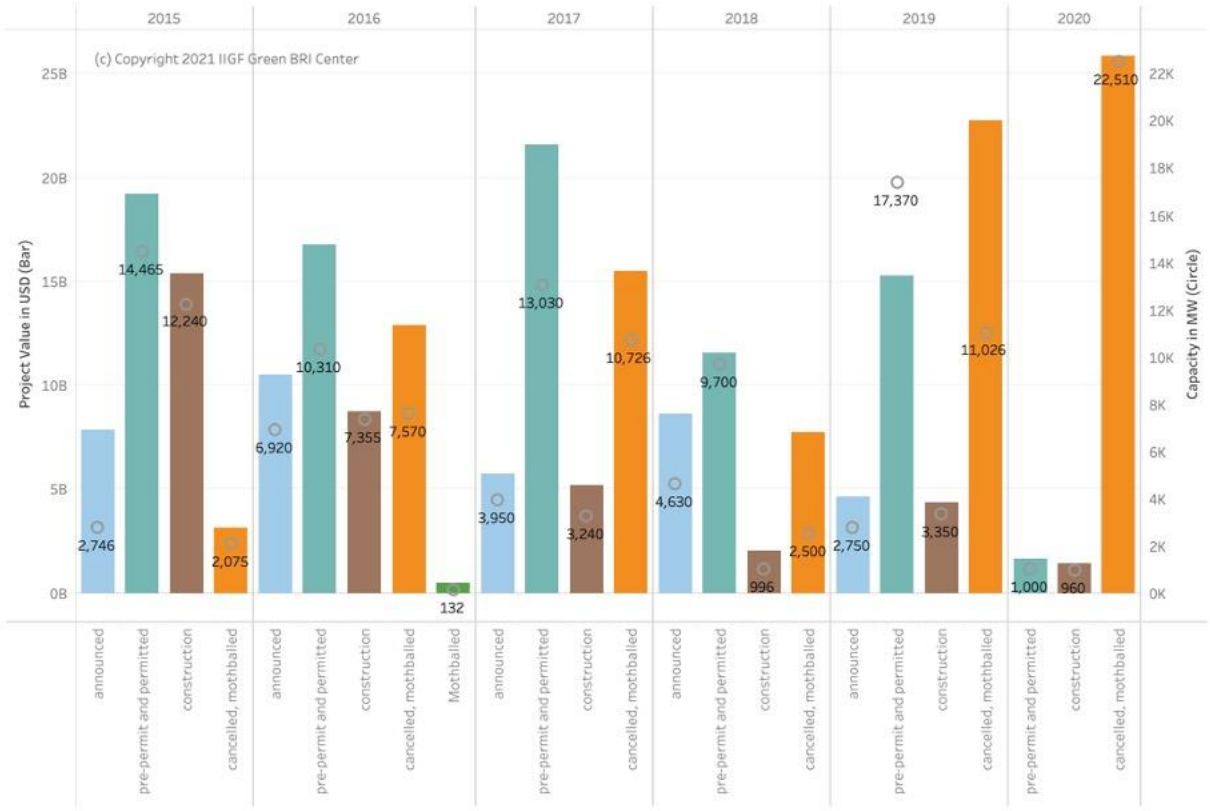
coal power station in Kalapara, Bangladesh, in the first half of 2020.

At the same time, 25 of the projects announced since 2014 have been shelved and 8 were cancelled[2]. Looking at the development between 2015 and 2020 (see

(that is projects whose status changed to cancelled, mothballed or shelved) increased from about USD2 billion in 2015 to about USD22 billion in 2019 and USD25 billion in 2020 (which equals about 23 GW of power). By 2020, less than USD1 billion worth of coal-fired power projects went into construction, while no new coal-fired power plants with Chinese financing were announced.

[2] Reasons for cancellations vary, from changes in local policy (e.g., Bangladesh, Egypt) to changes in financing conditions.

Figure 8: China's overseas coal investment pipeline (bars are value in USD, circles are capacity)



Source: Nedopil, 2021, Data: GEM[18]

Despite these encouraging trends, Chinese operators still owned about 30-40 operating coal-fired power plants outside of China at the end of 2020.

2.4 Profitability of Existing Coal-fired Power Plants

With decreasing cost of renewable energies, particularly a drop of 90% of the cost for solar panels over the past 10 years, the economics of coal-fired power plants have changed. Generally, the profitability of existing coal-fired power plants is affected by several factors such as:

- Volatility in fuel costs
- Carbon prices (e.g., emission trading system, carbon tax)
- Financing costs
- Revenues
- Emissions regulation and standards
- Subsidies

Based on the analysis of 6,685 coal plants worldwide, Carbon Tracker found that 42% of global coal capacity is already unprofitable because of high fuel costs; by 2040, that could reach 72% because existing carbon pricing and air pollution regulations drive up costs while the price of onshore wind and solar power continues to fall.[19] Other studies also make national or regional analyses, such as Australia's National Electricity Market (

Box 1).

Box 1 Australia's National Electricity Market (NEM)

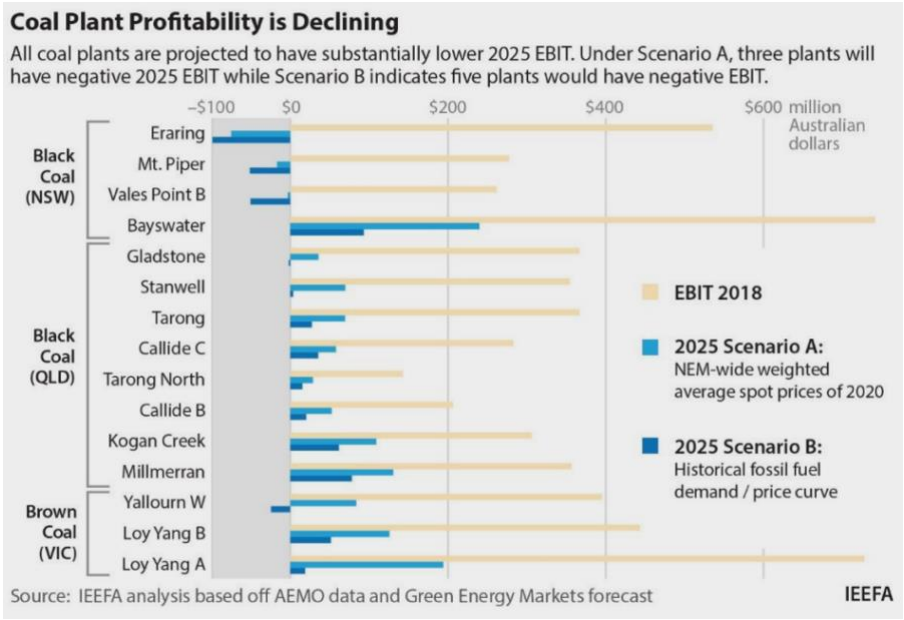
According to Green Energy Markets and Institute for Energy Economics and Financial Analysis (IEEFA), in the next 5 years, coal-fired power plants in Australia's National Energy Market (NEM) will face severe financial difficulties as a result of an influx of renewable energy supply. [20]

The analysis develops two scenarios:

A. Wholesale electricity prices in 2025 are the same as NEM-wide 2020 prices.
B. Prices fall below 2015 prices.

In both scenarios, Eraring, Mt Piper and Vales Point B would be expected to lose money (Figure 9). However, the projection is based on the assumption that generators are fully spot market exposed (i.e., do not include contracts). It also excludes revenue from other services such as frequency control and ancillary services.

