How To Retire Early

Making Accelerated Coal Phaseout Feasible and Just

Authors & Acknowledgments

Authors

Paul Bodnar, Matthew Gray (Carbon Tracker Initiative), Tamara Grbusic, Steve Herz (Sierra Club), Amanda Lonsdale (Magnitude Global Finance), Sam Mardell, Caroline Ott, Sriya Sundaresan (Carbon Tracker Initiative), Uday Varadarajan (Rocky Mountain Institute and Stanford Sustainable Finance Initiative)

** Authors listed alphabetically. All authors from Rocky Mountain Institute unless otherwise noted.*

Contacts

Caroline Ott, **cott@rmi.org**
Matthew Gray, **mgray@carbontracker.org**
Steve Herz, **sherz@sierraclub.org**

Suggested Citation

Paul Bodnar, Matthew Gray, Tamara Grbusic, Steve Herz, Amanda Lonsdale, Sam Mardell, Caroline Ott, Sriya Sundaresan, and Uday Varadarajan, *How to Retire Early: Making Accelerated Coal Phaseout Feasible and Just*, Rocky Mountain Institute, 2020, **https://rmi.org/insight/how-to-retire-early**.

Images courtesy of iStock unless otherwise noted.

Acknowledgments

This report has benefited from the input of over 60 individuals from over 30 institutions. For a complete list of individuals who informed this report, please see the acknowledgments on pages 54 and 55.

Funders

The authors thank the following foundations for supporting this work: Bloomberg Philanthropies, European Climate Foundation, Flora Family Foundation, ClimateWorks Foundation, Grantham Foundation for the Protection of the Environment, Rockefeller Brothers Fund, Someland Foundation, MacArthur Foundation, Yellow Chair Foundation, Bulb Foundation, and Pool Fund on International Energy.

About Us

About Us

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. RMI has offices in Basalt and Boulder, Colorado; New York City; the San Francisco Bay Area; Washington, D.C.; and Beijing.

The Carbon Tracker Initiative is a team of financial specialists making climate risk real in today's capital markets. Our research to date on unburnable carbon and stranded assets has started a new debate on how to align the financial system in the transition to a low-carbon economy.

The Sierra Club is America's largest and most influential grassroots environmental organization, with more than 3.5 million members and supporters. In addition to protecting every person's right to get outdoors and access the healing power of nature, the Sierra Club works to promote clean energy, safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and legal action. For more information, visit www.sierraclub.org.

Table of Contents

Executive Summary

Although coal has long been viewed as the cheapest way to power the global economy, this is no longer the case. New renewable energy is now cheaper than new coal plants virtually everywhere, even before considering coal's dire health, climate, and environmental impacts. The cost of renewables has fallen so far that it is already cheaper to *build new* renewable energy capacity, including battery storage, than to *continue operating* 39 percent of the world's existing coal capacity.[i] Based on a new global analysis—by Rocky Mountain Institute, the Carbon Tracker Initiative, and the Sierra Club—of nearly 2,500 coal plants, the share of uncompetitive coal plants worldwide will increase rapidly to 60 percent in 2022 and to 73 percent in 2025.

The total cost of phasing out the global coal fleet through efficiently structured financial solutions is already surprisingly small and shrinking quickly. Replacing uncompetitive coal with clean energy could already save electricity customers around the world $39 billion in 2020, and these annual savings rise quickly to $86 billion in 2022 and $141 billion in 2025. Phasing out and replacing the remaining competitive share of the global coal fleet would require $155 billion in subsidies in 2020,[ii] with this figure dropping rapidly to $80 billion in 2022 and $36 billion in 2025 (see Exhibit ES1). In other words, the theoretical net cost to society of completing the coal-to-clean transition in 2020 would be $116 billion, but this figure drops below zero by 2022 and generates net financial savings of over $100 billion by 2025.[iii] Those savings—which already exist for many geographies—can be captured and recycled to support a just transition for workers and communities. These figures do not even account for the social and environmental benefits of reducing carbon dioxide and other coal pollutants.

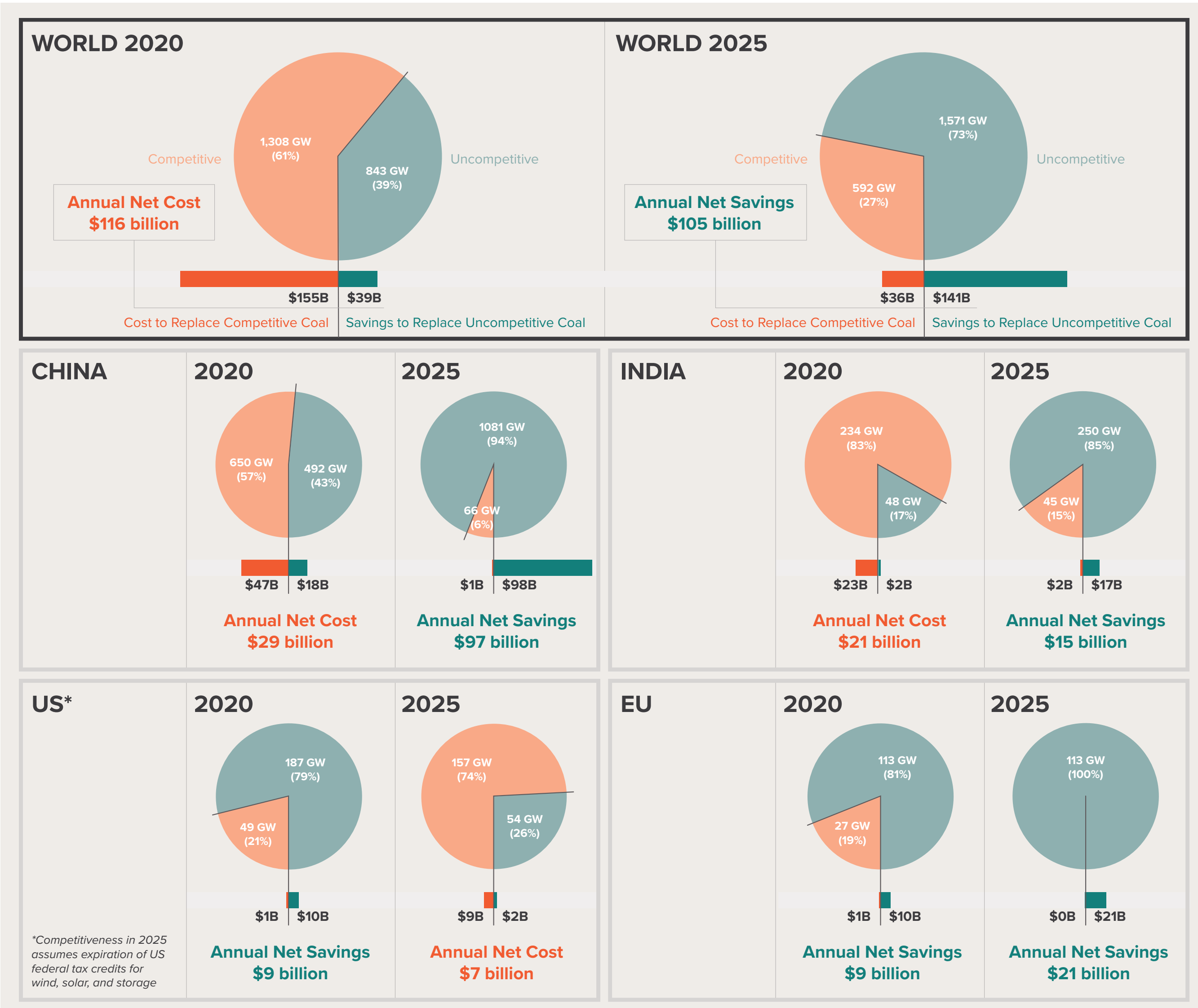
[i] This analysis defines a coal asset as "uncompetitive" if it costs more to continue to operate than the levelized cost to build and operate onshore wind or solar with four-hour storage rated at half the renewable capacity. The storage was included as a simple way to account for replacement of the capacity as well as the energy provided by a marginal existing coal plant at moderately high penetrations of variable resources. The coal costs are inclusive of any applicable carbon or emissions permits or taxes, but not of any unpriced health or environmental costs, while the renewable and storage costs include clean energy incentives.

[ii] "Phaseout" and "retirement" are used as general terms that encompass different strategies that lead to elimination of expected coal use in the operation of a plant, including transitioning to standby/backup service with little or no (at most, seasonal) expected operation, as well as retirement and decommissioning.

[iii] The cost to replace in a given year is the annual additional cost to customers that would result from replacement of all competitive coal assets with renewable energy and storage in that year. The total net cost in a given year is calculated by subtracting the annual cost savings from the cost to replace. For additional definitions, see the box on page 13.

Exhibit ES1

Cost Competitiveness of Existing Coal vs. New Renewables and Storage



Source: RMI

However, coal phaseout hasn't kept pace with eroding economics, and the slow pace of transition is costing consumers and taxpayers money while posing a significant threat to the climate, public health, and the environment. To keep the Paris Climate Agreement's temperature targets within reach, global coal use must decline by 80 percent below 2010 levels by 2030, requiring rapid transition in Organisation for Economic Co-operation and Development (OECD) countries over the next decade and phaseout in the rest of the world by 2040. Instead, according to the International Energy Agency, global coal use has continued to *increase* in recent years. Meanwhile, consumers are stuck paying for expensive and dirty coal generation, the public bears the health and environmental burdens of increased air and water pollution, and taxpayers bear the expense of redressing these costly environmental and health impacts.

A key barrier to accelerating phaseout is that the vast majority (93 percent) of global coal plants are insulated from competition from renewables by long-term contracts and noncompetitive tariffs. Customers are locked into paying for dirty and expensive coal power for years or even decades into the future, with limited options to alter these arrangements without facing penalties and costs or protracted legal and political battles. The Paris Agreement timeline necessitates switching from coal to clean long before most long-term coal power contracts expire or before coal plant investors have been fully repaid.

In many cases, a more rapid phaseout could be unlocked by aligning the incentives of customers and taxpayers, coal plant investors, and workers and communities with moving on from these legacy contracts and noncompetitive tariffs. An approach to dealing with legacy contracts and noncompetitive tariff structures that can align incentives would simultaneously achieve the following goals: Customers would save money on day one, while taxpayers and the general public would benefit from improved health and reduced climate-related risks. Coal plant owners and investors would have the opportunity to replace coal returns with clean returns by reinvesting capital into clean resources. Workers and host communities could access resources to preserve livelihoods, protect benefits, and ensure that they can continue to thrive.

Governments and public finance institutions can accelerate coal phaseout for assets with legacy contracts or tariffs through an integrated three-part approach: (1) refinancing to fund the coal transition and save customers money on day one, (2) reinvesting in clean energy, and (3) providing transition financing for workers and communities.

Where clean energy already outcompetes existing coal, it may be possible to achieve all three parts as a package without additional public funds. As demonstrated by phaseout deals struck recently in the United States, funding packages can turn the value remaining in legacy contracts and noncompetitive tariffs into an engine for transition by:

- **Refinancing** to free up capital to help fund coal transition while lowering customer costs (e.g., asset-backed securitization, ratepayer-backed bond securitization, and green bonds)

- Using the new low-cost capital in part to **reinvest in clean energy** to allow owners to phase out coal plants and reduce customer costs further, while replacing returns from coal plants with returns from clean energy

- Utilizing a portion of the new capital raised through refinancing to **provide transition financing** to coal workers and communities, offering immediate resources to preserve livelihoods, protect benefits, and ensure that host communities can continue to thrive

In circumstances where coal remains competitive (ignoring its unpriced health and environmental costs), this three-part approach may require additional public resources in the short term. We propose two concessional finance tools that can be used in conjunction with the refinancing, reinvestment, and transition financing mechanisms to achieve these objectives. First, governments or public financiers could offer “carbon bonuses” to better reflect the unpriced benefits of transitioning from coal to clean energy, making the economics of coal phaseout more attractive. These concessional payments for each ton of emissions abated are intended to reduce the cost of coal phaseout for customers while continuing to deliver the same electricity services and providing for a fair workforce transition. Second, instead of providing subsidies for emissions reductions through direct payments, the concession could be provided through debt forgiveness. For both mechanisms, public resources should be allocated through transparent and competitive processes. We propose using reverse auctions to maximize the emissions reductions achieved and limit the risks of excess subsidies. OECD countries should finance these mechanisms domestically and fund them in poorer countries as part of their climate and development assistance. However, one point bears repeating: with the share of uncompetitive coal plants increasing quickly, this kind of financing would be needed mostly in the short term to accelerate action.

Whether they require concessional funding or not, financial approaches to accelerating coal phaseout offer several advantages and are especially relevant to COVID-19-related stimulus spending. First, they can be structured as voluntary programs for both governments and asset owners. For example, a reverse auction to acquire outstanding debt on coal plants in exchange for closure does not mandate participation—but it can serve as a powerful mechanism to reveal the true appetite for accelerated phaseout on which subsequent policies can be built. Second, these approaches can help stakeholders find agreement on an acceptable allocation of savings and benefits, thus allowing nontraditional allies to find common ground. Third, these financial approaches can work in conjunction with local regulatory structures and market conditions. Fourth, the need to allocate stimulus spending as part of COVID-19 economic recovery presents a special opportunity to accelerate the coal-to-clean transition.

The United States could help customers save up to $10 billion annually using the three-part approach to phase out the 79 percent of the 236 gigawatt (GW) coal fleet that is uncompetitive today. More than three-quarters of the US coal capacity is in markets where customers are locked into paying utilities based on a cost-of-service tariff. As a result, in this time of national economic distress, customers are paying more for electricity from expensive coal just when they can least afford to. Refinancing customers’ tariff obligations to phase out uncompetitive coal can bring down customer costs and fund transition assistance to support a fair and more robust recovery.

Beyond the United States, the opportunity is ripe to accelerate the coal-to-clean transition using financial approaches that save customers money.

- In the **European Union**: 81 percent of the 140 GW coal fleet is uncompetitive in 2020, and that will rise to 99 percent in 2022 and 100 percent in 2025. Phasing out and replacing uncompetitive coal plants with renewable energy plus storage would generate savings of $10 billion in 2020, $16 billion in 2022, and $21 billion in 2025.

- In **China**: 43 percent of the 1,142 GW coal fleet is uncompetitive in 2020, and that will rise to 70 percent in 2022 and 94 percent in 2025. Phasing out and replacing uncompetitive coal plants with renewable energy plus storage would generate savings of $18 billion in 2020, $49 billion in 2022, and $98 billion in 2025.

- In **India**: 17 percent of the 283 GW coal fleet is uncompetitive in 2020, and that will rise to 50 percent in 2022 and 85 percent in 2025. Phasing out and replacing uncompetitive coal plants with renewable energy plus storage would generate savings of $2 billion in 2020, $8 billion in 2022, and $17 billion in 2025.

We plan to undertake further analysis on other regions in a second edition of this paper, but the preliminary data for these regions is also striking. For instance, for a group of other developing economies with aggregate coal capacity similar to that of the United States,[iv] replacement of the entire fleet would cost $38 billion in 2020. By 2026, continuing to operate 51 percent of this fleet will become uncompetitive relative to building new renewables plus battery storage. Given the long lead times for electricity system planning and decision-making, as well as the size of the opportunity, now is the time to start structuring accelerated coal phaseout in all regions.

Who should take the lead in exploring and implementing these approaches at the intersection of finance and policy? We make the case that public finance institutions—green banks, multilateral and national development banks, and development finance institutions—have the mandate, capital, and expertise to create programs to deploy these innovative financial tools and help countries capture the economic opportunity of transitioning away from coal. For the past decade, these institutions have been under pressure to end financing for new coal plants, and they have largely done so. In the next 10 years, they should help take the lead in accelerating phaseout of the existing coal fleet. In so doing, they can simultaneously address multiple development challenges at low or negative cost, reducing carbon pollution, alleviating severe public health impacts, improving standards of living, reducing mortality and illness, and enhancing economic productivity.