Figure 9: Coal Plant Profitability Projection



Source: Green Energy Markets and IEEFA (2021)

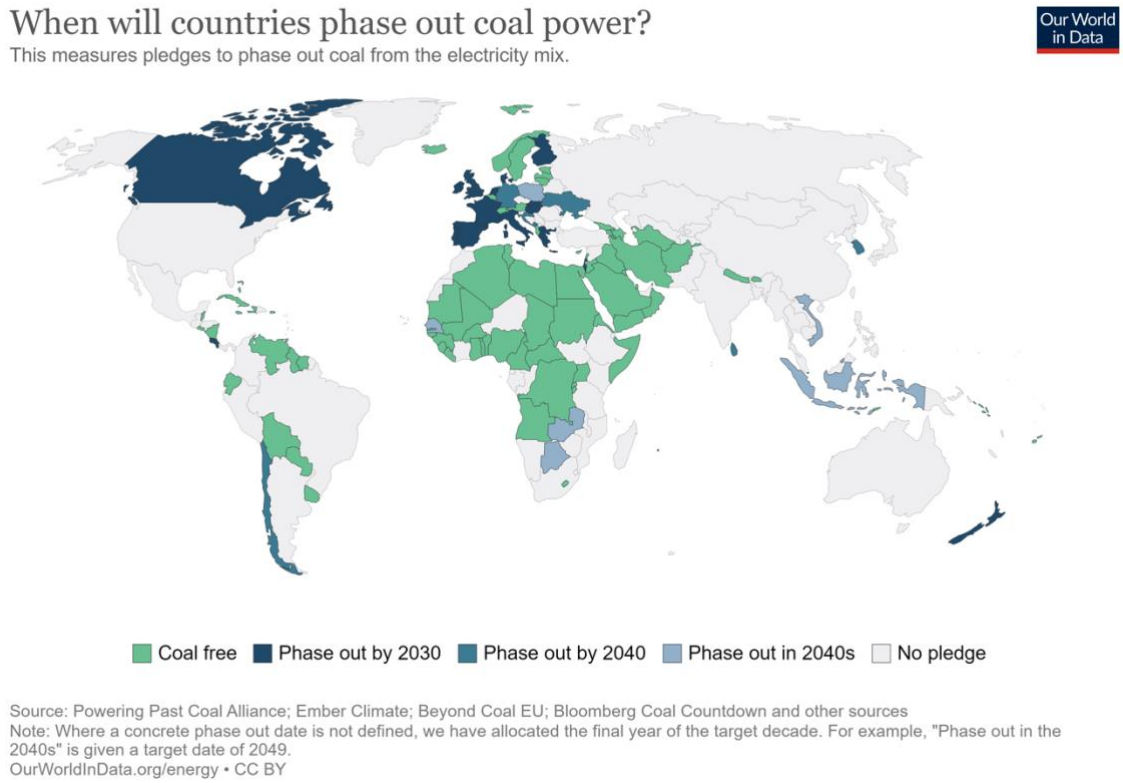
In practice, however, there is more complexity in the profitability of coal-fired power plants in different markets and during different times. For example, in the first three quarters of 2020, despite the decreased volume of on-grid electricity, most coal plant owners in China ended up with a profit because the prices of coal also plummeted amid COVID-19;[21] in 2021 as coal prices recover, most existing plants had become loss-making.[22] In other parts of the world where high subsidies for fossil fuels still exist or long-term PPAs are in effect, it might be hard for plant owners to recognize and quantify the profitability of their coal-fired assets.

2.5 Global Progress on Early Coal Retirement

Many countries have committed to phasing out coal power completely from their electricity mix by a certain year. Some countries are already coal-free.

Figure 10 shows the current progress.

Figure 10: Global commitments to coal phase-out



Source: Our World in Data (2021)[23]

OECD countries and the EU continue to take the lead in phasing out coal and retiring existing coal plants, with 56% of operating capacity either closed already since 2010 or scheduled to close by 2030.[24]

In non-OECD countries and emerging economies, as coal plants are generally decades younger, decommissioning of existing coal-fired power plants have been less popular. However, among non-OECD countries, 27 countries have ended the development of new coal power generation through project cancellations and/or policy commitments since 2015. [24]

In countries where coal power remains high in absolute capacity and high weight in electricity mix such as China, the retirement of existing power plants has been challenging. But China has seen a 74% reduction in the scale of its project pipeline, with 484 GW of cancellations since the Paris agreement.[24]

Table 2 Summary of current early coal retirement initiatives

	Initiative	Led by	Region	Funding sources	Details	Status
Global/ regional initiatives	Coal Asset Transition Accelerator (CATA)	RMI, Climate Smart Ventures, the Carbon Trust and the International Network of Energy Transition Think Tanks (INETT)	Global	Philanthropies including the IKEA Foundation and the Growald Climate Fund	- Serve as a centre of expertise to support accelerated coal transition globally - Engage core audiences including countries in transition, public finance institutions, private finance & asset owners, country donors and six society organisations	Inception and planned to launch in mid-2022
	Accelerating Coal Transition (ACT) Program	Climate Investment Funds (CIF) with six multilateral development banks	Developing countries globally	US, UK, Germany, Canada and Denmark	- Work with international development banks to provide a comprehensive financial toolkit and technical assistance.	In development
	Energy Transition Mechanism (ETM)	Asian Development Bank, Prudential, Citi, and Blackrock	Developing countries in the Asia Pacific region	Governments, multilateral banks, private sector investors, philanthropies, and long-term investors	- Buy out the plants and retire them within 15 years - Invest in renewable energy and enabling infrastructure	Feasibility studies for Indonesia and the Philippines are in progress
	Just Transition Mechanism	European Commission	EU countries	EU budget, EIB, national governments	Ensure no one is left behind during the transition to a climate-neutral transition through three pillars: - The Just Transition Fund - A dedicated scheme under InvestEU - New public sector loan facility leveraged by the European Investment Bank (EIB)	Capitalization
National initiatives	Indonesia	Ministry of Energy and Mineral Resources	Indonesia	Asian Development Banks and others	Part of ADB's Energy Transition Mechanism is to retire half of its coal plants early in the next 10 to 15 years	Feasibility study in progress
	Chile	Ministry of Energy	Chile	MSBs and DFIs, e.g., IDB	- Major generators sign voluntary agreements to retire coal plants - Funding from international sources supports the building of renewable energy facilities	Implementation
	South Africa	Government, JETP partner countries	South Africa	US, Germany, France, UK and EU	- Developed countries provide concessional debt instruments - South Africa repays with carbon mitigation performance and cash	In development
	Germany Coal Exit Law	Bundesnetzagentur	Germany	German taxpayer	- Several rounds of reverse auction	Implementation

					- Operators are asked to declare at which price they would be prepared to shut their plants - The regulator sets a maximum price per MW - The ultimate price takes into account the bidder's offers and the CO_2 emissions of the plants in question - Three rounds were held, retiring e.g., 1.35 GW in Oct 2022 - Prices ranged between 0 and 155,000 EUR per MW, with an average of 102,799 EUR per MW	
	US Climate Act, CEPP	White House	USA	Utility providers, taxpayers	- An incentive to increase the share of renewables in grid by 4% each year - Penalty for not meeting targets - Challenged by fossil unions and political representatives and failed to become legislation in Dec 2021	Not enacted

3. Approaches to Early Retirement of Coal-fired Power Plants

To reduce global coal use in electricity generation and contribute to aligning with the 1.5C pathway, cancelling coal projects in the pipeline and ending new financing for coal should be coupled with the early retirement and transition (e.g., repurposing to renewable energy sites) of existing coal plants.[25] This section provides a structured overview of ongoing and proposed approaches worldwide to retire coal-fired power plants before they reach life expectancy by looking at current multilateral and national schemes, as well as further solutions proposed that involve private and public financing options.

3.1 Current Initiatives for Early Coal Retirement

Currently, public entities including multilateral organisations and national governments are the driving force of early coal retirement initiatives. Table 2 provides a summary of what have just started being implemented or have proved some success. In this section, details of each initiative will be provided with a short "lessons learnt" comment.

3.1.1 Global and Regional Coal Retirement Initiatives

Multilaterals' initiatives usually support developing countries, where funding for a clean transition is limited compared with developed countries. While some have acted faster than others, most initiatives are still in the early stages of concept design and feasibility study.

Coal Asset Transition Accelerator (CATA)

CATA is a collaboration platform that provides transition support for the relevant audience including countries in transition, public financiers, private financiers, country donors and civil society organisations. It was funded by philanthropies, including the IKEA Foundation and the Growald Climate Fund, and was announced by RMI, Climate Smart Ventures, the Carbon Trust and the International Network of Energy Transition Think Tanks (INETT) at COP26.[26]

CATA will first support geographies and states that are already engaged in the discussion of energy transition mechanisms, including the Climate Investment Funds Accelerating Coal Transition Investment Program (CIF ACT).[27] Besides, through CATA, Carbon Trust will support Energy Transition Mechanism (ETM) on pre-feasibility study for coal plants retirement in Indonesia and the Philippines.[28]

CATA is in the inception phase and expected to launch in mid-2022.

Lessons learnt:

Partnership between all stakeholders including the public sector, private sector and civil society is key to early coal retirement. CATA provides an important platform to connect knowledge, skills and funding for stakeholders in need.

Accelerating Coal Transition (ACT) Program

Accelerating Coal Transition (ACT) is another transition support program that offers a holistic toolkit to support countries transitioning away from coal. It was established in early 2021, with Climate Investment Funds (CIF) as a multi-MDB financing platform. With financial support from the G7 (who announced up to USD2 billion in support for the ACT and other complementary CIF programs aimed at increasing the penetration of renewables in June 2021), CIF works with six multilateral development banks[3] to provide a comprehensive financial toolkit and technical assistance for participating coal transition countries. Pilots will be carried out in South Africa, India, Indonesia, and the Philippines (representing over 15% of coal-related emissions globally).[29]

In detail, ACT works through three pillars to help developing countries move away from coal:[30]

- ***Governance***: To achieve support and commitment at the country level, the programme will work with country governments on transformation strategies, economic and social development plans, etc.;
- ***People and Communities***: The programme will support socio-economic measures to minimize the impacts of transition on people and communities including a focus on upskilling and re-skilling to help people not only retain jobs where feasible but also prepare for new jobs as available;
- ***Infrastructure***: Reclaiming and repurposing the existing infrastructure, including land and power plants will be a core area of support.

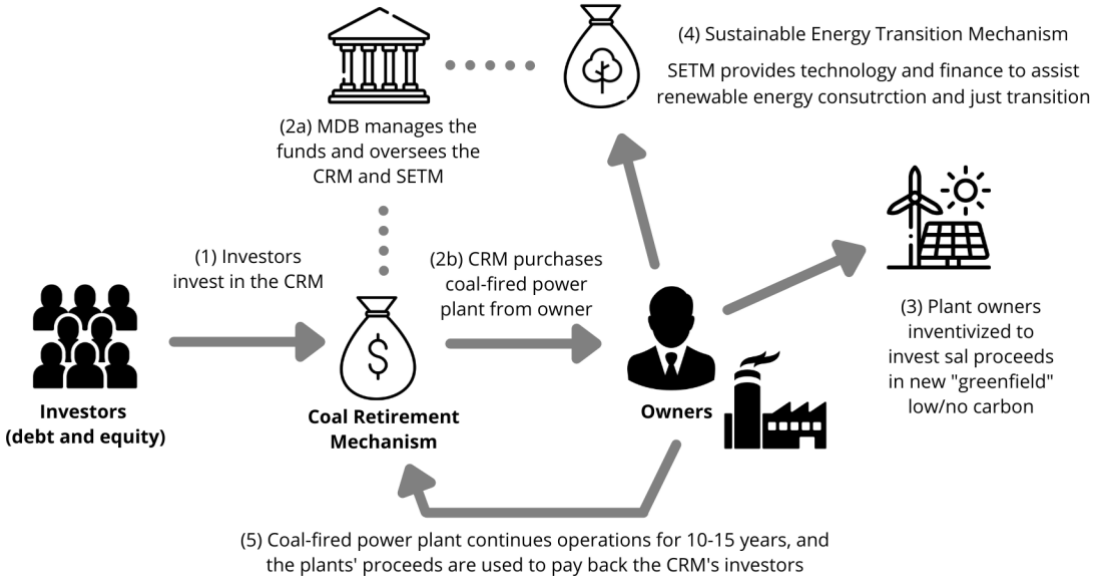
> ***Lessons learnt:***
>
> ***Successful transition in developing countries need multi-level support such as country-level policy and roadmap, lower-level government implementation, socio-economic acceptance, infrastructure preparation etc.***

Energy Transition Mechanism (ETM)

The Energy Transition Mechanism (ETM) is an initiative led by the Asian Development Bank in collaboration with international and regional partners to accelerate the transition from coal to clean energy. It focuses on Asia and the Pacific region and will create two multi-million-dollar funds financed by governments, multilateral banks, private sector investors, philanthropies, and long-term investors. One of the funds will be used to buy out the plants and retire (or repurpose) them within 15 years, far sooner than their usual life. The other one will be mobilised toward renewable energy plants and enabling infrastructure such as grids and storage to provide clean energy (see Figure 11).

[3] i.e., African Development Bank (AfDB), Asian Development Bank (ADB), European Bank for Reconstruction and Development (EBRD), Inter-American Development Bank Group (IDB) and World Bank Group, including the International Finance Corporation (IFC).

Figure 11: Illustration of ETM Coal Retirement Mechanism



Source: Adapted from Kanak (2020)[31]

Lessons learnt:

given the key role of coal electricity and grid conditions in many developing countries, plans for "buying out" existing coal-fired power plants should be coupled with measures to facilitate a smooth transition, such as funding for supporting renewables and enhancing the grid infrastructure.

The exact structure and transactions of the ETM will depend on regional and local needs and conditions. The ADB will provide technical assistance to facilitate a just transition to clean energy. Recent developments include:

- In Nov 2021, Vice-Minister for International Affairs at the Ministry of Finance of Japan Masato Kanda announced Japan's Ministry of Finance was committing a grant of USD25 million as the first seed financing for the mechanism.[32]
- The feasibility study for pilots in Indonesia[4] (where 62% of electricity is generated from coal), the Philippines[5] (57% of electricity from coal) and (possibly) Vietnam is underway involving civil society participation.[33]
- The pilot programme aims to retire 5-7 coal-fired plants in Indonesia and the Philippines, with the first (coal plant) acquisition expected to happen in 2022.[34]

EU Just Transition Mechanism (JTM)

The key mission of the EU Just Transition Mechanism is to alleviate the social and economic impact of the climate transition. It supports regions (e.g., coal-mining regions), industries (e.g., coal-related industries) and workers who will face the greatest challenges, through three pillars:[35]

[4] Indonesia has committed to reducing emissions by 29% by 2030 and achieving net-zero emissions by 2060.

[5] The Government of the Philippines in 2021 announced plans to place a moratorium on new coal-fired power plants.

- A new **Just Transition Fund** of EUR19.2 billion in current prices that supports member countries in need of investments in small and medium-sized enterprises, up-and reskilling of workers, job-search assistance, active inclusion of jobseekers programmes, the transformation of existing carbon-intensive installations, etc.
- The **InvestEU "Just Transition" scheme** that provides funding to companies for investments, within the framework of the Territorial Just Transition Plan, in projects for energy and transport infrastructure, decarbonisation projects, economic diversification and social infrastructure etc.
- A new **Public Sector Loan Facility** that combines EUR1.5 billion of grants from the EU budget with EUR10 billion of loans from the European Investment Bank (EIB), to mobilise public investment that will meet the development needs of just transition territories. It targets public entities and provides support to projects that do not generate a sufficient stream of own resources to be financed commercially. Fossil fuels related investments are excluded.

Lessons learnt:

In countries and regions where a larger and comprehensive climate transition plan is already in place, early coal retirement could be included to improve access to resources and acceptance among stakeholders.

3.1.2 National Coal Retirement Practices

Indonesia: Pilot of Energy Transition Mechanism

As a major producer and exporter of thermal coal, Indonesia has recently made several steps toward moving away from fossil fuels:

- In the 2021-2030 National Electricity Supply Plan (RUPTL) released in October 2021, the share of power generation capacity additions from renewables will account for 52% of total capacity;[36]
- During COP26, the government of Indonesia endorsed clauses 1, 2, and 4 of COP26 Coal to Clean Power Transition statement, committing to phasing out coal in the 2040s conditional on agreeing additional international financial and technical assistance.[37]

Indonesia is also one of the pilots of the Energy Transition Mechanism (ETM) and will get funding for the accelerated retirement of 50% of its coal-fired plants in the next 10 to 15 years. The pilot programme is made up of two funds – one to buy up the power plants before the end of their natural lifespan, and the other one to invest in clean energy and grid upgrades.[38] ADB will work closely with local stakeholders, especially state-owned electricity monopolist PLN to decide on the best retirement plan.

Lessons learnt:

Early engagement with local stakeholders is essential to the success of coal retirement. The business models and stakeholders in fossil fuel plants in developing (esp. Asian) countries can be quite different from the US, EU and Middle East, and thus specific retirement plans should reflect the differences.

Box 2 Challenges of early coal retirement in developing countries: the cases of Indonesia and Pakistan

Despite stronger climate pledges among coal-dependent countries, the early retirement of operating coal-fired power plants can be expensive and full of challenges for a few reasons.