This report describes the coal phaseout and transition opportunity in five sections. Section 1 presents new data on the collapsing competitiveness of coal with respect to renewables. Section 2 addresses how coal phaseout can be accelerated using a three-part approach consisting of refinancing to save customers money, reinvesting in clean energy, and supporting a just transition for workers. Section 3 describes financing options for accelerating this three-part transition. Section 4 provides specific examples of how these tools could be applied in the United States. Section 5 considers their application in other jurisdictions around the world.

[iv] This group consists of Bangladesh, Indonesia, Malaysia, Pakistan, the Philippines, South Africa, Turkey, Ukraine, and Vietnam.

1

The Economic Case for Phasing Out Coal

The Economic Case for Phasing Out Coal

Coal is no longer the cheapest power source for the global economy. New renewable energy has already become cheaper than new coal in nearly all geographies, even before considering coal's dire health, climate, and environmental impacts.[1] More importantly, the cost of renewables has fallen so far that *building new* onshore wind and utility-scale solar photovoltaic (PV), including battery storage, is now cheaper than *continuing operation of* 39 percent of the world's existing coal capacity. By 2025, that number will increase to 73 percent. This milestone marks a new opportunity to close existing plants while capturing savings that can be used to support the build-out of additional renewable capacity.

This report presents the results of a major new analysis by Rocky Mountain Institute, the Carbon Tracker Initiative (CTI), and the Sierra Club on the economic viability of 2,472 coal plants around the world. CTI's Global Coal Power Economics Model combines data from the Global Energy Monitor, the Global Coal Plant Tracker, the Platts World Electric Power Plants database, and national and regional sources on coal plant economics. It also considers the costs of renewable generation and storage. This data set allows us to assess the economic competitiveness of coal plants in 37 countries, covering 95 percent of the total global capacity. It also enables us to estimate the savings from replacing uncompetitive coal with renewables plus storage, as well as the cost to replace coal assets that remain competitive (ignoring their unpriced health and environmental costs).

The total cost of phasing out the global coal fleet is already surprisingly small and decreasing quickly. Replacing uncompetitive coal with clean energy could already save electricity customers around the world $39 billion in 2020, and these annual savings rise quickly to $86 billion in 2022 and $141 billion in 2025. Phasing out and replacing the remaining competitive share of the global coal fleet would require $155 billion in subsidies in 2020,[v] with this figure dropping rapidly to $80 billion in 2022 and $36 billion in 2025 (see Exhibit 1). In other words, the theoretical net cost to society of completing the coal-to-clean transition in 2020 would be $116 billion. However, this figure drops below zero by 2022 and generates net financial savings of over $100 billion by 2025.[vi] These figures do not even account for the social and environmental benefits of reducing carbon dioxide and other coal pollutants.

Our analysis identifies economic opportunities on an asset-by-asset basis across the globe to phase out and replace coal capacity with new wind or solar with battery storage. We assess the competitiveness of a coal asset in any given year by comparing the long-run cost to operate a coal plant (including any implemented carbon-pricing regime, but not any unpriced health or environmental costs) with the total cost to build and operate a replacement resource (including any clean energy incentives reflecting otherwise unpriced clean energy benefits). In technical terms, competitiveness compares the long-run marginal cost for coal assets with the levelized cost of energy for renewables and storage. This analysis uses a simplified overnight clean energy replacement scenario with sufficient capacity to replace annual coal generation from the plant by combining either onshore wind or solar power with a four-hour battery storage system rated at half the total capacity of the wind or solar system. For example, a 1 gigawatt (GW) coal plant with an 80 percent capacity factor would be replaced with 4 GW of solar or wind with an average 20 percent capacity factor, along with a 2 GW/8 gigawatt-

[v] "Phaseout" and "retirement" are used as general terms that encompass different strategies that lead to elimination of expected coal use in the operation of a plant, including transitioning to standby/backup service with little or no (at most, seasonal) expected operation, as well as retirement and decommissioning.

[vi] The cost to replace in a given year is the annual additional cost to customers that would result from replacement of all competitive coal assets with renewable energy and storage in that year. The total net cost in a given year is calculated by subtracting the annual cost savings from the cost to replace. For additional definitions, see the box on page 13.

hour (GWh) battery storage system. Replacing coal with renewables and storage hybrid systems also addresses capacity concerns that might arise from replacement with only variable wind or solar power. The cost competitiveness of coal varies by region and is projected to shift significantly over the next five years as both renewable generation and storage technologies become less expensive.

Understanding Various Metrics of Competitiveness, Savings, and Cost

Recognizing that different metrics are useful for different audiences, this report offers several metrics to describe the cost competitiveness of coal with respect to renewables plus storage. For example, some audiences may be interested in the savings potential from replacing uncompetitive coal with renewables, whereas others may be interested in the net cost to replace the coal fleet. Rather than presenting only a selection of the data, we include the complete results of our modeling across various measures of competitiveness, savings, and cost.

Uncompetitive coal describes assets for which the long-run cost to operate the plant exceeds the levelized cost to build and operate new solar or onshore wind plus storage. The coal costs are inclusive of any applicable carbon or emissions permits or taxes, but not of any unpriced health or environmental costs, while the renewable and storage costs include clean energy incentives. For each region, we present uncompetitive coal in terms of both aggregate capacity as well as a percentage of total capacity.

Annual cost savings describes the value that could be realized in a given year by replacing the electricity generated by uncompetitive coal assets with electricity generated by new renewables with storage. These annual figures describe the cost savings opportunities for a single year only; so, although the annual cost savings will generally increase over time as renewables costs decline, waiting until later years to phase out uncompetitive assets will still result in foregone annual savings.

Cost to replace describes the annual additional cost to customers that would result from replacement of all competitive coal assets with renewable energy and storage in a given year. This metric may be of particular interest to policymakers and public finance institutions seeking to accelerate the phaseout and replacement of coal in line with climate targets.

Total net cost to replace coal is calculated by subtracting the annual cost savings from the cost to replace. This metric describes the net cost to society of retiring and replacing the entire coal fleet.

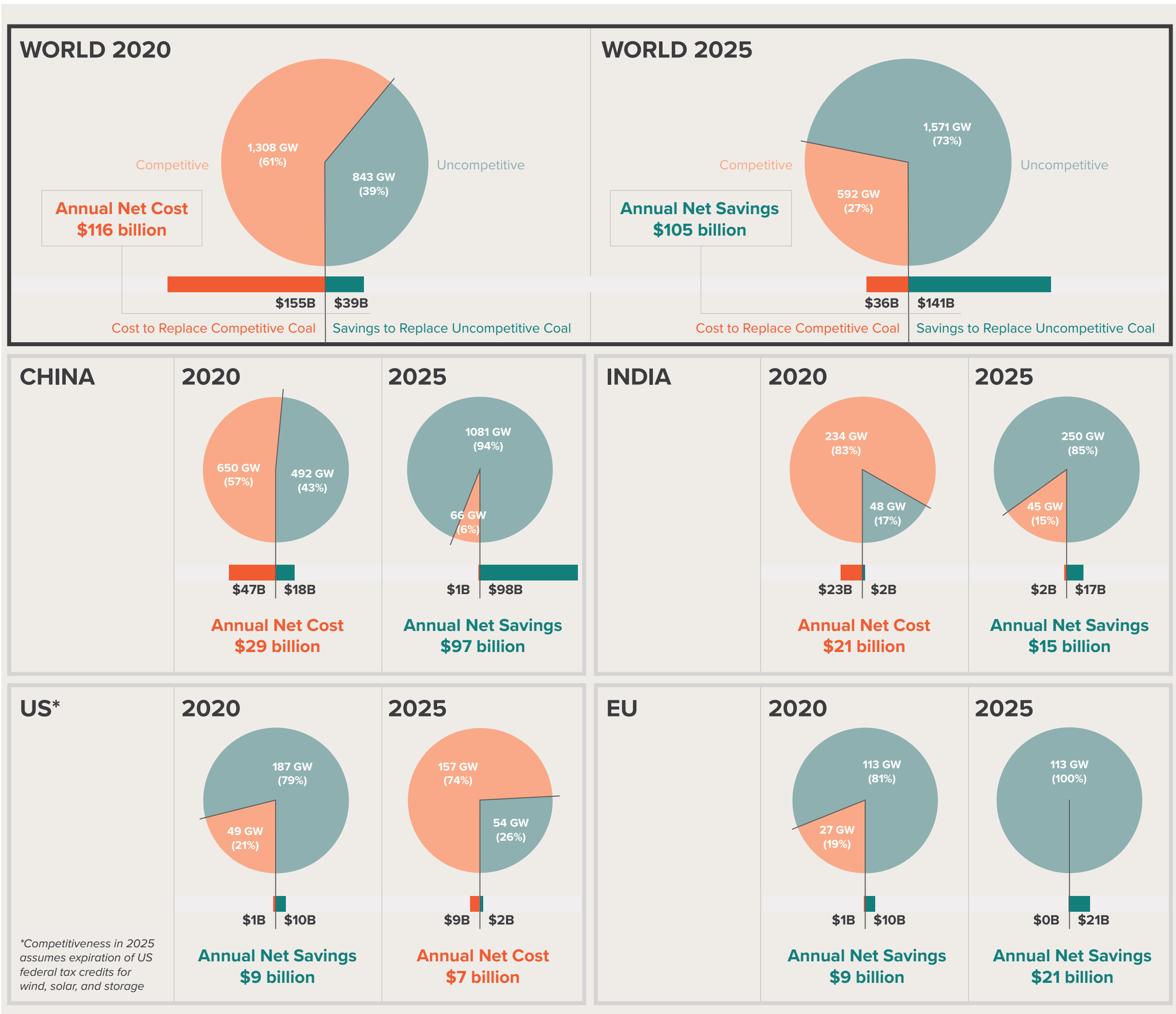
Finally, we present a set of metrics relating to the **carbon bonus**, a concession per ton of carbon dioxide abated that would make it more economic to replace a coal asset with renewables plus storage than to continue operating coal. We present the carbon bonus required to enable phaseout and replacement of 90 percent of the coal fleet, while calculating the cost savings to the customer that would result from the implementation of a carbon bonus program as well as the cost to public finance institutions. Finally, we calculate the net cost of the carbon bonus program by subtracting the cost savings to customers from the cost to public finance institutions.

In the United States today, 79 percent of the 236 GW coal fleet is uncompetitive relative to replacement by renewable energy with storage, and this number will rise to 91 percent by 2022. Phaseout and replacement of these plants could help customers save $10 billion annually today, with that number rising to $13 billion annually in 2022. As of mid-2019, 102 GW of capacity have already been retired or committed to retire since 2010.[2] By 2025, after federal tax incentives have phased out, a carbon price of $19/total carbon dioxide (tCO_2) would render 90 percent of the fleet uncompetitive. Even absent a carbon price, technology improvements and economies of scale are driving down renewable costs, such that solar costs of $20/megawatt-hour (MWh) to $30/MWh are likely to be the norm by 2025, even after the expiry of the federal tax incentives. Declining costs will therefore continue to drive coal power plants out of the market before their technical life ends. According to the latest Federal Energy Regulatory Commission (FERC) capacity estimates,[3] there is not a single new coal plant in the United States being considered by investors in the next three years, whereas there are almost 50 GW of wind and solar projects slated as highly probable.

Outside the United States, other geographies present a similar opportunity for rapid coal phaseout. In the European Union, 81 percent of the coal fleet is uncompetitive as of 2020, with this figure rising to 100 percent by 2025. Replacement of the uncompetitive portion of the EU coal fleet would result in savings of $10 billion annually in 2020 and $21 billion in 2025. **In China**, 43 percent of the fleet is uncompetitive as of 2020, with this figure increasing to 94 percent in 2025. Replacing uncompetitive coal with renewables with storage would yield annual savings of $18 billion in 2020 and $98 billion in 2025. **In India**, 17 percent of the coal fleet is uncompetitive with renewables and storage today, and this number will rise to 85 percent by 2025. Replacing uncompetitive coal in India could bring $2 billion in annual savings; by 2025, that number will rise to $17 billion per year.

Exhibit 1

Cost Competitiveness of Existing Coal vs. New Renewables and Storage



Source: RMI

Although 39 percent of global coal capacity is already uncompetitive relative to renewables with storage today, this number jumps to 73 percent in five years—and far more would be uncompetitive if the full environmental and social benefits of coal phaseout were considered. The climate benefits of phasing out coal and switching to clean energy are not reflected in the relative prices paid by consumers in most regions, nor are the avoided costs of sickness, premature deaths, and lost productivity from air pollution, the losses in agricultural yields, or the degradation of waterways and natural ecosystems. According to US Environmental Protection Agency estimates, the price of coal-powered electricity in the United States could rise by at least 50 percent if the public health costs were properly accounted for.[4] Globally, a rapid coal phaseout would deliver similar local public health and environmental benefits. A recent study found that when these impacts are considered, the economic benefits of phasing out coal exceed the costs virtually everywhere.[5] Finally, a complete accounting of the public benefits of transition would also include the elimination of public subsidies, greater energy security, reduced macroeconomic risk exposure, and other technology and innovation spillover benefits.

2 A Three-Part Approach to Finance Coal-to-Clean

A Three-Part Approach to Finance Coal-to-Clean

Accelerating the transition from coal to clean energy can provide enormous long-term benefits for both consumers and the broader public. Consumers could save money by switching to cheaper renewables. The public can reap the benefits of improved health, cleaner air and water, and a more stable climate. And taxpayers can benefit by being relieved of the burden of paying for costly environmental and health impacts.

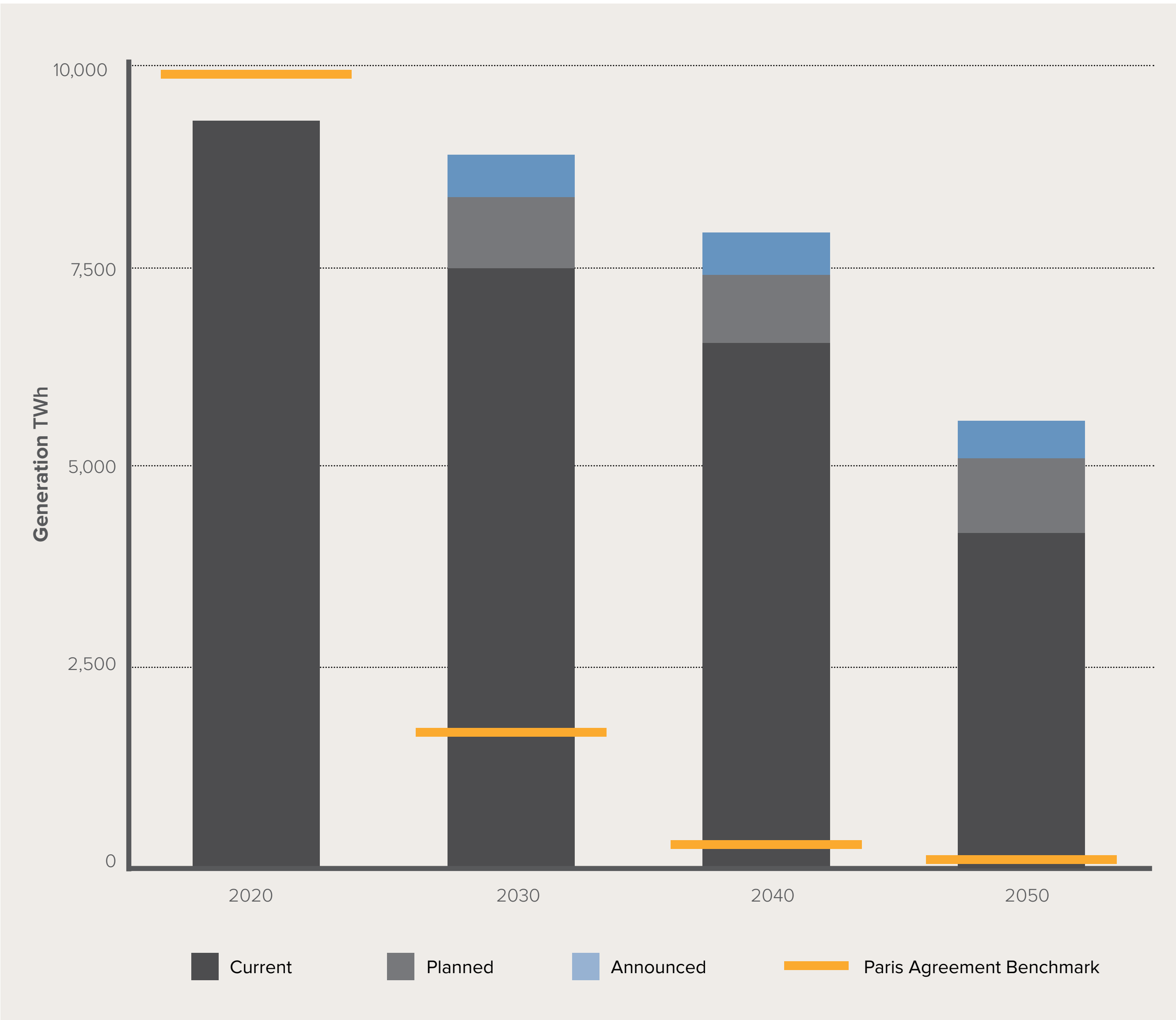
However, the eroding economics of coal haven't translated into action—coal use has actually begun to increase again in recent years, according to the International Energy Agency (IEA), leaving consumers and the public bearing increasing costs and risks.[6] The collapsing competitiveness of coal-fired power, coupled with its considerable externalized costs, has led to a global increase in coal retirements. The majority of these retirements have occurred in Organisation for Economic Co-operation and Development (OECD) countries, where coal power capacity has been falling since 2011.[7] In the United States, for example, more than half of the existing coal plants have retired or committed to retire since 2010. In the EU, 74 GW of coal-fired capacity has been retired since 2010, with another 93 GW slated for retirement under national phaseout commitments, leaving only 50 GW.[8] Outside of the OECD, where more than 75 percent of the global coal fleet is located, the pace of retirement has been slower. In some markets, coal remains a priority industry, and new plants are still being commissioned—and policymakers have been more concerned with expanding electricity production to meet growing demand than with capturing the social benefits from closing dirty and uneconomic coal plants.