First of all, with the government guarantees on the opaque, long-term power purchase agreements (PPAs), existing coal-fired power plants generally enjoy low-risk, low-cost financing and very high return on investment, e.g., projects under China–Pakistan Economic Corridor.

Second, government subsidies on fossil fuels remain in place around the world, including in many coal-heavy developing countries. For example, Indonesia's Domestic Market Obligation (DMO) policy requires that coal miners supply a quarter of their annual production to state utility PLN at a maximum price (USD70 per tonne) well below current market prices[39].

Furthermore, local content requirements for renewables discourage foreign imports and investment. For instance, the local content requirement for materials and services for solar projects is over 40% in Indonesia [40].

The challenges of early coal retirement and energy transition have been studied in detail by IEEFA[6], RMI[7], and others. To avoid overload of information, this report will focus on best practices and financing options.

Chile: Voluntary Agreements & Climate Finance

As part of its commitment to close all coal-fired power plants by 2040 and retire 65% of coal-fired power plants by 2025[41], the Chilean government has reached voluntary agreements with Chile's four largest generators (AES Gener, Colbún, Enel, and ENGIE) to phase out coal-fired plants without CCS or equivalent technologies. The agreements were signed after nine round-table sessions between Chile's Energy Ministry and industry stakeholders over six months.[42]

Meanwhile, generators will develop new renewable energy and energy storage to compensate for the power lost by the retirement of coal plants.[43]

In particular, IDB Invest (a member of the Inter-American Development Bank Group) provided a USD125 million financial package to ENGIE Energía Chile for building and maintaining a 151-MW wind farm near the city of Calama. The package consists of the following:[44]

- USD74 million senior loans from IDB Invest,
- USD15 million of blended financing from the Clean Technology Fund (CTF), and
- USD36 million from the Chinese Fund for Co-financing in Latin America and the Caribbean.

[6] For example, *Coal Lock-In in Southeast Asia: An Analysis of Existing and Planned Coal-Fired Capacity in Southeast Asia* by Haneea Issad in December 2021; *Indonesia Wants to Go Greener, but PLN Is Stuck With Excess Capacity From Coal-Fired Power Plants* by Elrika Hamdi and Putra Adhiguna in November 2021.

[7] For example, Seven Challenges for Energy Transformation in November 2019;

The financial mechanism supports decarbonization activities in Chile by monetizing the displacement of CO_2 from the retirement of fossil fuel power assets and establishing a minimum price for the emissions through a lower financing cost in the CTF loan. [45]

Lessons learnt: The case in Chile combines the lead of government, voluntary participation of major generators, and a climate finance mechanism supported by development institutions. The idea of combining several available options to facilitate the first steps could be learned.

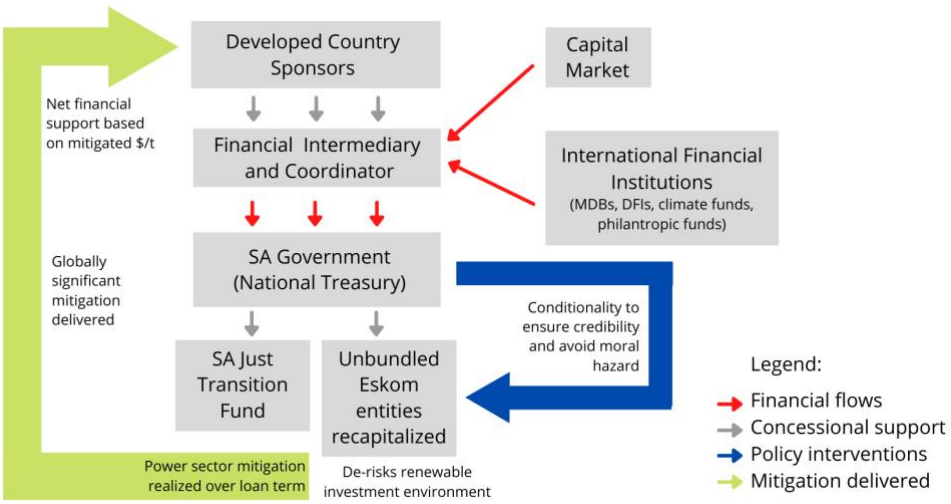
South Africa: Just Energy Transition Partnership

South Africa is highly dependent on coal electricity – 85% of its electricity was generated from coal in 2019,[46] but its government has shown strong interest in clean transition since 2021, including the formation of a Presidential Climate Commission and an updated NDC with a 1.5-degree-aligned lower-range goal for 2030.[47] In November 2021, the US, Germany, France, the UK and the EU announced they would mobilise USD8.5 billion over the next three to five years under the "Just Energy Transition Partnership (JETP)", to help South Africa achieve its Paris Agreement goals by:[48]

- early retirement of coal plants;
- building cleaner energy sources; and
- support for coal-dependent regions.

According to the JETP proposal developed by Meridian Economics, this initiative serves as a powerful tool to decarbonise South Africa's coal-dependent electricity sector and improve the economic conditions of the South African government and its state-owned power utility Eskom. It relies primarily on concessional debt instruments from developed countries, which will be repaid by South Africa with carbon mitigation performance and cash (Figure 12).

Figure 12: JTT Institutional structure and flow of funds



Source: Adapted from Meridian Economics (2021) [49]

JETP partner countries have promised to progress the details of the deal in 2022, especially on the investment packages, sectoral investment needs, concessional and standard financing, and a plan to resolve Eskom's debt.[47]

Lessons learnt:

JETP provides a unique perspective of working directly with government and public electricity utility (with debt problems) to retire coal plants while ensuring their long-term financial stability.

Germany: Coal Exit Law

In July 2020, Germany adopted the country's coal exit law. The law sets out a roadmap for shutting down the country's remaining coal power capacity (distinguishing between lignite and hard coal pathways to take account of employment in the mining sector as well). The government has reserved EUR40 billion for this.

According to the law, the exit will happen in three stages:

- 15 GW hard coal and 15 GW lignite capacity are left by the end of 2022 (down from 22.8 GW hard coal and 21.1 GW lignite in 2019);
- 8 GW hard coal and about 9 GW lignite remaining in 2030;
- no more coal power capacity left by 2038 at the latest (the new German government in 2022 wants to accelerate this to 2030).[50]

To achieve this goal, the government has negotiated an agreement with coal operators and premiers of affected states: to phase out 16.8 GW of lignite-operated coal plants, contracts have been negotiated with the operators where they will receive a total of EUR4.35 billion by 2030, while affected workers will get a maximum of EUR5 billion by 2048.

For hard coal, the Federal Network Agency will implement auctions until 2027, where coal plant operators can tender capacity volumes to be taken offline, offering a specific price (a maximum is set for each round of auction by the German government):

- Auction 1, September 2020 for 4 GW at a maximum price of 165,000 EUR/MW
- Auction 2, 2021 for 1.5 GW at a maximum price of 155,000 EUR/MW
- Auction 3: July 2021, for 2.1 GW (average price was 102,799 EUR/MW)

The German government was able to rely on the European integrated electricity grid ENTSO-E when planning the phase-out to ensure the stability of the electricity network without coal (and without nuclear power that Germany was also phasing out) but based on intermittent renewable energies.[51]

Lessons learnt:

Germany's experience provides an example of working with the operators and providing them a choice during the close-out of coal plants. It is also one of the earliest countries to put the pledge of coal exit into law. At the same time, Germany benefits from a highly integrated energy system within the EU.

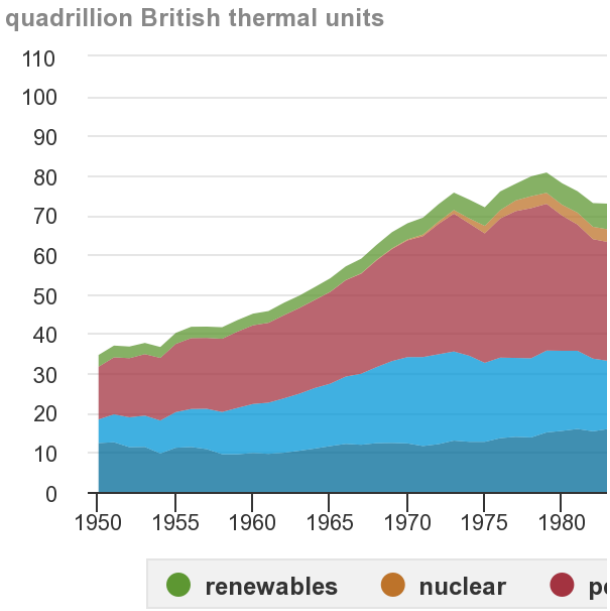
United States: Build Back Better Act (not enacted)

In the autumn of 2021, the United States federal administration was working on accelerating the phase-out of coal and gas-fired power plants as well as replacing them with wind, solar and nuclear energy as part of President Biden's climate agenda. In 2021, the US was getting about 10% of its energy from coal (compared to 12% renewable including hydropower) with a steady decrease in coal energy consumption since 2008,[52] as shown in Figure 13 (coal accounts for about 19% of electricity production in the US).