The slow pace of coal phaseout and replacement by portfolios of clean energy resources poses a significant threat to the climate. The current pace of coal phaseout needs to be dramatically accelerated everywhere to meet Paris Climate Agreement targets. To achieve the agreement's 1.5°C temperature goal, global coal-fired power generation must be reduced 80 percent below 2010 levels by 2030, requiring rapid transition in OECD countries over the next decade and phaseout in the rest of the world by 2040 (see Exhibit 2).[9] This amounts to reducing coal use by one coal unit every day until 2040,[10] and requires replacing the power with portfolios of clean energy resources.[vii] Meanwhile, consumers are stuck paying for expensive and dirty coal generation, the public bears the health and environmental burdens of increased air and water pollution, and taxpayers bear the expense of redressing these costly environmental and health impacts. The critical challenge, then, is to understand why progress has been slow and to identify how to accelerate phaseout in the context of the political, industrial, regulatory, and financial frameworks and priorities of each country.

[vii] Replacement of this generation with gas will not achieve the necessary reductions, and as the costs of renewables fall below the cost of gas, this risks replacing one uncompetitive energy source with another. See, e.g., *Lazard's Levelized Cost of Energy Analysis—Version 13.0* (New York: Lazard, 2019), **https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf**.

Exhibit 2

World's Coal-Based Power Generation
Incompatible with Paris Agreement Benchmarks



Source: Chart taken, with permission, from Paola A. Yanguas Parra, Gaurav Ganti, Robert Brecha, Bill Hare, Michiel Schaeffer, and Ursula Fuentes, *Global and Regional Coal Phase-out Requirements of the Paris Agreement: Insights from the IPCC Special Report on 1.5°C* (Berlin, Germany: Climate Analytics, 2019), **https://climateanalytics.org/media/report_coal_phase_out_2019.pdf**. Their underlying data comes from the Global Coal Plant Tracker (Global Energy Monitor) and the IAMC 1.5°C Scenario Explorer hosted by the International Institute for Applied Systems Analysis.

Impediments to Rapid Coal Phaseout

A key reason for the slow pace of coal phaseout is that the vast majority of coal plants globally are insulated from competitive forces by legacy contracts or tariff structures. Globally, 93 percent of the operating coal fleet is located in regulated or semiregulated markets,[11] meaning most coal assets operate under (1) long-term agreements that offer a guaranteed stream of payments through power purchase agreements (PPAs), (2) a regulated rate of return to the asset owner, or (3) a government mandate to a state-owned enterprise (SOE). Because these plants are insulated from market forces, they can be profitable even when the cost of coal exceeds that of renewables. Coal power customers face the risk of penalties and costs if they attempt to break or alter these arrangements—as well as legal and political challenges from coal plant owners, workers, and communities that benefit financially from the status quo. As a result, coal plants often continue operating long after they have ceased to be cost-competitive, which can be up to 30 years in the case of long-term PPAs.[12]

In addition, coal assets often benefit from public subsidies that bolster their competitiveness and the lack of technical, regulatory, financial, or policy infrastructure for development or integration of renewable or storage alternatives. One recent study found that in 2016–17, G20 countries provided over $47 billion per year in public finance, fiscal support, and SOE investment directly to coal-fired power production, and an additional $13.4 billion to coal production and consumption.[13] Governments continue to support fossil fuel generation through consumption subsidies or subsidies that lower the price of fossil fuels for the end-consumer.[14] Further, competition can also be stifled through the absence of active government engagement to put in place the necessary technical, regulatory, financial, or policy framework or infrastructure needed to develop clean energy alternatives.

As a result, various stakeholders—owners, consumers, and workers—may not find it in their short-term interest to support an accelerated transition. Coal plant owners can often continue to profit from uncompetitive assets due to regulatory frameworks or contractual obligations. In those cases, consumers may be on the hook to compensate owners for early plant retirements, making accelerated phaseout and replacement much less attractive over the short term. And coal workers and host communities may not see a concrete pathway toward transition.

A Three-Part Approach to Accelerating Coal Phaseout

Rapid coal phaseout could be unlocked by aligning key stakeholder interests around more efficient long-term electricity market structures and outcomes. A more rapid transition could be achieved with an approach that simultaneously (1) saves customers money on day one, (2) provides coal investors with an opportunity to turn coal returns into clean returns, and (3) shares the benefits of the transition with coal workers and communities, who could benefit from dedicated resources to preserve livelihoods, protect benefits, and ensure that host communities continue to thrive. Meeting these conditions would give each key stakeholder group a reason to support the transition, while leading to broad taxpayer and public benefits through reduced health and climate-related risks and costs.

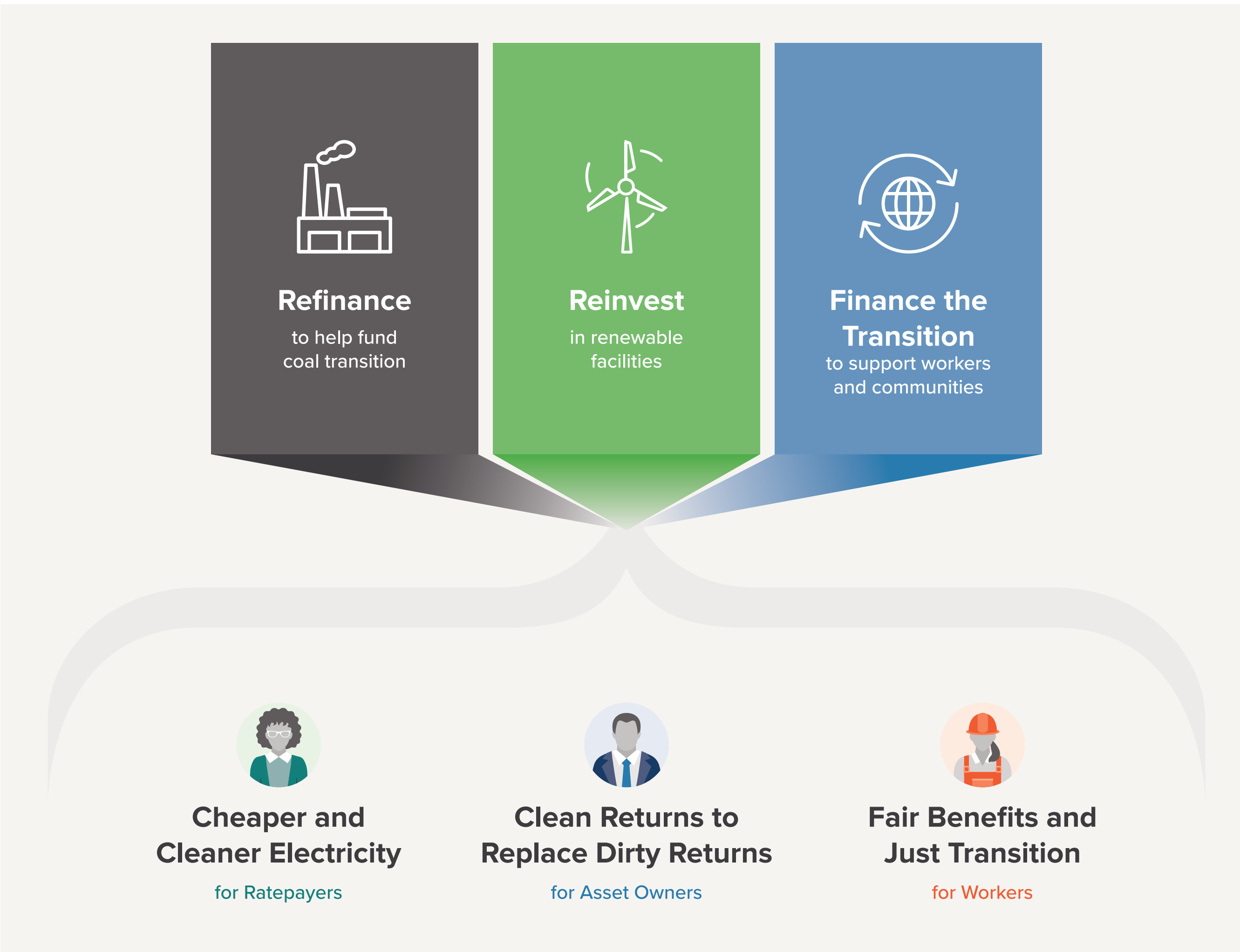
Governments and public finance institutions can accelerate coal phaseout through an integrated three-part approach: (1) refinancing to help fund coal transition and save customers money on day one, (2) reinvesting in clean energy, and (3) providing transition financing for workers and communities. These approaches work by turning the value remaining in the legacy contracts or tariffs into an engine for transition. The existing contracts or tariffs generally provide sufficient revenue to both operate the coal plant and pay financing costs to coal investors. The three-part approach uses financial tools to repurpose these two revenue streams to align key stakeholders—including consumers, current coal asset owners, and coal workers and communities—with more rapid transition.

Whether they require concessional funding or not, financial approaches to accelerating coal phaseout offer several advantages. First, they can be structured as voluntary programs for both governments and asset owners. For example, a reverse auction to acquire outstanding debt on coal plants in exchange for closure does not mandate participation—but it can serve as a powerful mechanism to reveal the true appetite for accelerated phaseout on which subsequent policies can be built. Second, these financial approaches can work in conjunction with local regulatory structures and market conditions. Third, these approaches can help stakeholders find agreement on an acceptable allocation of savings and benefits, thus allowing nontraditional allies to find common ground.

Financial approaches to accelerating coal phaseout can also complement long-term solutions to accelerate the transition, such as restructuring electricity markets, eliminating public subsidies, and reflecting the relative benefits of clean energy in prices. These solutions often face barriers to rapid implementation due to the misalignment of near-term incentives. However, financing approaches that align stakeholder interests can help overcome transition challenges, thus smoothing the path for long-term market and policy reform.

Exhibit 3

The Three-Part Approach to Accelerating Coal Phaseout



Source: RMI

Part I: Refinancing to Free Up Capital for Phaseout and Lower Customer Costs

Refinancing provides low-cost capital to help fund coal transitions and pass on savings to customers immediately. Long-term contracts and tariffs are helpful for financing and building new coal plants, but they can lock customers into these high-carbon, high-cost assets. Unwinding the obligations that sustain this status quo requires targeting the contracts and tariffs themselves. Refinancing agreements that modify contracts and tariffs tied to existing coal plants can raise new, lower-cost capital that can be used to pay off banks and other investors whose returns currently depend on the coal plant continuing to operate. Under the right circumstances, this frees up the utility to invest in clean generation assets instead and reduces ratepayer costs directly, because tariffs incorporate financing costs. We propose several mechanisms for refinancing coal assets, including asset-backed securitization, ratepayer-backed bond securitization, and green bonds. These are described in Section 3.

But refinancing agreements are not likely to be viable without reinvestments in clean energy and support for a just transition. Most power contracts include early termination penalties or take-or-pay clauses that make payoff very unattractive to customers. And early return of capital in most cost-of-service tariffs would result in coal asset owners losing future earnings, resulting in reinvestment risk. As a result, refinancing agreements that pass through financing cost savings to customers usually require the parts II and III below to align stakeholder interests.

Part II: Reinvesting in Clean Energy

In both emerging and developed economies, clean energy represents a significant growth opportunity for investment and job creation in the electricity sector. Energy demand is expected to continue growing in emerging economies, due to economic growth. In developed countries, energy demand has largely been flat but is expected to rise, due to increased electrification. Although private-sector investments in clean energy have exploded over the past 15 years, they must be significantly expanded and coupled with storage to cover both growing demand and lost capacity from retired coal.[15]

Providing current coal plant owners the opportunity to reinvest capital in clean energy projects can further reduce customer costs while making refinancing agreements more feasible. Refinancing requires an agreement between current asset owners and customers to modify current contracts or tariffs to pass through financing cost savings to customers. This requires that a coal asset owner have an incentive to renegotiate an existing long-term contract or, in the case of a cost-of-service tariff, some opportunity to replace expected future returns from coal assets that mitigates reinvestment risk. The opportunity for reinvestment in cheaper, clean energy while phasing out an existing, more expensive coal asset can provide just such an incentive in both cases, allowing coal asset owners to replace dirty profits with the opportunity to grow clean profits. And if the coal is uneconomic, the agreement can allow customers to save even more money by replacing the costs to operate the coal plant in current tariffs or contracts with the lower total cost of the clean capacity.

Part III: Transition Financing for Coal Workers and Communities

Although coal phaseout offers broad economic and public health benefits, the costs and benefits of the transition will not be shared equally. Coal plant and mine workers and ancillary businesses may be particularly hard hit, as may the communities that host them. Closure plans must therefore address the critical needs of affected workers and communities, including the need to preserve jobs and incomes, protect workers' healthcare and retirement benefits, and ensure that host communities can continue to provide critical social services. Approaches that benefit plant or mine owners while leaving communities and workers to bear the full weight of their losses are unlikely to be politically viable.

A strong social consensus on the goals and pathways of the coal transition is critical to reaching fair and successful outcomes.[16] This kind of consensus can be achieved only through an informed dialogue that brings the various stakeholders to the table early in the decision-making process and allows workers and communities to help create their own economic future.

A portion of the new capital raised through refinancing can be used to provide transition financing to coal workers and communities. By both increasing the tariff or contract price paid by customers and the size of the refinancing facility, additional capital can be raised to make immediate resources available for coal workers and communities to preserve livelihoods, protect benefits, and ensure that host communities can continue to thrive.

Addition of Concessional Financing

Where clean energy already outcompetes existing coal, it may be possible to achieve all three parts of the coal phaseout approach without additional public funds. Coal phaseout deals struck recently in the United States have demonstrated that these elements can be achieved in the absence of explicit government funding. For example, the Energy Transition Act of 2019 in New Mexico[17]—which authorized the use of securitization to finance utility cost recovery for the retirement of San Juan Generating Station, transition financing for coal communities, and utility reinvestment in clean energy—demonstrates how financing packages can turn the value remaining in noncompetitive tariffs into an engine for transition without public funds.

When coal remains competitive (ignoring its health and environmental costs), public resources may need to augment this three-part approach in the short term. In Section 3, we discuss two concessional finance tools that can be used in conjunction with the refinancing, reinvestment, and transition financing mechanisms to achieve these objectives: carbon financing and debt forgiveness via reverse auctions. OECD countries should finance these mechanisms domestically and fund them in poorer countries as part of their climate and development assistance. But one point bears repeating: with the share of uncompetitive coal increasing quickly, this kind of financing would be needed mostly in the short term to accelerate action.

Why Public Finance Should Support Coal Phaseout

Given the political nature of decisions to phase out coal, it is reasonable to ask whether public money should ever be given to coal plant owners. After all, shouldn't the "polluter pays" principle apply? And, as a matter of fairness, wouldn't public money be better spent ensuring a just transition for hard-hit workers and communities than paying off investors? These questions have confounded previous closure efforts but can largely be resolved with innovative financing tools and well-structured, inclusive decision-making processes.

There are a few reasons why public finance should—in some cases—be made available to support coal phaseout:

First, **ratepayers, not coal plant investors, are the primary beneficiaries** of the tools proposed in this report. Where rates are regulated or determined by long-term PPAs, refinancing and debt forgiveness programs relieve customers of the obligation to continue to buy expensive power from uneconomic coal assets. Similarly, payments for reduced emissions under a carbon bonus would be passed on to customers in the form of cheaper electricity, not retained by owners as windfall profits.

Second, **in regulated markets, owners may assert a legal right** to recover their invested capital and to earn a fair return on any unrecovered costs. These claims can take years to resolve, needlessly delaying the necessary transition. In these circumstances, it is better to allow plant owners to recoup their investments by closing than by continuing to operate. The best way to do this is to allow them to recycle the capital from closing coal plants into replacement renewables and to earn their returns on the new investments.

Smart program design and sound management practices can ensure that plant owners do not realize excess profits. Where concessional funding is used, it should be allocated via competitive processes, such as reverse auctions, to minimize costs. And in all cases, proposed financing packages and the underlying plant economics should be publicly disclosed to enable public oversight and accountability.

Most importantly, inclusive social dialogues should be used to reach agreement on overarching priorities and ensure that financing is not allocated to plant owners at the expense of hard-hit workers and communities. The financing tools described in this brief can facilitate such agreements by providing stakeholders the tools needed to flexibly allocate costs and benefits among owners, workers, communities, taxpayers, and ratepayers.

Finally, although social dialogue should mainly determine where public resources are spent, there may be certain circumstances in which granting public funds to utility owners would be *a priori* inappropriate. For example, compensating owners for closing plants that are destined to close in the near term anyway is an unwise use of public funds.

3

Financial Instruments to Speed Coal-to-Clean

Financial Instruments to Speed Coal-to-Clean

Financing has a key role to play in accelerating the phaseout of coal assets and reinvestment in renewable energy while ensuring a just transition for workers and communities. Financing mechanisms can align the interests of asset owners, ratepayers, and coal workers and communities by unlocking the residual value in legacy contracts to facilitate a transition to renewable energy that maintains or improves the well-being of each party.

This section describes in greater detail specific refinancing and concessional financing mechanisms that can help accelerate coal phaseout. The four refinancing mechanisms described below—single-asset refinancing, ratepayer-backed bond securitization, asset portfolio securitization, and green bonds—provide a menu of financing options that can be packaged with reinvestment and transition financing to address the specific circumstances of coal phaseout in many regions. These packages can help align the interests of asset owners, ratepayers, and coal workers and communities with rapid transition of the 93 percent of coal insulated from market forces by long-term contracts or tariffs. The two concessional financing mechanisms—carbon bonus and debt forgiveness with reverse auctions—can complement the three-part approach and accelerate phaseout for the 60 percent of coal assets operating globally in regions where the relative costs to customers of coal and clean energy do not currently reflect the full benefits of transition.[viii]

These instruments are proposed in their simplest form and intended as a starting point for further discussion, adaptation, and modeling. Exhibits 4–8 depict how each instrument is intended to facilitate the move away from business as usual by replacing higher-cost capital, facilitating reinvestment by coal asset owners, lowering payments and providing cleaner energy for ratepayers, and facilitating a just transition for coal workers and communities.

1. Refinancing

Refinancing offers coal asset owners and customers the ability to unlock lower-cost capital to fund the phaseout and replacement of coal assets.[ix] Refinancing instruments rely on a regular, contracted stream of payments from either customers or a government entity. These payments are typically contracted through a PPA or via regulatory approval for charging ratepayers the cost of service. Because of this reliability, refinancing instruments should be attractive to investors from a risk perspective and have the potential to offer a commercial return without significant subsidies. However, some concessionary finance may be needed in less developed markets or for new instrument structures to (1) prove the concept, (2) structure the instrument, (3) mitigate some country or off-taker risk (e.g., political risk, currency convertibility), and (4) fund additional just transition costs. Some examples of refinancing instruments include the following:

[viii] Note that the concessional financing mechanisms can be deployed with or without the three-part approach—with the latter relevant for the fraction of the 7 percent of global coal that is subject to market competition and that remains competitive (ignoring health and environmental costs).

[ix] Total debt capital available will depend on anticipated cash available for debt service from the new renewable assets and the required debt service coverage ratios. The instrument structures show a single actor (the asset owner) responsible for both the phaseout and replacement of the coal assets. This could be done by a large energy company with an existing renewable energy business, through acquisition, or through some form of partnership between energy companies and/or a public entity.

Single-asset refinancing: Under single-asset refinancing, a coal plant owner borrows money to pay down any remaining debt on the existing plant, buy out any fuel supply agreements, and fund the new renewable energy facility.[x] The owner then reinvests capital to finance and build the new facility and obtains a new PPA or mandate for the new renewable facility (or swaps the existing PPA or regulatory mandate from coal to renewables once it reaches commercial operation). The covenants of the refinancing loan could explicitly stipulate proportionate funds that could be used toward replacement energy versus funds for a just transition.

Exhibit 4

Single-Asset Refinancing

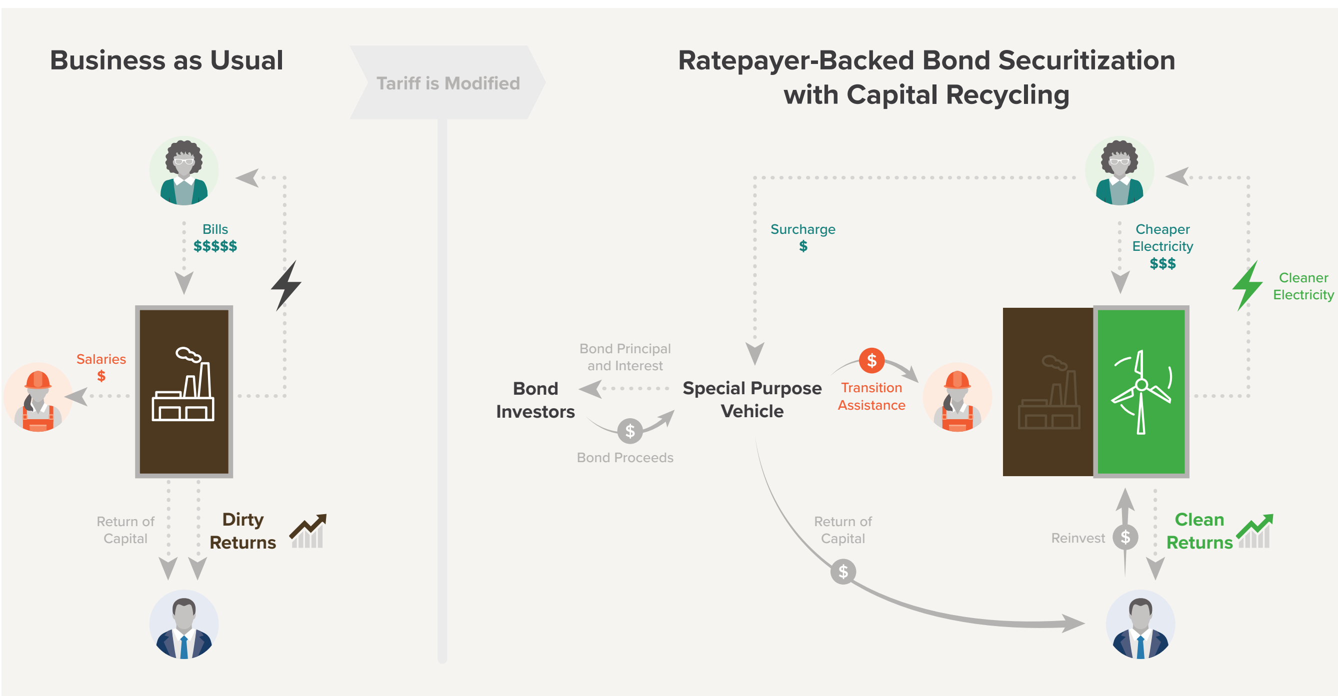
Source: RMI

[x] Total capital available for developing the replacement facility will depend on the remaining debt principal on the coal asset, the cost to buy out the fuel supply agreement, the cost of the replacement facility (or facilities), and the expected cash flows for debt service from the replacement PPA.

Ratepayer-backed securitization: A ratepayer-backed securitization allows ratepayers to directly raise low-cost debt on the basis of a pledge of the future revenues from a dedicated surcharge on their bills. The proceeds from the debt issuance can then be used to finance near-term ratepayer obligations or needs. For example, a rate-regulated tariff on a coal plant is generally sized to allow for both recovery of investments in the plant made by its owner, along with an administratively set return on that investment over the life of the plant. If the plant becomes uneconomic to run, then barring any utility malfeasance, the owner is generally able to continue to recover historic investments and a return on unrecovered capital through tariffs, even if the plant is factored down or retired. Much like refinancing a mortgage, securitization allows ratepayers to refinance that obligation to reduce their financing costs from a higher return on utility capital (often including higher-cost equity as well as debt) to lower-cost securitized debt.

Exhibit 5

Ratepayer-Backed Securitization

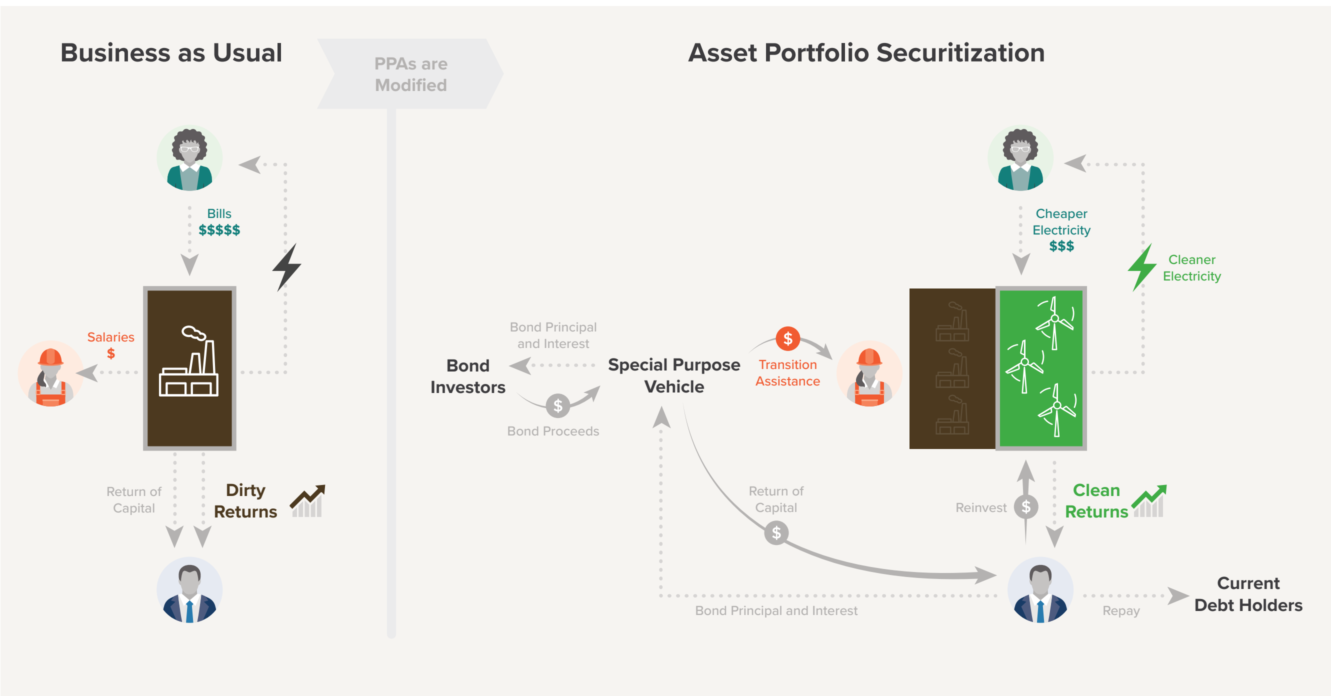


Source: RMI

Asset portfolio securitization: This mechanism is similar to ratepayer-backed securitization and can also be applied toward an independent power producer (IPP) with a portfolio of coal PPAs. In this case, instead of raising debt to be repaid by a surcharge on customer bills, debt is raised to be repaid from expected revenues from the portfolio of renewable PPAs. This financing could then be used by the IPP to raise the capital it needs to shut down its existing assets and replace them with lower-cost clean energy options. In this case, the sale requires that the IPP and the off-takers pre-agree that the coal PPAs could be replaced with renewable PPAs to allow for a seamless stream of payments to secure the instrument.

Exhibit 6

Asset Portfolio Securitization



Source: RMI

Green bonds: Green bonds—fixed-income instruments issued on the capital markets or to a smaller group of investors—were created to finance projects with positive environmental attributes. These instruments can be certified by a third party such as an Approved Verifier under the Climate Bonds Standard and Certification Scheme,[18] and they typically come with stringent environmental requirements. Green bonds can be issued by governments, SOEs, companies, or other entities with a credit rating and a commitment to green energy. These bonds can be backed by revenue streams from projects (the ratepayer and asset portfolio securitizations are forms of green bonds), taxes and fees levied by a government entity, or the balance sheet of the issuing entity that repays the bond from other sources of revenue. The bonds are rated and priced according to the repayment risk of the issuing entity.

Green bonds represent an approach that governments and large asset owners with steady and diverse sources of revenue can use to refinance the debt on their existing coal assets and obtain more favorable financing to phase out and replace their existing coal fleet. Green bonds are similar in structure to the asset portfolio securitizations.

2. Concessional Finance Mechanisms

Although each of the refinancing options described above can (along with reinvestment in clean energy and transition financing for workers and communities) facilitate rapid transition for assets in regions where the relative costs of coal and clean energy sufficiently reflect the benefits from transition, this is currently not the case for over 60 percent of coal globally. Concessional financing mechanisms can complement (where needed) the above three-part approach to drive more rapid transition of assets, even in regions where coal transition would not currently translate into savings for customers.

Carbon finance—the monetization of emissions reductions resulting from mitigation activities—offers one way to better reflect the true relative economic benefits of coal phaseout in customer costs. When used as a complement to the three-part transition approach, it can enable immediate customer savings from coal phaseout, even in regions where coal is otherwise insulated from market pricing and competition. However, carbon finance instruments must be designed to avoid perverse incentives, including the deferment of coal plant closure or the inflation of emissions baselines to maximize profits.[19] Globally, policymakers have adopted a range of approaches to monetize emissions reductions, with some involving bilaterally negotiated payments to emitters and others relying on markets for tradable credits or allowances. However, few carbon finance instruments have been designed to explicitly target a comprehensive transition to renewable energy.[xi] Likewise, policymakers charged with designing incentives have more often focused on the "stick" of carbon pricing rather than the "carrot" of payments for reducing emissions.