From 2015 to 2020, an average of 11 GW of coal-fired electricity generation

was retired annually, while 22 GW are scheduled to retire in 2022 (equalling about 6% of the US coal-fired power generating capacity of 2021).[53]

Figure 13: US primary energy consumption by major sources, 1950-2020



Source: Energy Information Administration[54]

With its goal to create an electricity system that is 80% carbon-free by 2030 and entirely carbon-free by 2030, however, electricity generation through coal and gas must be phased out even quicker than current trends. In 2021, as part of the climate legislation proposed by President Biden, a Clean Electricity Performance Program (CEPP) was proposed. Within this plan, electricity retailers (including utilities) would have been incentivized to increase the share of clean energy by 4% each year with USD150 for every MWh greater than 1.5% above the prior year's clean electricity sales (that means that payments happen only if the increase of clean electricity is more than 1.5% above the previous year's target). For example, a provider with a 50% clean electricity share in 2019-2020 would have a 2023 target of 54%, while a utility with an average of 25% clean electricity would have a 2023 target of 29%. Once the utility reaches 85% clean energy, no payments would be made.

At the same time, utilities that would not achieve their annual targets would have to pay USD40 to the federal government for every MWh difference between the 4% increase goal and the actual share. To also compensate for the envisaged losses in 130,000 jobs in the oil, gas and coal sectors, the White House proposed a USD16 billion plan to help workers transition to new jobs.

In December 2021, however, the plan was voted down in the legislature. Besides politically motivated reasons, one possible reason was concerns over ensuring a just transition, where some union leaders reasoned that their members would have to take a 75% pay cut, while they also feared that people were not able or willing to make job moves.[55]

Lessons learnt:

A just transition plan needs to be made ahead of the retirement plans being implemented. The transition of potentially affected groups determines whether a project could be carried out; it in many cases also determines whether a plant could be successfully shut down. This is often an emotional and political issue as much as an economic issue.

3.2 Other Proposals to Accelerate Coal Retirement

Besides initiatives that are already under implementation, more solutions have been proposed by think tanks and academia regarding early coal retirement, including both comprehensive frameworks and individual proposals to identify the best paths for retiring coal-fired power plants.

In 2020, RMI, Carbon Tracker and Sierra Club proposed a "three-part approach" for governments and public sectors to accelerate the phase-out of coal assets with legacy contracts or tariffs, including:[56]

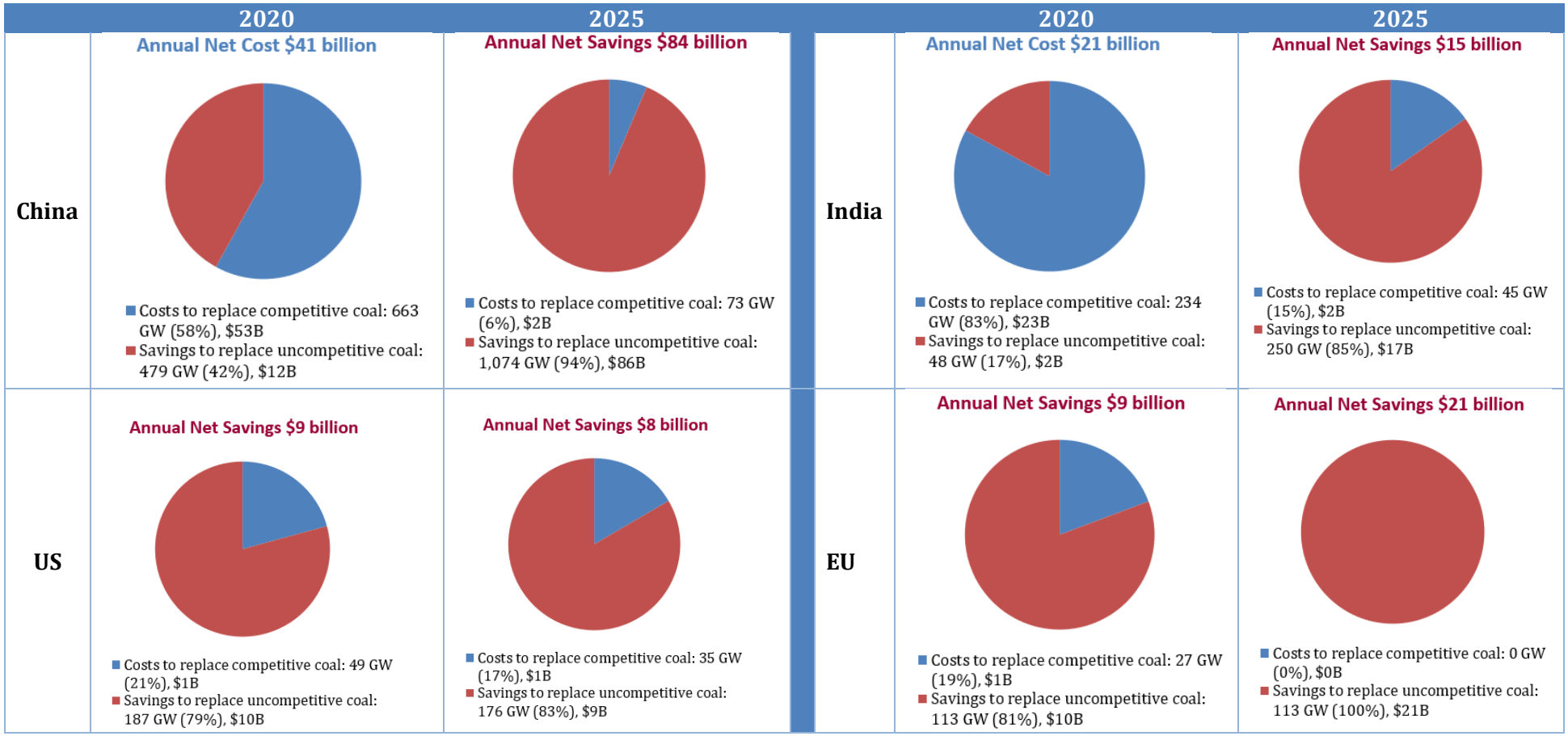
- **refinancing** to free up capital to fund the coal transition, through e.g., asset-backed securitisation, ratepayer-backed bond securitisation, and green bonds;
- using the new low-cost capital in part to **reinvest in clean energy**; and
- using a portion of the new refinanced capital to provide **transition financing** for workers and communities.

In cases where coal remains competitive, two concessional finance tools can be used in conjunction with the three-part approach:[56]

- Provide "carbon bonuses" to reflect the unpriced benefits of transitioning from coal to clean energy, thus making the economics of phasing-out coal more attractive;
- Instead of providing subsidies for emissions reductions through direct payments, the concession could be provided through debt forgiveness.

As is proposed by RMI, Carbon Tracker and Sierra Club, due to the falling cost of renewables, the world's existing coal capacity will be increasingly uncompetitive to stay in operation, and the bonus of replacing coal plants with clean energy will become more obvious. In 2020, for example, 61% of the world's coal plants operate at a competitive cost, and it takes USD161 billion to replace them with clean energy. Meanwhile, the remaining 39% are uncompetitive, and replacing them will save electricity consumers USD33 billion. In 2025, however, only 22% of the world's coal plants will operate at a competitive cost and it takes USD29 billion to replace them, compared with USD136 billion in savings to replace uncompetitive coal plants. There are some discrepancies between different regions and the conclusion is consistent (see Figure 14).