A carbon bonus provides a simpler pathway to monetizing emissions reductions. Under a carbon

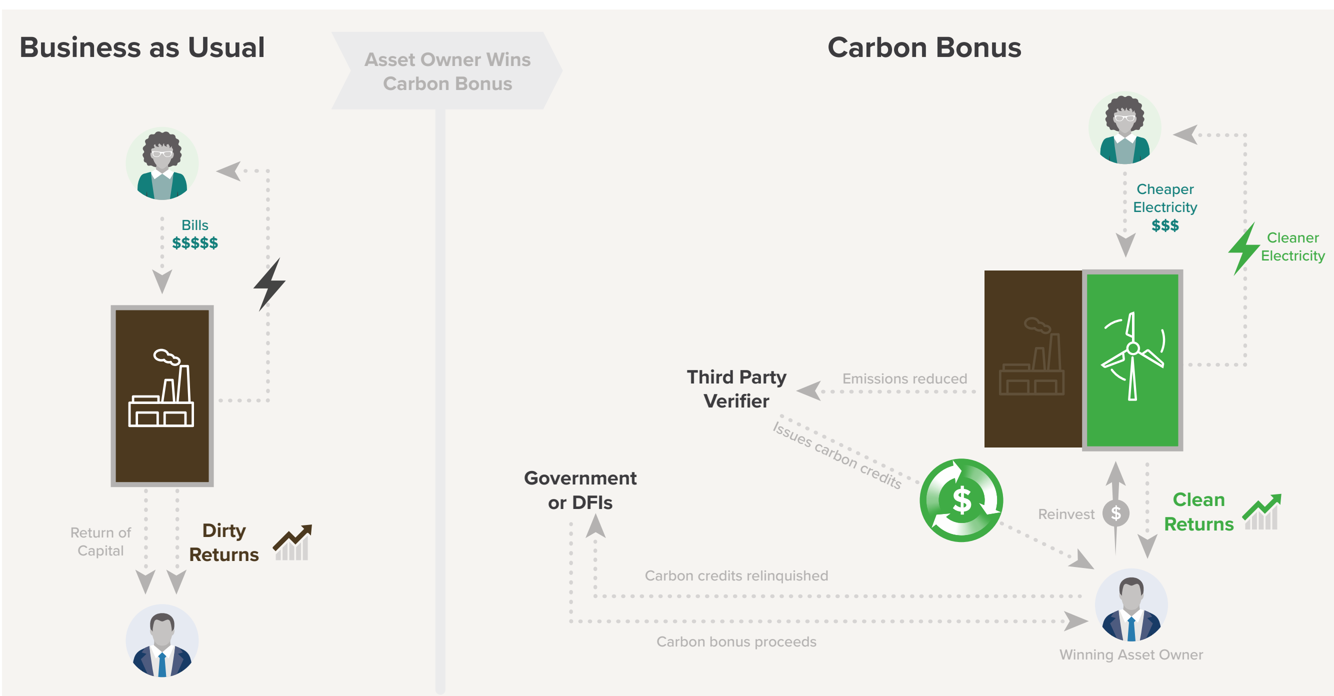
[xi] The Clean Development Mechanism in 2005 approved a methodology for replacing fossil fuel-powered plants with renewable energy (Methodology AM0019), but no projects were ever submitted under this methodology.

bonus, government or public financiers could offer payments to electricity providers for each ton of emissions abated while continuing to provide the same value of electricity services and ensuring a fair workforce transition. The emissions reductions must be verifiable, permanent, and additional (i.e., there should be proof that closure would not have happened in the absence of a payment), and the payments should be allocated competitively (e.g., via reverse auctions). As opposed to traditional carbon-pricing regimes, in which utilities owning and operating plants pay a fee to continue operations, the carbon bonus incentivizes utilities to abate. Governments or public finance institutions would typically make carbon bonus payments in the form of cash payments. But they could also be provided in other forms, such as tax credits, debt forgiveness, or concessional interest rates on new debt to finance replacement renewable energy.

In regulated or semiregulated markets, these incentives should be passed through to customers in the form of reduced electricity rates, and used to support transition financing to coal workers and communities. One way to do this is to combine the carbon bonus with any of the financing structures described above to address the challenges posed by legacy contracts and tariffs. The carbon bonus does not require a carbon-pricing or carbon-trading scheme to implement and could be implemented at the project level or on a national or regional scale. Exhibit 7 shows an example of a carbon bonus being used to replace a coal plant with renewable energy.

Exhibit 7

Carbon Bonus



Source: RMI

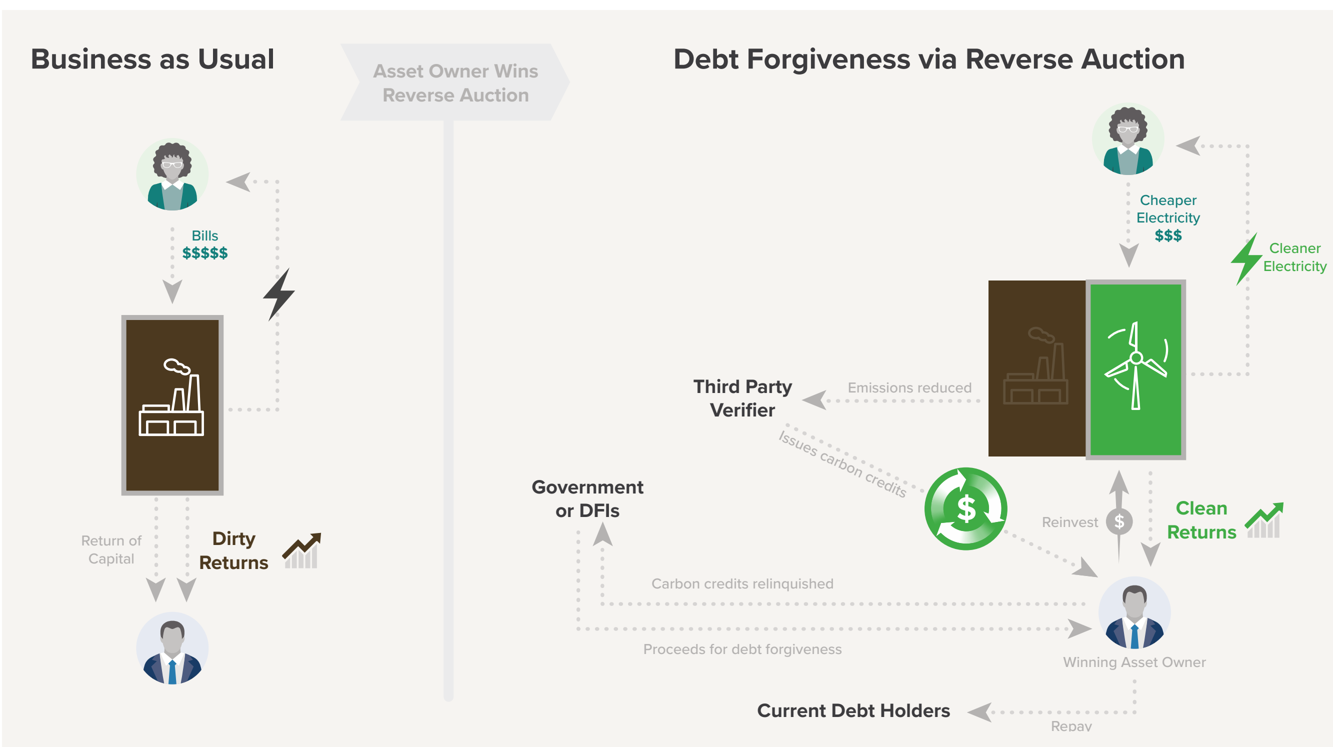
Debt forgiveness via reverse auction: Debt obligations can make coal phaseout challenging, as asset owners rely on electricity payments to service their loans. Debt relief as an incentive to asset owners or utilities to phase out their coal plants and reinvest capital in renewable assets can accelerate the transition from coal to renewables and unburden overly leveraged balance sheets.

Debt forgiveness should be conditioned on a transition from coal to clean and allocated competitively based on the relative benefits of the transition. Allocation of debt forgiveness via reverse auctions can contain costs and limit the risks of excess subsidies. In a reverse auction, a government or public finance institution establishes a fund to support the phaseout of coal assets and reinvestment in renewable energy. The entity may choose to establish a separate fund to support the just transition. Asset owners then submit bids for the cost to phase out their coal plants and replace the service provided with clean energy. If the bid selection criteria are designed to maximize the carbon reductions achieved, the mechanism is a type of carbon bonus.

Reverse auctions can work in markets with private ownership or publicly owned plants in which the facility's debt burden is being passed along to ratepayers. In these cases, the government or public finance institution could determine that paying to phase out the asset poses a net benefit in terms of both providing relief to ratepayers and curbing emissions. Exhibit 8 shows a debt forgiveness mechanism allocated through a reverse auction, with a carbon bonus component.

Exhibit 8

Debt Forgiveness via Reverse Auction + Carbon Bonus



Source: RMI

4 The United States: Financial Pathways to Close Coal

The United States: Financial Pathways to Close Coal

The United States could help customers save up to $10 billion in 2020 using the three-part approach to phase out the 79 percent of the coal fleet that is uncompetitive today. More than three-quarters of the 236 GW of US coal capacity is in markets where customers are locked into paying utilities based on a cost-of-service tariff. As a result, in this time of national economic distress, customers are paying more for electricity from expensive coal just when they can least afford to. With the tax benefits available for wind, solar, and storage today, the three-part strategy outlined above can provide transition assistance and save customers money from coal phaseout on day one.

When crafting COVID-19 recovery plans, federal (and international) decision makers can learn from the financial packages that US states have previously used to assist major transitions in the power sector. When state power markets were restructured in the 1990s, many utilities were forced to divest from their generation assets. States used ratepayer-backed bond securitization to help them retire plants that utilities could no longer own. Now, a similar issue looms as ratepayers of investor-owned utilities are on the hook for nearly $100 billion in unrecovered costs associated with operating coal plants across the country. These plants are already largely uncompetitive and being used less and less each year.[20] Ratepayer-backed securitization to refinance these obligations and unlock savings from the phaseout of coal has already been enabled by legislation in six states, and policymakers have introduced legislation in another five.

Federal policymakers can offer direct loans or loan guarantees from the Treasury or Energy Departments to provide securitization across the country so utilities can take advantage of federal tax incentives, save customers money from coal phaseout, and support transition assistance. The Department of Energy (DOE) already provides direct loans, loan guarantees, and other innovative financing mechanisms to reduce greenhouse gas emissions through its loan program office. This program could be modified to provide financing in a way that mimics ratepayer-backed bond securitization at the state level, replacing private bonds with either direct federal loans or bonds with federal guarantees. Although private finance backed with state legislation can support ratepayer-backed securitization, a federal program administered by the DOE would likely be more efficient and would provide access to many more coal asset owners and their ratepayers.

As clean energy tax benefits expire (fully by 2025), US federal policymakers could employ debt forgiveness of \$19/tCO_2 to transition 90 percent of coal to clean, reducing CO_2 emissions by 1 gigaton annually and saving customers up to \$14 billion per year. Further, as federal tax benefits expire, policymakers can authorize these agencies to offer debt forgiveness linked to verifiable, additional emissions reductions from switching from coal to renewable energy plus storage—that is, as a carbon bonus implemented as debt forgiveness via reverse auction. Debt relief to pay for carbon reductions at a cost of \$19/tCO_2 over 20 years could make it cost-effective to transition 90 percent of the remaining coal in the United States to renewables with storage by 2025, while delivering up to \$14 billion per year in savings to customers in fuel and operating expenses alone.

Recommendations for US Policymakers

Department of Energy Financing for Ratepayer-Backed Bond Securitization

The existing Loan Programs Office of the Department of Energy (DOE) could offer partial or full loan guarantees, authorized through an expansion of DOE's authority under Title XVII of the Energy Policy Act of 2005, to allow utilities across the country to implement ratepayer-backed bond securitization with reinvestment and transition assistance to accelerate coal phaseout.

To use this financing, regulated investor-owned utilities would first submit financing orders to their regulatory commission requesting approval to apply for a DOE direct loan or a loan guarantee. The DOE financing would back a bond to be repaid through a dedicated bill rider that is sized to cover the estimated unrecovered costs associated with phaseout of a carbon-emitting plant and to provide transition support for plant employees. The utility would also submit to the commission a resource procurement plan to replace the services provided by a carbon-emitting asset with carbon-free power. If the commission approves the financing order and the resource procurement plant, and the utility's application to DOE is subsequently approved, the commission uses its existing rate authorities to create a rider on ratepayer bills that will repay the bond principal and interest over time. The government-backed bond will receive a high rating with low yields and can create savings for ratepayers in the near and long term. The utility can then reinvest freed liquidity in clean energy replacement resources and fund just transition efforts.

Carbon Bonus as Debt Forgiveness via Reverse Auction

Congress can drive significant decarbonization and badly needed economic activity across the country by applying carbon finance, in the form of a carbon bonus program, to recovery financing. The carbon bonus creates an effective carbon price but aims financial incentives for decarbonization at companies that most need to reduce their emissions. With the significant cost decreases in clean energy technologies, the cost for companies to decarbonize—and, therefore, the subsidy needed to fund the carbon bonus—are likely to be modest.

Under the carbon bonus, any entity with debt held or guaranteed by the Federal Reserve, a federal agency, or a federal financing authority may petition the secretary of the Treasury to reduce its repayment of principal and interest by an amount proportional to its planned CO_2-equivalent emissions reductions relative to a 2019 baseline. Petitions must specify how the entity and its partners will achieve CO_2 emissions reductions while delivering equivalent goods and services and planning for a fair transition for workers. Emissions reductions must be realized directly by the entity and its partners and may not be achieved through offsets or unbundled renewable energy certificates. Entities may reapply for repayment relief every two years. A reverse auction mechanism can be used to arrive at a price that most efficiently incents applications for repayment relief. The program could be administered by the secretary of the Treasury, the DOE, and the Environmental Protection Agency. Approved repayment reductions would be subject to recapture, with an additional penalty if emissions reductions cannot be certified.

Utilities operating coal plants across the country can combine securitization from the DOE with the carbon bonus program to finance a just transition from coal that can deliver savings to customers immediately.

5 Financial Pathways to Close in Global Markets

Financial Pathways to Close in Global Markets

Outside the United States, 34 percent of the global coal fleet is already uncompetitive with renewables with storage today. By 2025, that number will more than double to 78 percent. Phasing out uncompetitive coal plants could generate significant savings each year, beginning with $29 billion in annual savings in 2020 and $139 billion in 2025. Retiring and replacing the entire global coal fleet outside the United States could be accomplished at a cost of $154 billion in 2020, or $27 billion in 2025. These costs do not take into account savings from replacing already uncompetitive coal, or the benefits of eliminating adverse health and environmental impacts.[21]

These aggregate numbers inevitably mask regional variation. In the largest coal power regions—Europe, China, and India—the percentage of uncompetitive coal plants is rising fast and will average over 90 percent by 2025. In other developed and developing countries, the picture is more mixed. For some countries, the cost of building new renewables plus storage will become cheaper than continuing to operate coal plants in the mid- to late-2020s. Even in those situations, however, the economic case for planning coal phaseout is becoming more apparent every year. For a group of other developing economies with aggregate coal capacity similar to that of the United States, $38 billion in concessional finance would be needed to phase out and replace the entire fleet in 2020. By 2026, continuing to operate 51 percent of this fleet will become uncompetitive relative to building new renewables plus battery storage. Given the long lead times for electricity system planning and decision-making, as well as the size of the opportunity, now is the time to start structuring accelerated coal phaseout in all regions.

Public finance institutions—development finance institutions (DFIs), international climate funders, national institutions—have the wide geographical presence, capital, and expertise to mobilize resources and deploy innovative financial tools to spur a worldwide transition away from coal. Over the past decade, these institutions have responded to significant pressure to stop funding new coal plants—and private banks are following suit. But the conversation has moved on from new coal. In the next 10 years, these entities are well positioned to lead the accelerated phaseout and replacement of existing coal. This can allow them to simultaneously address many development challenges at a low or negative cost, reducing carbon pollution, alleviating severe public health impacts, improving standards of living, reducing mortality and illness, and enhancing economic productivity. In addition, public finance institutions have an opportunity to reshape the global energy future in the aftermath of the COVID-19 crisis by aligning the relevant pieces of their coronavirus responses with their existing priorities and commitments under the Paris Agreement. By focusing on this alignment from the outset of the recovery, they can ensure that longer-range energy targets can be met. Coal phaseout worldwide is a critical piece of a sustainable response, though it will differ depending on regional context and market structures.

Over the past decade, the lending policies of DFIs, particularly multilateral development banks (MDBs), have increasingly prioritized climate change, as the crisis threatens to reverse recent development gains and trap millions of additional people in poverty. Consequently, many have already stopped supporting new coal projects while significantly expanding their support for renewable energy. Some, like the World Bank, have also helped governments deliver a just transition for communities adversely affected by coal mine closures.[22] However, they have not directly helped countries accelerate the phaseout of their existing coal fleets. DFIs can catalyze coal phaseout by creatively packaging funding for all three elements of a comprehensive coal phaseout, in accordance with their development and climate priorities. DFIs can also mobilize additional donor support for coal phaseout, channeling concessional funds to speed the coal transition. The case for them to integrate coal phaseout into their work is compelling, as it offers them the opportunity to address multiple development and climate challenges at once. Importantly, country buy-in will be critical, especially in markets where coal assets are predominantly state owned and/or where policy or regulatory changes are also needed.

International climate funders (ICFs) such as the Green Climate Fund, Climate Investment Funds, and bilateral donors have focused their grantmaking and investments on supporting renewable projects, scaling up end-use efficiency, and providing off-grid clean energy services. Although these investments from ICFs (as well as DFIs) have helped drive down costs, the need for public support will diminish as the economics of clean energy solutions continue to improve. Moreover, in markets with burgeoning energy demand, these investments will merely supplement, not displace, existing coal. By offering concessional finance for coal phaseout and replacement, climate funders have a clear role to play in piloting approaches that encompass all three elements of the coal transition.

Finally, national institutions (including national development banks, green banks, and central banks) also have a role to play in funding refinancing, reinvestment, and transition packages. For instance, green banks could receive and pool funds from multiple sources—such as domestic bank balance sheets, MDBs/DFIs, and the private sector—and structure financing to support context-sensitive three-part approaches. National institutions might also be best placed to funnel post-COVID-19 stimulus funds into green recovery programs, including the phaseout and replacement of uneconomic coal through financial mechanisms outlined in this report. In addition, national coal phaseout can effectively redirect subsidies that many governments have lavished on coal mining and power generation. Central banks, in collaboration with national treasuries and policymakers, could establish short-term facilities allowing coal plant owners to borrow on favorable terms under strict conditions: commitment to an accelerated phaseout schedule, recycling of capital into replacement renewable energy with storage, and the setting aside of enough funds for a just transition. One example of a central bank's short-term facility intended to support the real economy is the Bank of England's 2016 Term Funding Scheme, which offers very low interest rates to banks for a maximum of four years, with strict requirements that they on-lend to households and businesses.[23]

On the following pages, we outline regional case studies to provide overviews of some of the largest coal-hosting regions in the world and illustrate the deteriorating economics of coal in international markets. Importantly, these excerpts are not intended to serve as deep dives on geographies or exhaustive illustrations of regional electricity markets. More in-depth analyses are needed to fully flesh out each regional case and present a detailed evaluation of each market's idiosyncrasies.

CHINA

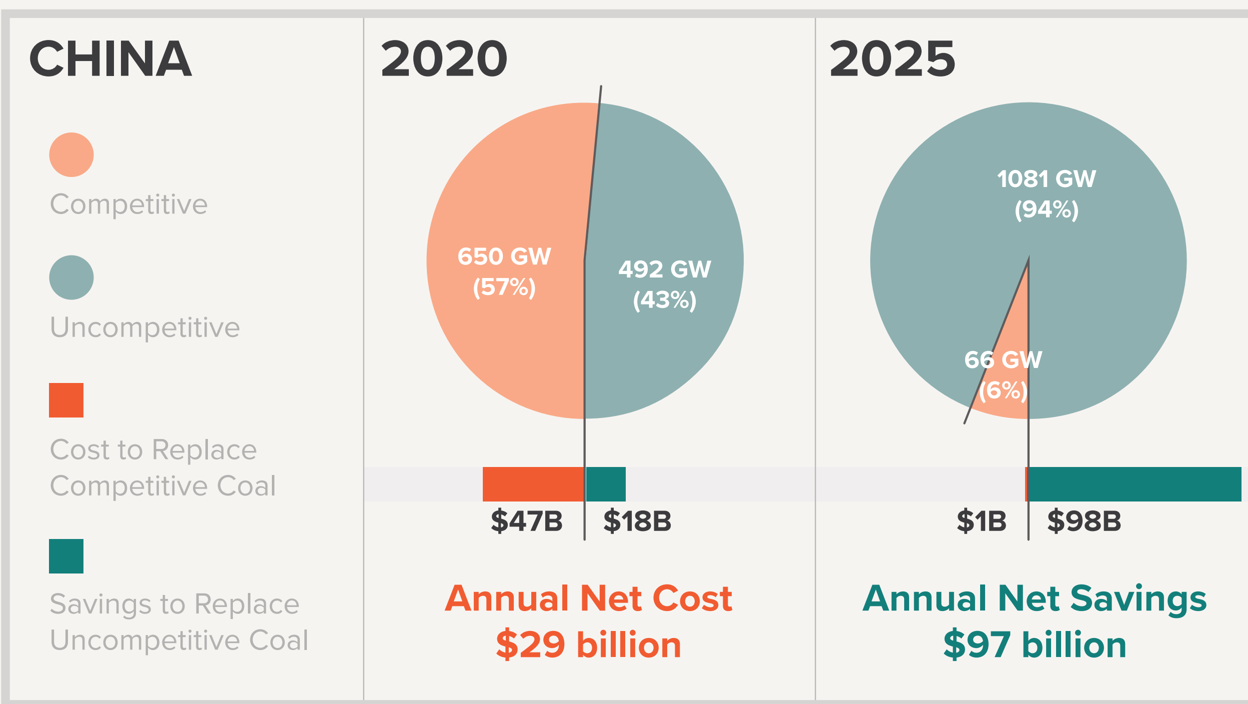
China is home to over 50 percent of the world's coal capacity. China has largely relied on coal to meet its growing power demand, in large part because inflexible system operation and the lack of a spot market have hampered the system integration of variable renewables. In recent years, the increasing shares of variable, intermittent wind and solar PV power have raised concerns about power supply security, which has been built around coal since the People's Republic of China was established. China increased renewable energy investment 100 times between 2005 and 2018, accounting for one-third of the world's renewable energy investments in 2018.[24] This increase in investment can be explained in part by a desire to minimize extreme air and water pollution from coal.[25] In addition to losing competitiveness with renewables, coal plants in some parts of China also struggle financially from operating at low utilization rates due to overcapacity.[26]

We estimate that 43 percent of Chinese coal is already uncompetitive with renewables plus storage today: the Chinese power system could save $18 billion annually by retiring this portion of the fleet in 2020. The remaining 57 percent of coal plants could be replaced at a cost of $47 billion in 2020. However, by 2025, the percentage of uncompetitive plants will rise to 94 percent, their retirement offering $98 billion in annual savings. The remaining 6 percent would cost $1 billion to replace in 2025.

Though the uncompetitive portion of the fleet should not require financial intervention to phase out and replace, China may require public finance to overcome barriers posed by market regulation, regional complexity, and politically shielded coal production. Refinancing SOE assets through debt forgiveness via reverse auctions or a carbon bonus could help achieve this objective. Practically, phaseout and replacement of coal plants could be undertaken by national and multilateral public finance institutions operating in China, in close collaboration with the Chinese Communist Party. These institutions include the Chinese central bank (People's Bank of China), the Asian Development Bank, and the World Bank.

Exhibit 9

China: Cost Competitiveness of Existing Coal vs. New Renewables and Storage



INDIA

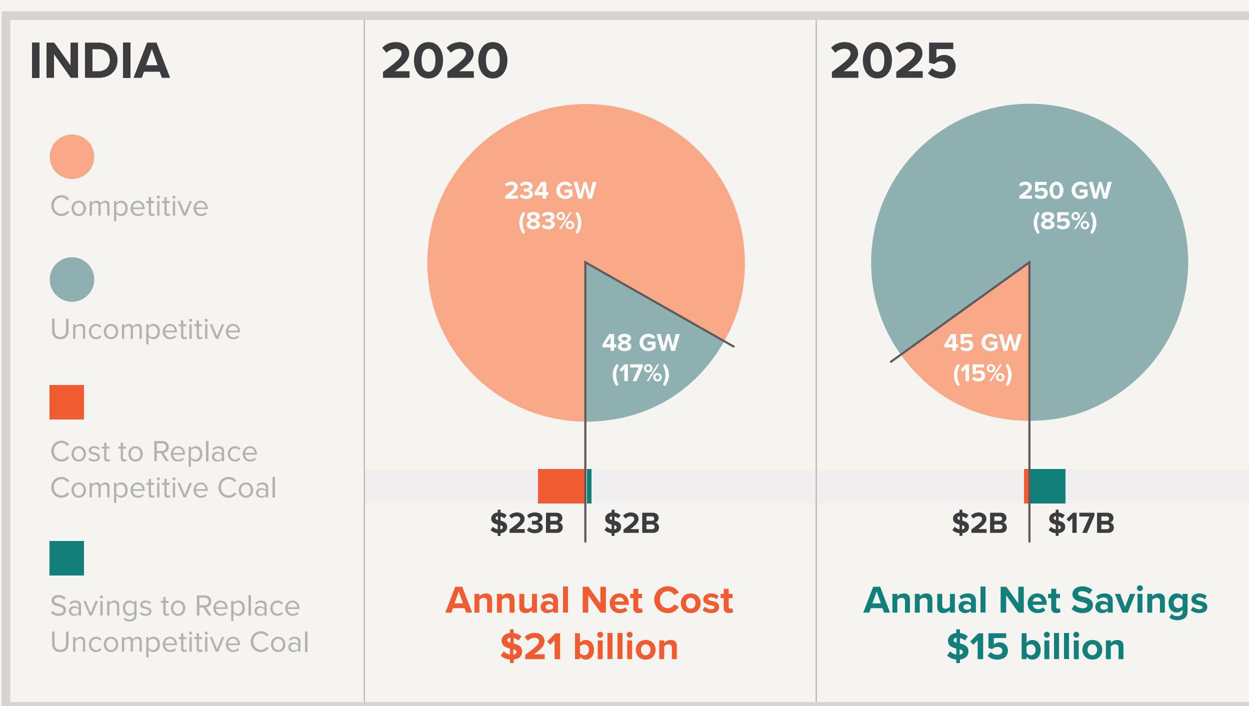
India has set aggressive targets for renewable energy development, aiming to increase clean energy output from 86 gigawatts (GW) in 2019 to 175 GW by 2022, and 450 GW by 2030.[27] Although India expects continued growth in energy demand, the government has identified almost 23 GW of obsolete coal plants to be considered for retirement by 2022, and an additional 25.6 GW to be considered for retirement by 2027.[28] Aside from meeting growing demand, coal also employs hundreds of thousands of people in India, both directly and indirectly. Therefore, a just transition for affected workers will be of particular importance.

Today, 17 percent of the Indian coal fleet is uncompetitive compared with renewables with storage, and the immediate phaseout and replacement of this portion of the fleet could bring India $2 billion in annual savings. The remaining 83 percent could be phased out and replaced at a cost of $23 billion immediately. However, these numbers are rapidly changing: by 2022, 50 percent of the Indian coal fleet will be uncompetitive, and by 2025, 85 percent will be. In 2025, savings from retiring uncompetitive plants will increase nearly ninefold compared with 2020, to $17 billion per year. The remaining 15 percent would cost $2 billion to replace in 2025.

India has already implemented a robust reverse auction system to determine tariffs for renewable energy.[29] Therefore, an auction targeting coal phaseout to meet the government's phaseout goals—in concert with building renewables with storage to replace the coal and serve the growing demand—would be a variation on a proven existing approach. With coal rapidly becoming uncompetitive, international support could potentially be used to accelerate the pace of large-scale phaseout and protect affected communities, but not to subsidize returns. Public finance institutions best positioned to facilitate coal phaseout in India include the Asian Development Bank, the Asian Infrastructure Investment Bank, and the World Bank.

Exhibit 10

India: Cost Competitiveness of Existing Coal vs. New Renewables and Storage



EUROPEAN UNION

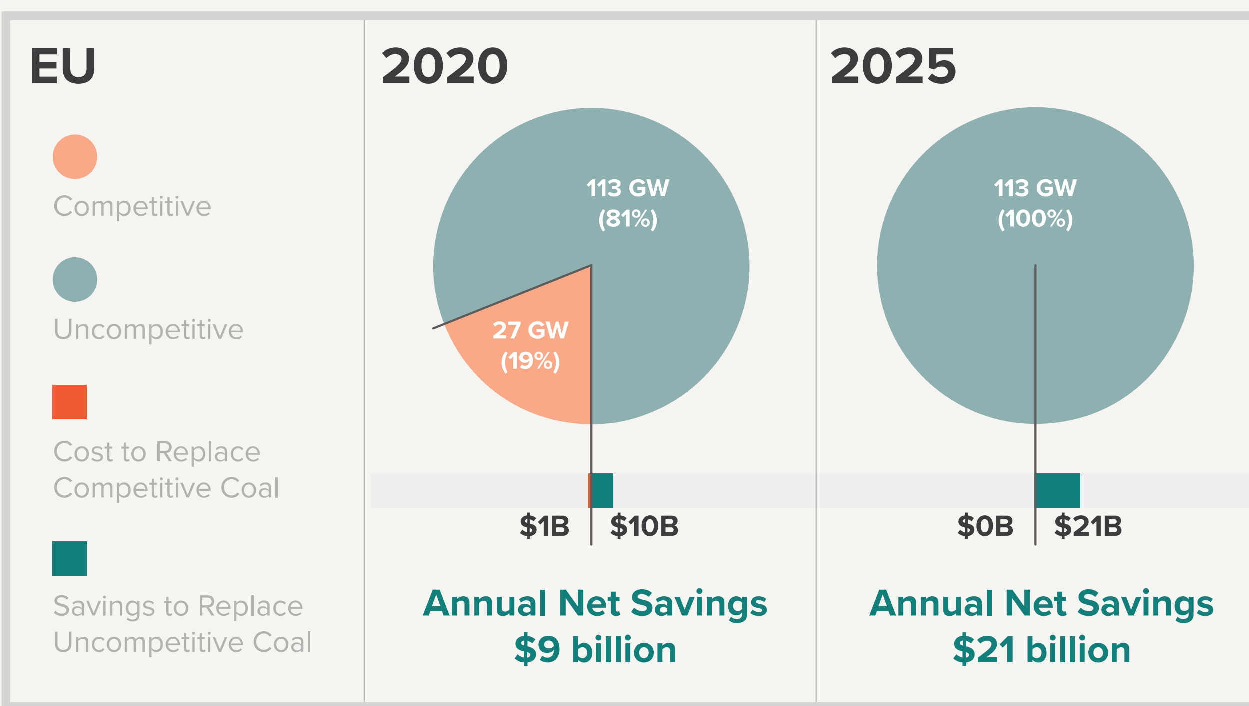
The Carbon Tracker Initiative estimates that the European Union should be free of hard coal and lignite generation by 2030.[30] However, 50 gigawatts (GW) of European coal have no closing date,[31] and retirement policies vary widely by country. Coal retirement in some regions of the EU faces political opposition, due to fears of an insufficiently supported just transition for workers and communities, and due to the overall governance of the energy sector.

Today, 81 percent of EU coal is already uncompetitive and would yield $10 billion in annual savings if immediately replaced with renewables with storage. The remaining 19 percent could be phased out at a cost of $1 billion in 2020. The economics of coal will only get worse: by 2025, 100 percent of EU coal plants will be uncompetitive with renewables plus storage, with annual savings from their replacement totaling $21 billion.