Figure 14: Cost Competitiveness of Existing Coal vs. New Renewables and Storage in Different Regions



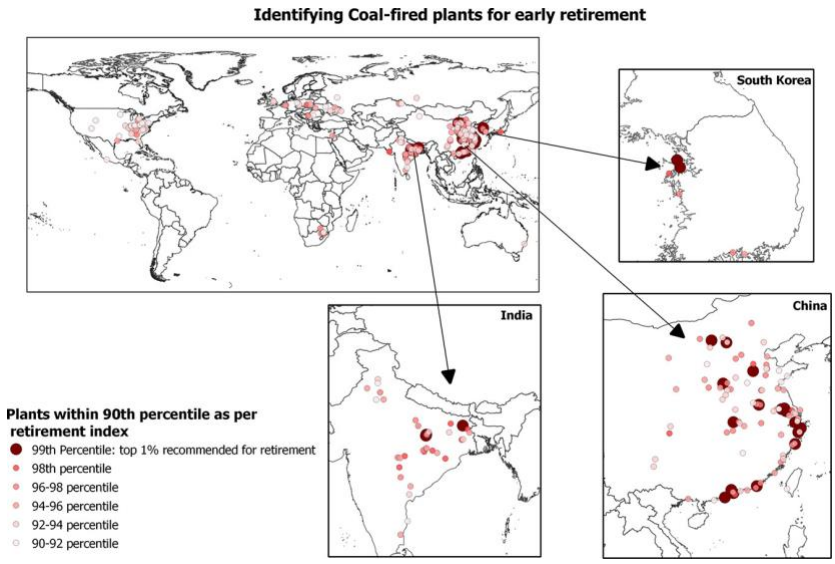
Source: Adapted from RMI (2020)[56]

Besides a holistic coal retirement framework, other studies have shed light on key questions that influence the decision-making in early coal retirement, such as which plants to retire first, what schedule to follow to meet the climate goals, what more economical ways to explore other than decommissioning the plants.

In the early phase, a retirement index constructed by Maamoun et al (2020)[57] helps identify the top polluting plants that are in most need of early retirement. The index ranks 2,143 global coal-fired power plants based on their age, carbon emissions, and potential for air pollution, and points out that the top plants for retirement are located in China, India and South Korea (see

Figure 15).

Figure 15: Identifying coal-fired plants for early retirement (Maamoun et al 2020[57])



More specifically, Cui et al. (2021)[58] developed a plant-by-plant strategy for high-ambition coal power phaseout in China for meeting China's 2060 carbon neutrality goal and the global climate goal. They find that as 18% of China's 1037 operating coal plants (11% of total capacity) perform poorly under technical, economic, and environmental criteria. become "low-hanging fruits" for rapid retirement, and retiring them allows the rest to gradually reduce operation with a 20- or 30-year minimum lifetime while still achieving the 1.5 °C or well-below 2 °C climate goals, respectively, with complete phaseout by 2045 and 2055.

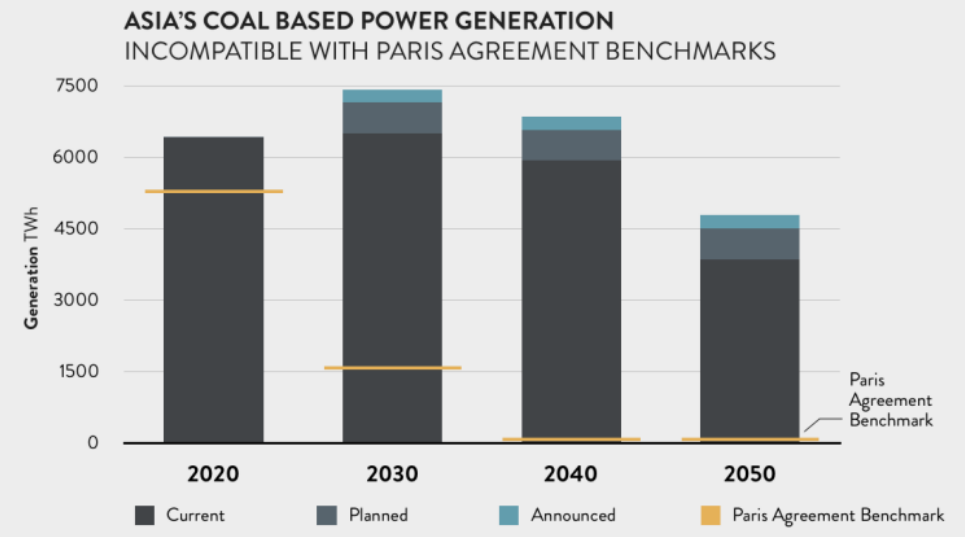
To support planning into the next 30 years, Climate analytics lays out updated timelines for coal retirement in different regions compatible with the 1.5-degree climate goal, with the following phase-out dates:[59]

- OECD: 2031
- Non-OECD Asia: 2037
- Latin America: 2032
- The Middle East and Africa: 2034
- Eastern Europe and the Former Soviet Union: 2031

In Asia, for example, cancelling the planned coal power plant units and retiring current plants are equally urgent to be compatible with the Paris Agreement benchmarks (see

Figure 16).

Figure 16: Potential coal generation in Non-OECD Asia against Paris Agreement benchmarks



Source: Climate Analytics (2019)[59]

As for the exact ways of coal plants retirement, it has also been argued that in the case of developing economies, repurposing may address the resistance to decommissioning by creating jobs and keeping the business alive,[60] and that repurposing coal plants into solar and battery can pay up to 5 times more than decommissioning.[61]

3.3 Public and Commercial Financing Options

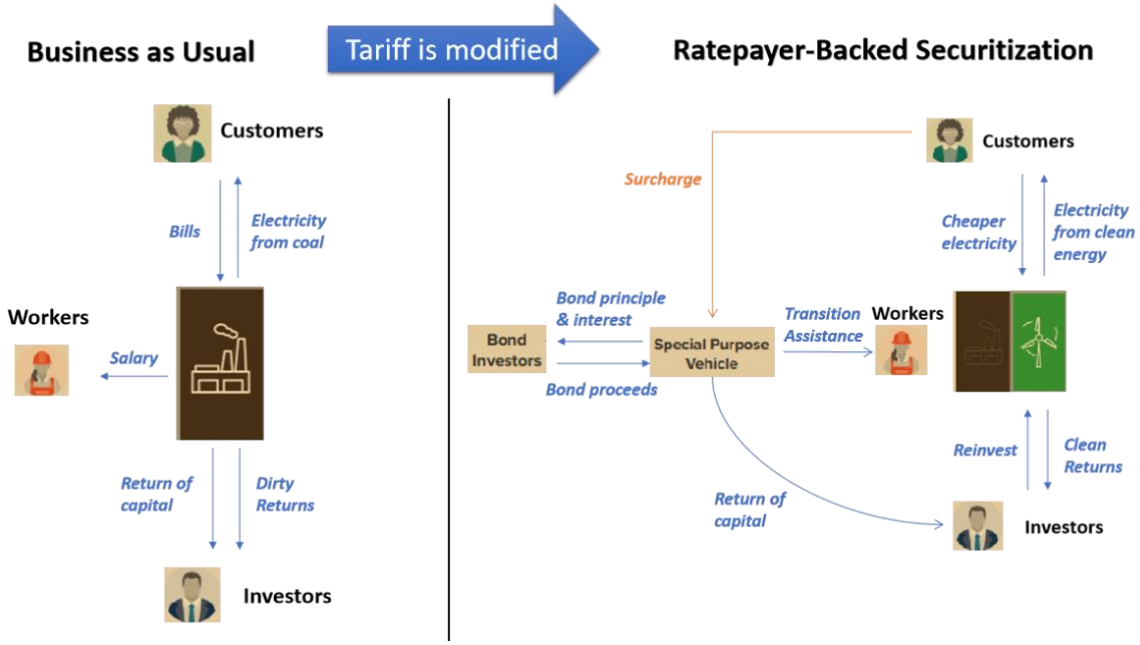
To utilise the constantly sinking cost of solar and wind energies that make producing a unit of energy with many existing coal-fired power plants more costly, several commercially driven options have been developed to allow for the early retirement of coal-fired power plants.