In areas of the European Union where uncompetitive coal assets are insulated from market pressure to phase out (46 percent of total capacity), financial instruments will prove crucial in accelerating coal phaseout. Refinancing tools (e.g., single-asset refinancing, ratepayer-backed securitization, asset portfolio securitization, and green bonds) can help align the interests of asset owners, ratepayers, coal workers, and communities with a rapid transition of coal. Given the unfavorable economics of coal, public finance will be most effectively used to accelerate phaseout while providing support for workers and communities. Institutions well placed to support the transition include the European Bank for Reconstruction and Development and the European Investment Bank (EIB)—especially with the latter's new climate mandate.[32] In addition, the European Union's Just Transition Fund (which recently increased its pledged capitalization from €7.5 billion to €40 billion amid the COVID-19 pandemic) will play a central role. Coal-dependent Poland is one of the larger intended beneficiaries of the Just Transition Fund, which signals the EU's commitment to coal phaseout in the aftermath of the pandemic and as part of the broader green recovery. The EIB will join this effort with €10 billion in loans.[33]

Exhibit 11

European Union: Cost Competitiveness of Existing Coal vs. New Renewables and Storage



OTHER DEVELOPED COUNTRIES

Outside of the United States and the EU, four coal-reliant countries (Australia, Japan, Russia, and South Korea) host 154 gigawatts, or the vast majority, of the remaining coal plants in the developed world. Today, the cost to replace the existing fleet with renewables plus storage totals $46 billion, with this figure dropping to $32 billion in 2022 and $15 billion in 2025. For comparison, Australia, Japan, Russia, and South Korea have a combined gross domestic product (GDP) of over $9 trillion.[34] Thus, accelerated phaseout and replacement of their entire coal fleets would require a negligible percentage of their GDPs. These costs also do not take into account savings from eliminating considerable externalized costs of coal, including those associated with dire health and environmental consequences. Furthermore, the economics of coal in these four countries are also rapidly changing: by 2028, 55 percent of these coal fleets will become uncompetitive with renewables with storage, offering $7 billion in annual savings from replacement, while the remaining 45 percent would cost $3 billion to replace in 2028. Before the end of this decade, the entire coal fleets of Australia, Japan, Russia, and South Korea will cost far more to operate than to replace with renewables plus storage. These countries' power transitions, which take time to plan and execute, should start immediately in order to yield maximum savings from the coal phaseout opportunity.

OTHER DEVELOPING COUNTRIES

This category comprises nine developing countries with significant coal fleets with a combined current capacity of 197 gigawatts.[xii] Many of these countries, especially those in Southeast Asia, are facing booming energy demands, which they plan to meet, in large part, with new coal. However, around the world, new coal is almost always more expensive than new renewables with storage. In addition, the competitiveness of existing coal with respect to new renewables plus storage is also quickly deteriorating.

For this set of developing countries, $38 billion in concessional finance would be needed to phase out and replace the entire fleet in 2020. By 2026, continuing to operate 51 percent of this fleet becomes uncompetitive relative to building new renewables plus battery storage, and retiring this coal would yield $14 billion in annual savings. In 2028, the uncompetitive share of the fleet will grow to 83 percent, with associated annual savings of $20 billion.

Though coal competitiveness is rapidly deteriorating, power sector transitions take time to plan and implement. Developing countries, just like developed countries, should start planning their coal exits immediately to maximize the benefits of a timely coal phaseout. Where existing coal remains competitive with new renewables plus storage (ignoring its health and environmental costs), developed countries should dedicate concessional financing for its phaseout and replacement as part of their development assistance funds. Public finance institutions with the most expertise and presence in relevant regions could, then, deliver those concessional funds where needed through the innovative financial mechanisms presented in this brief. In addition, public finance institutions could structure their own funding packages for the three-part coal phaseout in developing countries as part of their development and climate priorities. Two specific mechanisms we propose for subsidy delivery, in conjunction with refinancing of coal assets, are debt forgiveness via reverse auctions and carbon financing, which can ensure transparency and maximize the impact of public finance.

[xii] Countries included are Bangladesh, Indonesia, Malaysia, the Philippines, Pakistan, South Africa, Turkey, Ukraine, and Vietnam.

Early Examples of Financing Approaches in Action

The approaches described in this report are being practiced already. Below, we outline some examples of how financial packages can be structured and applied internationally to accelerate coal phaseout and replacement, and just transition.

Blended finance for coal phaseout: South Africa's Just Transition Transaction offers a current example of a blended finance approach to phaseout and replacement. Under the transaction, which President Cyril Ramaphosa announced in a statement to the 2019 United Nations Climate Summit,[35] the South African government and monopoly utility, Eskom, committed to delivering additional and measurable emissions reductions from a coal phasedown trajectory that surpasses current policy. In exchange, a long-term climate finance loan facility at a concessionary rate will be extended by DFIs and donor governments. Through the transaction, Eskom's access to traditional finance sources (including DFIs, capital markets, and banks) would be restored after being restricted due to its unsustainable debt load and mismanagement issues. In addition, net proceeds from the transaction will support affected labor and communities, and the transaction will also seek to crowd in new energy and other infrastructure projects.

Auction facility for coal phaseout and replacement, and just transition: Governments and public finance institutions could consider establishing an auction facility to identify the minimum cost to phase out and replace coal plants in targeted markets or geographies. As a flexible, market-based approach, auctions could be designed to meet the objectives of the funder while guaranteeing maximum emissions reductions per dollar. Although this type of approach has not been piloted in the context of coal phaseout and replacement, the World Bank's Pilot Auction Facility offers a precedent for the use of auctions to deliver cost-effective emissions reductions.[36] Countries taking a leadership position in calling for the phaseout and replacement of coal (e.g., the 33 national members of the Powering Past Coal Alliance) could consider pooling funds to support a similar scheme around coal phaseout.

Carbon finance to support more favorable loan terms: Carbon finance can play a role in accelerating coal phaseout and replacement by offering a supplemental revenue stream that utilities can use to negotiate more favorable loan terms. IDB Invest (the private-sector arm of the Inter-American Development Bank) and the Clean Technology Fund are currently piloting this approach in Chile, where a large private developer has agreed to retire a portion of its coal fleet and replace this capacity with wind generation. IDB Invest will calculate the quantity of avoided emissions and assign them an implied carbon price. IDB Invest will reduce the interest rates on a loan to the developer to fund replacement wind power based on the implied value of those emissions. For its part, the developer will replace part of its corporate-level coal PPA with a renewable energy PPA once the coal plants are retired and wind projects are operational. IDB Invest is in talks with developers and other asset owners in the country to replicate this mechanism once the initial financing is complete.

Conclusion

Conclusion

Coal is no longer the global economy's cheapest power source, though it is still the dirtiest. Even without accounting for coal's significant and varied externalized costs, new renewables with storage are nearly ubiquitously cheaper than building new coal. What is more, existing coal is increasingly uncompetitive with new renewables: by 2025, 73 percent of the global coal fleet will be more expensive to operate than the cost of building new renewable energy with storage. Some major coal-producing regions, like the United States and the European Union, can phase out over 75 percent of their coal with cost savings today. Around the world, policymakers can secure enormous benefits and savings for ratepayers by accelerating the phaseout of coal power and its replacement with clean energy sources. This is an opportunity for policymakers, utilities, and public finance institutions to engage in ambitious climate change adaptation on positive terms.

What is lacking is a clear path to phaseout. Electricity market regulation, legacy contracts, and unpriced externalized costs prevent costly coal power from being replaced with cheaper and cleaner renewable technologies via market competition. Our recommendations for an effective, rapid coal phaseout rest on the use of innovative financial packages that combine three elements of coal transition: refinancing to fund coal phaseout, reinvesting in renewable energy, and providing financing for a just transition for affected communities and workers. Solutions resting on financial mechanisms are advantageous for several reasons. They can facilitate establishment of common ground among many stakeholders without precluding complementary policy and regulatory approaches, and their voluntary nature can reveal the extent of existing demand for coal plant phaseout that future policy can effectively build upon.

Public finance institutions are particularly well suited to support coal phaseout, due to their interest in protecting ratepayers and ensuring that ratepayers enjoy the most affordable energy provision that is, at the same time, in service of public health and sustainable economic development. In the United States, political leaders have the opportunity to expedite the energy transition toward economic and climate-aligned outcomes by championing coal phaseouts. Existing examples show how this can be done successfully at state and utility levels. Internationally, both international finance institutions (DFIs, climate funds) and national institutions (green banks, central banks, national development banks) are well positioned to undertake coal phaseout while ensuring a just transition. Public subsidies may not be required to phase out coal in many cases in which significant portions of coal fleets already are or soon will be cost-uncompetitive with renewables. However, in places where public subsidy is necessary, public finance institutions could create financing packages for three-part coal phaseout as part of their development and climate priorities. They could also channel and operationalize development and climate assistance funds, earmarked for coal phaseout, from OECD countries.

What comes next? With 39 percent of coal capacity already uncompetitive with new renewables plus storage today, and with this number growing to 73 percent in 2025, the question is not whether renewables will replace the global coal fleet, but when. And as successful cases of negotiated coal phaseouts have taught us, these transitions take time to get right. If we want to stay on track to avert the most disastrous impacts of climate change, and save money while doing so, the time to start is now.

Data and Methodology

Data and Methodology

Data is sourced from the CTI Global Coal Power Economics Model (GCPEM).[37] The GCPEM covers approximately 95 percent of the global operating coal fleet, and under-construction and planned coal capacity at the boiler level, drawing data from the Global Energy Monitor (GEM), the Global Coal Plant Tracker, the Platts World Electric Power Plants database, and national and regional sources.

This report builds on GCPEM outputs to assess the competitiveness for each coal unit in 2020 and 2025. Data is presented for six countries and regions: China, the European Union, India, the United States, “other developed countries,” and “other developing countries.” “Other developed countries” includes Australia, Japan, Russia, and South Korea. “Other developing countries” includes Bangladesh, Indonesia, Malaysia, Pakistan, the Philippines, South Africa, Turkey, Ukraine, and Vietnam. Total figures are sums from these six countries and regions.

Regional summary metrics are presented in data tables at the end of this methodology section. Metrics are grouped into two categories: competitiveness metrics and carbon bonus metrics.

Competitiveness Metrics

The cost competitiveness of each coal asset is assessed by calculating the difference between the long-run marginal cost (LRMC) and the levelized cost of energy (LCOE) supplied by a replacement resource. Coal asset LRMCs include short-run marginal costs plus fixed operation and maintenance, and any capital additions from meeting environmental regulations. Replacement resources are sized to replace the annual energy generation produced by the operating coal power plants. Competitive coal plants have a lower LRMC than the replacement LCOE; uncompetitive coal plants have a higher LRMC than the replacement LCOE.

The cost competitiveness analysis used in the report uses a replacement resource that includes onshore wind or solar PV plus four-hour battery storage sized to 50 percent of the generation resource capacity. Onshore wind and solar PV LCOE values are taken from GCPEM.[xiii] Four-hour battery storage sized to 50 percent of the generation resource capacity is assumed to increase the LCOE of the hybrid resource by 50 percent in 2020. This value is consistent with a recent empirical survey of hybrid systems from the Lawrence Berkeley National Laboratory.[38] Storage costs are modeled to decrease over time on a trajectory consistent with projections in the Bloomberg New Energy Finance (BNEF) 2019 Energy Storage System Costs Survey.[39]

US costs are calculated using data sources that are available only for US technologies. Onshore wind and solar PV LCOE values are calculated using capital and operational cost information from Lazard’s Levelized Cost of Energy and Levelized Cost of Storage 2019,[40] and the National Renewable Energy Laboratory (NREL) Annual Technology Baseline (ATB) 2019.[41] Capacity factors are calculated at the state level from recent project information sourced from S&P Global Market Intelligence. Wind capacity factors improve over time, according to projections from the NREL ATB. LCOE

[xiii] With the exception of the United States, see subsequent paragraph on detailed US methodology.

values include full investment tax credit (ITC) and production tax credit (PTC) impacts in 2020 and 2025. ITC declines to 10 percent in 2025, and PTC phases out to 0 percent. US coal asset LRMC values are drawn from multiple data sources, depending on availability, listed preferentially: FERC Form 1, BNEF, and CTI. FERC Form 1 data covers up to 2018, and BNEF projections are made through 2025. For this data, asset-level CTI cost trajectories are used to interpolate changes to FERC and BNEF costs through 2030.

Cost savings are calculated for each region by summing the multiple of the difference between uncompetitive coal plant LRMC and replacement LCOE by the 2018 annual generation from the coal plant. Cost-to-replace calculations use the same methodology for competitive plants.

Carbon Bonus Metrics

Carbon bonus ($/tCO_2$) measures the incremental carbon concession that would render a percentage of the coal fleet uncompetitive and is calculated by the following formula:

$$[\text{Replacement LCOE } (\$/\text{MWh})] - \text{Coal LRMC } (\$/\text{MWh})] * [\text{Generation (MWh)} / \text{Emissions } (tCO_2)]$$

Generation and emissions are annual values from the CTI data set. Abated carbon is calculated using the amount of coal phased out according to the IEA scenario and GEM emissions factors (emissions from operating units for their remaining useful lives or announced dates based on company reporting).

Each carbon cost figure can be calculated for a point along the marginal carbon cost curve. For example, a 90 percent value describes the carbon bonus on the regional $/tCO_2$ supply curve at the marginal asset by cost ($/tCO_2$) for 90 percent of coal assets on a capacity (MW) basis. All metrics presented in the summary tables are calculated at 90 percent.

Total net cost is the net annual cost to make a fixed percentage of the coal fleet uncompetitive. The cost to replace plants requiring a positive carbon bonus are netted out by the savings from plants that are uncompetitive without a carbon bonus.

Annual cost savings describes the savings to customers at each percentage and is found by the following formula:

$$\Sigma \text{ Emissions } (tCO_2) * \text{Carbon Bonus} - \text{Total Net Cost}$$

The sum is restricted only to plants that would be uncompetitive at the given level of the carbon bonus.

Cost to government is the expected annual cost of the carbon bonus payments, assuming replacement of all plants that would be uncompetitive at the given level of the bonus:

$$\Sigma \text{ Emissions } (tCO_2) * \text{Carbon Bonus}$$

And again, the sum is restricted only to plants that would be uncompetitive at the given level of the carbon bonus.

Exhibit 12

Cost Competitiveness Data

Global Coal Fleet, 2020								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Uncompetitive (GW)	Competitive (GW)	Uncompetitive Annual Cost Savings ($B)	Competitive Retire + Replace Cost ($B)	Total Net Carbon Cost ($B)
China	1142	10	0%	492 (43%)	650 (57%)	18	47	$28
India	283	10	0%	48 (17%)	234 (83%)	2	23	$20
United States	236	41	21%	187 (79%)	49 (21%)	10	1	–$8
European Union	140	33	54%	113 (81%)	27 (19%)	10	1	–$9
Other Developed Countries	154	26	16%	0 (0%)	154 (100%)	0	46	$45
Other Developing Countries	197	18	0%	3 (1%)	194 (99%)	0	38	$37
Total or Average	2152	17	7%	843 (39%)	1308 (61%)	39	155	$114

Global Coal Fleet, 2022								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Uncompetitive (GW)	Competitive (GW)	Uncompetitive Annual Cost Savings ($B)	Competitive Retire + Replace Cost ($B)	Total Net Carbon Cost ($B)
China	1147	12	0%	808 (70%)	339 (30%)	49	15	–$34
India	295	12	0%	148 (50%)	147 (50%)	8	8	–$1
United States	226	43	21%	205 (91%)	21 (9%)	13	0	–$12
European Union	133	35	53%	131 (99%)	1 (1%)	16	0	–$15
Other Developed Countries	155	28	14%	3 (2%)	152 (98%)	0	32	$31
Other Developing Countries	213	20	0%	7 (3%)	206 (97%)	0	26	$25
Total or Average	2169	19	6%	1301 (60%)	867 (40%)	86	80	–$6

Exhibit 12 (continued)

Global Coal Fleet, 2025								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Uncompetitive (GW)	Competitive (GW)	Uncompetitive Annual Cost Savings ($B)	Competitive Retire + Replace Cost ($B)	Total Net Carbon Cost ($B)
China	1147	15	0%	1081 (94)	66 (6%)	98	1	–$97
India	296	15	0%	250 (85%)	45 (15%)	17	2	–$15
United States	211	46	21%	54 (26%)	157 (74%)	2	9	$7
European Union	113	38	53%	113 (100%)	0 (0%)	21	0	–$21
Other Developed Countries	159	31	13%	30 (19%)	130 (81%)	1	15	$13
Other Developing Countries	237	23	0%	44 (19%)	193 (81%)	2	10	$8
Total or Average	2163	22	6%	1571 (73%)	592 (27%)	141	36	–$105

Exhibit 13

Carbon Bonus Data

Global Coal Fleet, 2020, 90% Bonus Coverage								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Carbon Bonus ($/t$CO_2$)	Annual Cost Savings ($B)	Cost to Government ($B)	Total Net Cost ($B)	GtCO_2 Abated
China	1142	10	0%	$23	$95	$101	$6	4.36
India	283	10	0%	$38	$29	$42	$13	1.11
United States	236	41	21%	$4	$13	$4	-$9	1.06
European Union	140	33	54%	$6	$13	$4	-$9	0.66
Other Developed Countries	154	26	16%	$97	$30	$59	$29	0.61
Other Developing Countries	197	18	0%	$68	$27	$55	$28	0.81
Total or Average	2152	17	7%	$41	$321	$360	$39	8.74

Global Coal Fleet, 2022, 90% Bonus Coverage								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Carbon Bonus ($/t$CO_2$)	Annual Cost Savings ($B)	Cost to Government ($B)	Total Net Cost ($B)	GtCO_2 Abated
China	1147	12	0%	$9	$84	$38	-$46	4.35
India	295	12	0%	$18	$26	$21	-$5	1.17
United States	226	43	21%	-$2	$11	-$2	-$13	1.02
European Union	133	35	53%	-$5	$12	-$3	-$15	0.62
Other Developed Countries	155	28	14%	$72	$25	$43	$19	0.60
Other Developing Countries	213	20	0%	$47	$23	$41	$18	0.87
Total or Average	2169	19	6%	$25	$277	$219	-$58	8.79

Exhibit 13 (continued)

Global Coal Fleet, 2025, 90% Bonus Coverage								
Region	Total Capacity (GW)	Average Fleet Age (years)	Average Merchant Capacity (%)	Carbon Bonus ($/t$CO_2$)	Annual Cost Savings ($B)	Cost to Government ($B)	Total Net Cost ($B)	GtCO_2 Abated
China	1147	15	0%	-$6	$71	-$26	-$97	4.35
India	296	15	0%	$6	$23	$7	-$17	1.19
United States	211	46	21%	$19	$14	$18	$4	0.94
European Union	113	38	53%	-$17	$11	-$9	-$21	0.54
Other Developed Countries	159	31	13%	$44	$21	$26	$5	0.60
Other Developing Countries	237	23	0%	$22	$17	$22	$5	0.98
Total or Average	2163	22	6%	$10	$221	$87	-$134	8.56

Source: RMI, CTI

Note: Totals reflect the sum of non-rounded figures and may vary slightly from the sum of the rounded figures presented for countries or country groupings.