3.3.1 Ratepayer-backed Bond Securitisation (RBS)

Ratepayer-backed bond securitisation has been frequently used in the US lately for coal plants retirement. It is similar to refinancing a mortgage but applies specifically to the coal-exit context: while the average interest rate for financing the coal plants could be 8-10%, RBS allows ratepayers to refinance the coal plants with a low-interest-rate bond in exchange for a surcharge on their future bills (

Figure 17).[62]

Figure 17: Illustration of Ratepayer-Backed Securitization



Source: Adapted from RMI (2021)[56]

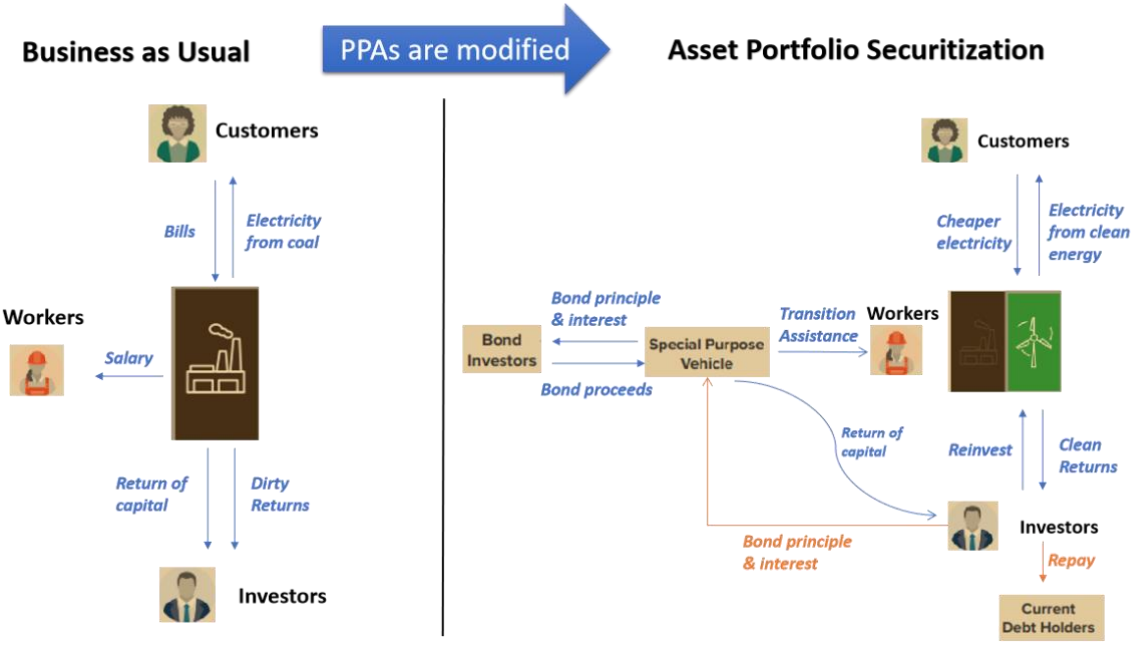
Example: Several US states, such as Wisconsin, Michigan, New Mexico, and Colorado, are planning to implement or have implemented the RBS. In December 2020, for instance, the Michigan Public Service Commission approved Consumers Energy's proposal to use USD688 million in securitised bonds to retire the D. E. Karn coal plant. The latter has also committed to procuring new clean energy, training and transitioning current employees to new positions, and redeveloping coal sites for Figure 18).[56] This could be used to replace coal PPAs with renewable PPAs future uses that benefit local communities.[62]

3.3.2 Asset Portfolio Securitization

Similar to RBS, asset-backed securitisation can be applied to an independent power producer (IPP) with a portfolio of coal PPAs. In that case, instead of being repaid by a surcharge on customer bills, debt is raised to be repaid from expected revenues from the portfolio of renewable PPAs (

as long as the IPP and off-takers agree on a seamless stream of payments.

Figure 18 Illustration of Asset Portfolio Securitization



Source: Adapted from RMI (2021)[56]

3.3.3 Carbon Retirement Portfolio (CRP)

A CRP purchases coal generation assets, with the mandate to retire them ahead of schedule. With this approach, the previous owner of a coal plant does not need to take responsibility for decommissioning the asset, while CRP investors use low-cost financing (e.g., backed by the public sector, or carbon avoidance bonus incentives) to offset the lost present value of retiring the plant early and support affected communities.[63]

Example: Energy Transition Mechanism pilot in Indonesia as discussed in the sections

3.3.4 Carbon Avoidance Bonus for Early Retirement

In this case, public sectors, e.g., government or public financiers establish a fund to pay electricity providers for every ton of verifiable, permanent, and additional emissions abated.[63] Such bonus could be in the form of cash, tax credits, debt forgiveness or concessional interest rates on new debt, to incentivise coal plant owners to replace their fossil fuel assets with renewable energy projects.

Example: IDB Invest pilot in Chile as discussed in the sections

4. Lessons and Requirements for Financing a Just Transition and Ensuring Energy Security

Discussions, concepts, and applications on how to retire coal-fired power plants before the end of their run-time have been quickly accelerating driven by global climate pledges and a rapidly decreasing cost of solar and wind power.

Based on the examples listed above, several lessons can be drawn from early retirement:

Lessons learnt for early coal-retirement

1. **Political buy-in**: broad application of early retirement of coal-fired power plants is currently driven by government initiatives, for example in Germany, Chile, as well as through multilateral (politically supported) institutions. These government-led programmes can range in size and scope and might require new laws, public funding for possible compensations for coal-fired power plant operators, and a long-term buy-in from political parties to reduce uncertainty for investors and operators.

2. **Cooperation with operators**: Cooperation with operators of coal-fired power plants (both privately owned and government-owned) is a crucial element for the successful retirement of coal-fired power plants. As in the case of Germany, operators were given a choice – within the coal exit law – which coal-fired power plants to retire first depending on the operator's economic calculations.

3. **Devising a just transition plan for affected employees and communities**: Employees of to-be-retired coal-fired power plants and possibly affected communities and supply chains (e.g., coal mining) will lose their jobs through the plant retirement. To cushion adverse social impacts and to provide new opportunities to those affected, a just transition plan needs to be made. A just transition plan can be developed 1-5 years in advance of the retirement of a coal-fired power plant. Just transition plans can consist of different elements for different employees and communities. E.g., for employees close to retirement age, an offer could be made for early retirement; for younger employees, retraining should be supported, and depending on the circumstance and transition mechanism, new jobs should also be offered. With coal-related employment often spanning more than one generation, some workers will feel emotionally attached to their work related to coal. To secure public support for the coal-plant retirement, it is essential to not only offer "handouts", but to develop solutions with the affected communities on how they want to transition out of coal – fitting to their specific requirements. Affected communities will need to be supported to weather the structural change in the local economy. This goes beyond "Just Transition" (as mentioned above) but needs to address broader grievances.

4. **Financing – many options**: Financing of the early retirement of coal-fired power plants can take various forms, including both public finance and commercial finance. Particularly with increasing evidence of the relatively higher cost of generating electricity through coal over solar or wind, new commercial financing models are being developed to buy out existing operators and have them retire their plants without any financial losses while generating a profit for the new operators. These models are particularly attractive to operators of older and less effective coal plants or in regions where a price on carbon emissions is additionally increasing cost.
   Also, public financing options are explored and applied – including for developing countries through multilateral development banks or bilateral initiatives, where such finance can be used for various purposes – from feasibility studies to creating new long-term energy plans, from providing incentives to operators of coal plants to retire early to providing transition mechanisms and capacity for affected employees and communities.

5. **Electricity and grid planning**: closing coal-fired power plants reduces the available electricity in the power grid. To ensure a stable power supply, electricity needs and supply need to be evaluated and planned for. While this challenges particularly countries with rapidly increasing electricity demand, countries with overcapacities in the power grid (e.g., due to higher energy efficiency of its economy, a decreasing population, and/or existing oversupply) also need to properly plan and simulate electricity supply and demand to compensate for any intermittences of green energies or long distances between the electricity source and demand.

6. **Legal and institutional planning:** Both the set-up of an official framework and the implementation and supervision during coal plant phase-out need some legal and institutional planning in advance, e.g., formalise or prioritise some requirements for a just and inclusive transition or offer penalties to asset owners who fail to use the funds properly. Providing legal certainty is important to all parties.

5. Policy Recommendations for Chinese Stakeholders

China has taken the important step of committing itself to not building any new coal-fired power plants abroad in 2021 and promising to support a green development of the Belt and Road Initiative (BRI), to support green energy development under the Forum on China Africa Cooperation, and to be a leader in the global fight against climate change. In March 2022, the "Opinions on Promoting the Green Development of "One Belt, One Road" published by China's most influential ministry, the National Development and Reform Commission (NDRC) together with other departments highlighted how "risks and challenges of green development of the BRI are still prominent", and encouraged the "full implementation of the United Nations Framework Convention on Climate Change and its Paris Agreement" together with the BRI countries and through Chinese engagement in the BRI countries.[64] Also, various BRI country governments are evaluating how to accelerate the retirement of existing coal-fired power plants, while the March 2022 NDRC opinions also highlighted the promotion of "green and low-carbon development of coal power".