Acknowledgments

The authors thank the following individuals and organizations for their input on this work. This acknowledgment does not imply endorsement by these individuals or institutions of the analysis and views presented in this report.

Brad Markell	American Federation of Labor and Congress of Industrial Organizations
Alfredo Bano Leal	Asian Development Bank
Kathrin Guttman	Beyond Coal Europe
Emma Champion	BloombergNEF
Dario Traum	BloombergNEF
Sarah Brennan	Bloomberg Philanthropies
Ailun Yang	Bloomberg Philanthropies
Durand D'souza	Carbon Tracker Initiative
Rob Schuwerk	Carbon Tracker Initiative
Mark Fulton	Carbon Tracker Initiative
Amal-Lee Amin	CDC Group
Bruce Nilles	Climate Imperative
Mafalda Duarte	Climate Investment Funds
Michael Grimm	Climate Investment Funds
Hugh Searight	Climate Investment Funds
Vikram Widge	Climate Policy Initiative
Peter Sweatman	Climate Strategy and Partners
Adhiti Gupta	Convergence
Andrew Apampa	Convergence
Ayesha Bery	Convergence
Claire Healy	E3G
Chris Littlecott	E3G
Artur Patuleia	E3G
Leo Roberts	E3G
Louise Burrows	E3G
Sonia Dunlop	E3G
Iskander Erzini Vernoit	E3G
Jonathan Walters	E3G
Jesse Burton	E3G
Keith Allott	European Climate Foundation
Matt Phillips	European Climate Foundation
Adrien De Bassompierre	European Investment Bank
Jonathan First	GFA Climate & Infrastructure
Sara Jane Ahmed	Institute for Energy Economics and Financial Analysis

Melissa Brown	Institute for Energy Economics and Financial Analysis
Tim Buckley	Institute for Energy Economics and Financial Analysis
Fernando Cubillos Prieto	Inter-American Development Bank
Hilen Gabriela Meirovich	Inter-American Development Bank
Adrien Vogt-Schilb	Inter-American Development Bank
Graham Watkins	Inter-American Development Bank
Bert De Wel	International Trade Union Confederation
Samantha Smith	Just Transition Centre
Adam Roff	Meridian Economics
Emily Tyler	Meridian Economics
Frank Van Lerven	New Economics Foundation
Alex Doukas	Oil Change International
Stephan Hoch	Perspectives Climate Group
Ricardo Nogueira	Pollination
John Morton	Pollination and European Climate Foundation
Andrei Ilaş	RES Kapital Partners
Dan Wetzel	Rocky Mountain Institute
Koben Calhoun	Rocky Mountain Institute
Yiyan Cao	Rocky Mountain Institute
Xiang Li	Rocky Mountain Institute
Bingqi Liu	Rocky Mountain Institute
Lucy Lu	Rocky Mountain Institute
Roy Torbert	Rocky Mountain Institute
Olivia Coldrey	Sustainable Energy for All
Jeremy Fisher	The Sierra Club
Justin Guay	The Sunrise Project
Steve Hammer	The World Bank

Endnotes

1 Matt Gray and Sriya Sundaresan, *How to Waste over Half a Trillion Dollars: The Economic Implications of Deflationary Renewable Energy for Coal Power Investments* (London: Carbon Tracker Initiative, 2020), **https://carbontracker.org/reports/how-to-waste-over-half-a-trillion-dollars/.**

2 "More U.S. Coal-Fired Power Plants Are Decommissioning as Retirements Continue," Energy Information Administration, July 26, 2019, **https://www.eia.gov/todayinenergy/detail.php?id=40212.**

3 Cecilia Keating, "FERC: US to See Nearly 50 GW of Green Energy Additions in Three Years," *PV-Tech*, March 9, 2020, **https://www.pv-tech.org/news/50gw-of-new-clean-energy-expected-in-the-us**.

4 State and Local Energy and Environment Program, *Public Health Benefits per kWh of Energy Efficiency and Renewable Energy in the United States: A Technical Report* (Washington, D.C.: US Environmental Protection Agency, 2019), **https://www.epa.gov/sites/production/files/2019-07/documents/bpk-report-final-508.pdf**; and *Lazard's Levelized Cost of Energy Analysis—Version 13.0* (New York: Lazard, 2019), **https://www.lazard.com/media/451086/lazards-levelized-cost-of-energy-version-130-vf.pdf**

5 Sebastian Rauner, Nico Bauer, Alois Dirnaichner, Rita Van Dingenen, Chris Mutel, and Gunnar Luderer, "Coal-Exit Health and Environmental Damage Reductions Outweigh Economic Impacts," *Nature Climate Change* 10 (2020): 308–12, **https://www.nature.com/articles/s41558-020-0728-x.**

6 "World Coal Consumption, 1971–2018," International Energy Agency, 2019, **https://www.iea.org/data-and-statistics/charts/world-coal-consumption-1971-2018.**

7 "Mapped: The World's Coal Power Plants," Carbon Brief, March 26, 2020, **https://www.carbonbrief.org/mapped-worlds-coal-power-plants**; and Christine Shearer, Lauri Myllyvirta, Aiqun Yu, Greig Aitken, Neha Mathew-Shah, Gyorgy Dallos, and Ted Nace, *Boom and Bust 2020: Tracking the Global Coal Plant Pipeline* (San Francisco, CA: Global Energy Monitor; Washington, D.C.: Sierra Club, Greenpeace; Helsinki, Finland: Centre for Research on Energy and Clean Air, 2020), **https://endcoal.org/wp-content/uploads/2020/03/BoomAndBust_2020_English.pdf.**

8 Chris Littlecott and Leo Roberts, "Coal, Covid-19 and COP26: Recovering Better," *E3G*, April 9, 2020, **https://www.e3g.org/library/coal-covid-19-and-cop26-recovering-better1.**

9 "Coal Phase-Out—Global and Regional Perspective," Climate Analytics, **https://climateanalytics.org/briefings/coal-phase-out/#:~:text=Global%20coal%20use%20in%20electricity,by%202040%20at%20the%20latest.**

10 "Mapped: The World's Coal Power Plants."

11 Matt Gray, Sebastian Ljungwaldh, Laurence Watson, and Irem Kok, *Powering Down Coal: Navigating the Economic and Financial Risks in the Last Years of Coal Power* (London: Carbon Tracker Initiative, 2018), **https://carbontracker.org/reports/coal-portal/.**

12 Yulanda Chung, *Overpaid and Underutilized: How Capacity Payments to Coal-Fired Power Plants Could Lock Indonesia into a High-Cost Electricity Future* (Cleveland, OH: Institute for Energy Economics and Financial Analysis, 2017), **http://ieefa.org/wp-content/uploads/2017/08/Overpaid-and-Underutilized_How-Capacity-Payments-to-Coal-Fired-Power-Plants-Could-Lock-Indonesia-into-a-High-Cost-Electricity-Future-_August2017.pdf.**

13 Ipek Gençsü, Shelagh Whitley, Leo Roberts, Christopher Beaton, Han Chen, Alex Doukas, Anna Geddes, Ivetta Gerasimchuk, Lourdes Sanchez, and Anissa Suharsono, *G20 Coal Subsidies: Tracking Government Support to a Fading Industry* (Washington, D.C.: Oil Change International, 2019), **http://priceofoil.org/content/uploads/2019/06/g20-coal-subsidies-2019.pdf.**

14 Wataru Matsumura and Zakia Adam, "Fossil Fuel Consumption Subsidies Bounced Back Strongly in 2018," International Energy Agency, June 13, 2019, **https://www.iea.org/commentaries/fossil-fuel-consumption-subsidies-bounced-back-strongly-in-2018.**

15 Climate Finance Leadership Initiative, *Financing the Low-Carbon Future: A Private-Sector View on Mobilizing Climate Finance* (New York: Bloomberg L.P., 2019), **https://data.bloomberglp.com/company/sites/55/2019/09/Financing-the-Low-Carbon-Future_CFLI-Full-Report_September-2019.pdf**.

16 *Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All* (Geneva, Switzerland: International Labour Organization, 2015), **https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_432859.pdf.**

17 See New Mexico Legislative Act, S.B. 489, 2019 Regular Session, **https://www.nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf**.

18 "Approved Verifiers under the Climate Bonds Standard," Climate Bonds Initiative, **https://www.climatebonds.net/certification/approved-verifiers**.

19 Kristin Qui, *The Future of the Clean Development Mechanism under a New Regime of Higher Climate Ambition* (New York: Environmental Defense Fund, 2018), **https://www.edf.org/sites/default/files/documents/Potential_Supply_of_CDM_Credits.pdf**.

20 *Utility Transition Scorecards 1.0* (Boulder, CO: Rocky Mountain Institute, forthcoming).

21 Sebastian Rauner, "Guest Post: Why Coal Phaseout Is a 'No-Regret' Plan for Tackling Climate Change," Carbon Brief, April 21, 2020, **https://www.carbonbrief.org/guest-post-why-coal-phaseout-is-a-no-regret-plan-for-tackling-climate-chan**.

22 Riccardo Puliti, *Managing Coal Mine Closure: Achieving a Just Transition for All* (Washington, D.C.: The World Bank, 2018), **https://www.worldbank.org/en/topic/extractiveindustries/publication/managing-coal-mine-closure**.

23 Bianca Ginelli Nardi and Chukwuma Nwankwo, "The Term Funding Scheme: Design, Operation and Impact," *Bank of England Quarterly Bulletin,* Q4 (2018), **https://www.bankofengland.co.uk/-/media/boe/files/quarterly-bulletin/2018/term-funding-scheme-web-version.pdf.**

24 Qi Ye, Jiaqi Lu, and Mengye Zhu, *Wind Curtailment in China and Lessons from the United States* (Washington, D.C.: Brookings Institution, 2018), **https://www.brookings.edu/research/wind-curtailment-in-china-and-lessons-from-the-united-states/**.

25 Dominic Chiu, "The East Is Green: China's Global Leadership in Renewable Energy," *New Perspectives in Foreign Policy*, 13 (Summer 2017): 3–12, **https://www.csis.org/east-green-chinas-global-leadership-renewable-energy**.

26 "China Suspends New Coal-Fired Power Plants in 29 Provinces: Report," Reuters, May 12, 2017, **https://www.reuters.com/article/us-china-power-capacity/china-suspends-new-coal-fired-power-plants-in-29-provinces-report-idUSKBN1880P4**.

27 "India to Have 450 GW Renewable Energy by 2030: President," *Economic Times*, January 31, 2020, **https://economictimes.indiatimes.com/small-biz/productline/power-generation/india-to-have-450-gw-renewable-energy-by-2030-president/articleshow/73804463.cms?from=mdr**.

28 Ministry of Power, *National Electricity Plan, Volume 1: Generation* (Delhi, Government of India, 2018), **http://www.cea.nic.in/reports/committee/nep/nep_jan_2018.pdf**.

29 Sumit Sarkar and A.S. Bose, "India's E-Reverse Auctions (2017–2018) for Allocating Renewable Energy Capacity: An Evaluation," *Renewable and Sustainable Energy Reviews* 112 (September 2019): 762–74, **https://www.sciencedirect.com/science/article/abs/pii/S1364032119304186**.

30 *Apocoalypse Now* (London, Carbon Tracker Initiative, 2019), **https://carbontracker.org/reports/apocoalypse-now/**.

31 Littlecott and Roberts, "Coal, Covid-19 and COP26: Recovering Better."

32 Richard Willis, "EU Bank Launches Ambitious New Climate Strategy and Energy Lending Policy," European Investment Bank, November 14, 2019, **https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy**.

33 Frederic Simon, "EU Boosts 'Just Transition Fund,' Pledging €40 Billion to Exit Fossil Fuels," *Euractiv,* May 28, 2020, **https://www.euractiv.com/section/energy/news/eu-boosts-just-transition-fund-pledging-e40-billion-to-exit-fossil-fuels/**.

34 Gross domestic product for 2019, current prices. See "World Economic Outlook Database, October 2019," International Monetary Fund, **https://www.imf.org/external/pubs/ft/weo/2019/02/weodata/weorept.aspx?sy=2017&ey=2024&scsm=1&ssd=1&sort=country&ds=.&br=1&pr1.x=85&pr1.y=4&c=193%2C922%2C158%2C542&s=NGDPD&grp=0&a=**.

35 "Statement by H.E. President Cyril Ramaphosa of South Africa to the United Nations Secretary-General's Climate Summit, 23 September 2019," Department of International Relations and Cooperation of the Republic of South Africa, **http://www.dirco.gov.za/docs/speeches/2019/cram0923.htm**.

36 International Bank for Reconstruction and Development, *Climate Auctions: A Market-Based Approach to National Climate Action* (Washington, D.C.: World Bank Group, 2019), **https://openknowledge.worldbank.org/bitstream/handle/10986/31322/134832-WP-PUBLIC-ClimateAuctionsAMarketBasedApproachtoClimateAction.pdf?sequence=1&isAllowed=y**.

37 Power and Utilities Team, *Global Coal Power Economics Model Methodology* (London: Carbon Tracker Initiative, 2020), **https://carbontracker.org/wp-content/uploads/2020/03/Global_Coal_Methodology_Vwebsite2.pdf**.

38 Will Gorman, Andrew Mills, Mark Bolinger, Ryan Wiser, Nikita G. Singhal, Erik Ela, and Eric O'Shaughnessy, "Motivations and Options for Deploying Hybrid Generator-Plus-Battery Projects within the Bulk Power System," *The Electricity Journal* 33:5 (June 2020), **https://www.sciencedirect.com/science/article/pii/S1040619020300312**.

39 "Energy Storage Investments Boom as Battery Costs Halve in the Next Decade," *BloombergNEF*, July 31, 2019, **https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/**.

40 "Levelized Cost of Energy and Levelized Cost of Storage 2019," Lazard, November 7, 2019, **https://www.lazard.com/perspective/lcoe2019**.

41 "Annual Technology Baseline: Electricity," National Renewable Energy Laboratory, **https://atb.nrel.gov/**.

22830 Two Rivers Road
Basalt, CO 81621 USA
www.rmi.org