The retirement of coal-fired power plants remains both a politically sensitive and technically, financially and socially complex issue. China for its domestic electricity production has re-affirmed its policy of building the new before dismantling the old[65]. Chinese high-level authorities have also publicly considered providing financing for upgrading existing coal-fired power plants abroad.[66] At the same time, current knowledge on specific contractual arrangements of operators, power purchasing agreements (PPA), financing costs, government guarantees, risk evaluation and risk mitigation, are often not known.

Nevertheless, for Chinese overseas coal assets, it could be beneficial to host countries and Chinese partners to evaluate whether international efforts on coal-fired power plant retirement can be actively applied. Reasons could include a reduction of electricity costs

for consumers in BRI countries due to lower green energy costs, a reduction of climate emissions, and the avoidance of risks of carbon border adjustment mechanisms (CBAM) that would make imports of high emission goods from BRI countries into, for example, the European Union (EU), more expensive.

With China's internationally recognized advantage of supporting green energy, as witnessed by international partners choosing Chinese contractors for solar power, such as in India for a 2 GW installation of wind power through Vision Energy signed in 2022[67], or through the 100 MW international cooperation wind project in Zhanatas, Kazakhstan[68], China's could also benefit by replacing coal energy with green energy. This is further highlighted by various Chinese manufacturers of green energy building factories abroad, such as Trina Solar in Vietnam[69], to support not only local green energy transition but also provide manufacturing jobs and technical capacity building for a "just transition".

For those countries interested in accelerating an early retirement of coal-fired power plants and working with Chinese investors, or where Chinese stakeholders have been financing, operating or owning coal-fired power plants, relevant stakeholders can support the early retirement of coal assets. Based on the general recommendations and China's specific role as the main sponsor, operator of existing coal fleets, the strong role of policy signals and a highly competitive green energy industry, several steps could be taken (partly in parallel) to evaluate and support in early coal retirement:

Policy Recommendations for Chinese overseas coal-fired powerplants

1. **Understand the economics**: Evaluate the *net present value (NPV)* of existing Chinese-backed overseas coal-fired power plants in comparison to the NPV of alternative new energy installations (including relevant grid extensions and power storage facilities) on an asset level for select pilot countries. The pilot countries should be a country with relevant Chinese engagement in coal-fired power plants and a stated interest in reducing the share of fossil fuel energy in the power mix (e.g., Pakistan, Indonesia, Vietnam). In the calculations, relevant financing costs, as well as various scenarios for shadow carbon prices, fuel prices, price decreases in solar/wind energy and timeframes (e.g., retirement in 2025, 2030, 2035) should be included. Furthermore, evaluate the economics including *electricity prices*: should green sources of electricity provide lower-cost electricity to consumers, including industrial consumers, this could be included in the overall economics of replacing the coal-fired power plant, particularly for government-to-government projects.

2. **Evaluate Chinese and host country policy goals:** Chinese policymakers have emphasized the relevance of green development at home and abroad, the relevance of the Paris Agreement to limit global warming domestically and for BRI development, and explicitly announced support for green energy development in BRI countries, in African countries and globally. With fossil-fueled power being recognized as a non-Paris-aligned energy source, Chinese investors, developers, and fossil fuel owners can evaluate how to support publicly stated Chinese policy goals. At the same time, BRI host countries have explicitly stated goals to de-carbonize their economies, not least through their nationally-determined contributions (NDCs). Accordingly, supporting BRI

countries to achieve these goals could take the form of supporting early coal retirement.

3. **Engage with pilot countries**: Engage pilot countries on a political level to discuss technical, legal, political, and financial cooperation on early coal-retirement of identified potential assets. This should help understand hidden costs and opportunities, as well as other legal and social risks of early coal retirement while ensuring political interest and support in the host country. Engage with local society to understand requirements and needs to reduce coal reliance and possibilities to reduce electricity costs. This could also help local policymakers in their decisions and provide relevant policy frameworks for early retirement.

4. **Develop and evaluate green energy scenarios with the pilot country**: Understand specific requirements of energy planning in the pilot country and simulate supply and demand in various scenarios of early coal retirement. Particularly as networks might not be available for supporting intermittent electricity supply or as energy storage might not be sufficiently developed, this energy planning should take a phased approach.

5. **Engage with existing asset owners**: Evaluate requirements and negotiation strategies with asset owners on early retirement. As each country and the coal-fired power plant might be owned and operated under different governance structures, competent negotiation partners could also provide existing asset owners relevant participation in new energy parks to improve willingness to engage.

6. **Financing mechanism**: Depending on the NPV calculations (e.g., NPV of existing coal-fired power plants is much/little lower/higher than NPV of alternative energy investment), evaluate different financing mechanisms that can include both domestic and international, as well as multilateral sources of finance:
    a. NPV of alternative energy is higher: evaluate commercial financing solutions;
    b. NPV of alternative energy is slightly lower: evaluate blended finance solutions;
    c. NPV of alternative energy is much lower: no action or secure philanthropic/public funding.

    As international commercial and development financial institutions are interested in supporting the expansion of green energy in their portfolio, more financing options for green energy investments, including financing retirement are available, some of which were mentioned above (e.g., ADB ETM).

7. **Support engagement with local communities and employer**s: although this step would also be the responsibility of the local government and asset owner, competent Chinese partners could provide guidance and share experience in job transition. For example, Chinese partners can provide relevant capacity

building and provide job opportunities in energy transition by investing in local manufacturing of relevant equipment.

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About the Green Finance & Development Center, FISF Fudan University

The Green Finance & Development Center (GFDC) is a leading research centre 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.

To drive green finance development, GFDC works in four inter-related labs:

1. Green BRI Lab
2. ESG Lab
3. Green Innovation Lab
4. Biodiversity Finance Lab

The Green Finance & Development Center was founded in 2021 and continues much work from the IIGF Green BRI Center. It is associated with the Fanhai International School of Finance (FISF) at Fudan University in Shanghai, P.R. China.

About the Centre for Sustainable Finance at SOAS, University of London

The SOAS Centre for Sustainable Finance aims to advance the transition to an equitable, low-carbon economy by providing a forum for interdisciplinary research and teaching on sustainable finance and investment. It seeks to enhance the knowledge and understanding of sustainable finance in both the Global North and South and act as a focal point for policy debates in this area. Located at SOAS, University of London, in the heart of one of the world's leading financial hubs, the Centre's research and policy work addresses pressing issues including green financial governance; the impact of climate risks on public and corporate finances; the scaling up of low-carbon and resilient investment in vulnerable countries; climate risk insurance; mobilising financing for the Sustainable Development Goals; inclusive green finance; low-carbon innovation policy and renewable energy investments; and the role of public financial institutions in advancing the green transition.

The Centre is part of the Global Research Alliance for Sustainable Finance and Investment, a network of leading research universities, as well as the International Network for Sustainable Financial Policy Insights, Research, and Exchange, a global research network that feeds into the work of the Network of Central Banks and Financial Supervisors for Greening the Financial System. It is also a knowledge partner of the Green Growth Knowledge Partnership and the Asia Sustainable Finance Initiative, and host to the Sustainable Finance Data Initiative, an innovative new venture gathering data on inflows and outflows of climate and sustainable finance in developing and transition economies.

Researchers at the SOAS Centre for Sustainable Finance are working with national and international partners, with funding from different institutions, including the UK's Natural Environment Research Council, the Economic and Social Research Council, the Foreign, Commonwealth and Development Office (FCDO), the United Nations Environmental Programme, the MAVA Foundation, the ClimateWorks Foundation, the European Climate Foundation, the Alliance for Financial Inclusion, and the World Resources Institute.

The Centre is running an annual 'Summer School on Sustainable Finance and Climate Change' and a master's course on 'Green Finance'. Centre staff have convened major capacity building and executive training programmes in sustainable finance and climate risk for numerous central bank and commercial financial institutions. Centre staff have also convened courses in climate negotiations, and climate and sustainable finance for the UK FCDO and the UK Cabinet Office.