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RETROFITTING COAL-FIRED POWER PLANTS IN MIDDLE-INCOME COUNTRIES: WHAT ROLE FOR THE WORLD BANK?

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JULY 2014

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EXECUTIVE SUMMARY

In July 2013, the World Bank decided to phase-out lending for *new* coal-fired power plants in middle-income countries,¹ except in rare circumstances where no financially feasible alternatives to coal exist. This decision was made for a combination of reasons including concerns about local air pollution and global climate change, as well as evidence that these projects have little trouble attracting private capital without World Bank involvement.²

Now, policymakers are considering whether the World Bank's policy should also cover projects designed to retrofit *existing* coal-fired power plants in middle-income countries by adding scrubbers and other technologies that increase efficiency and reduce air pollution.

There are several fundamental questions underlying this debate: Is financing coal power plant retrofits a good use of World Bank resources? If so, should the World Bank insist on the use of best available technologies when it finances these retrofits? These questions are vitally important, as retrofit technologies are designed to minimize toxic air pollutants, including soot and smog, which are both dangerous for human health and the world's climate. Older coal plants without retrofit technologies are less efficient, and emit more pollutants per unit of coal burned than those with retrofits applied. Evidence shows that soot and smog can cause respiratory illness and asthma, especially in children and elderly people, and can diminish local agricultural production by reducing sunlight. Furthermore, in many countries coal plants are the single largest source of carbon dioxide emissions driving climate change.

To help inform the policy debate, this analysis surveys the technologies in use in more than 2,000 coal-fired power plants currently in operation, under construction, or planned in middle-income countries. The findings reveal that roughly 70 percent of these power plants rely on old, inefficient technologies. Retrofitting these plants would reduce pollution, increase efficiency and save lives. In middle-income countries that do not mandate coal retrofits, the World Bank could play a helpful role in financing those improvements, particularly as part of broader policy reforms designed to reduce climate pollution and increase efficiency across the power sector.

Importantly, however, the data also show that important qualifications should be made. First, because coal is a major source of greenhouse gas emissions and retrofits are likely to keep coal plants operating longer, the World Bank should insist that retrofit projects occur within a context of national and local policy reforms designed to abate greenhouse gas pollution. Toward this end, the World Bank should continue to help countries build capacity to adopt and enforce climate pollution controls and other offsetting actions and policies. Second, the World Bank should insist that projects it finances use best available pollution control technologies. Already, the substantial majority of coal retrofits completed to date in middle-income countries have used best available technologies.³ These retrofits were almost universally financed exclusively by private capital. The World Bank should not use its capital to support inferior retrofit technologies that are below the standards already adopted by the private sector in middle-income countries.

INTRODUCTION

At the opening of the World Bank Group's spring meetings in April, and on the heels of the latest Intergovernmental Panel on Climate Change's fifth assessment report, World Bank president Jim Kim issued another urgent call to action on balancing climate change and poverty reduction, warning that, "climate change could reverse hard-won development gains and could stop our [efforts to] end poverty completely. We can't end poverty unless we take serious steps to protect our planet."⁴

Since taking the helm in 2012, the World Bank Group has taken important steps on climate change under Kim's leadership, including the release of new guidance on energy lending in July 2013. The Energy Sector Directions Paper provides high-level policy guidance for energy sector lending decisions for the entire World Bank Group over the next decade.⁵ The new strategy places strong emphasis on both providing energy access to the poor and, where feasible, promoting environmentally sustainable technologies. It includes quantitative targets for expanding energy access for the world's poor and for the percentage of low carbon energy in the World Bank's lending portfolio, and introduces new greenhouse gas accounting requirements that will be phased-in over the next several years.

Simultaneously, the World Bank's largest shareholder, the United States, released its national Climate Action Plan, which calls for an end to U.S. government support for public financing of *new* coal-fired power plants overseas—except for (a) the most efficient coal technology available in the world's poorest countries in cases where no other economically feasible alternative exists, or (b) facilities deploying carbon capture and sequestration technologies. To apply this new coal lending policy to U.S. actions in multilateral development banks (MDBs), including the World Bank Group, the U.S. Treasury Department issued new guidance in October 2013.⁶

The United States is not alone in taking these measures. Several other World Bank shareholders and public financing institutions have similarly phased-out support for new, coal-fired power plants, including Denmark, Finland, Iceland, Norway, Sweden, the United Kingdom, the European Bank for Reconstruction and Development, and the European Investment Bank.⁷

Retrofits: A Gray Area

In addition to new coal-fired power plants, the U.S. guidance to the World Bank contained new policies for securing U.S. support for projects to retrofit *existing* coal plants in middle-income countries. Retrofits (excluding carbon capture) are technologies installed after a plant is built to reduce air pollutants such as sulfur dioxide (SO₂), particulate matter (PM), and nitrogen oxides (NO_x), usually through scrubbing or absorbing pollutants after combustion.

Treasury's new guidance would support coal-lending policies that allow finance for retrofits in middle-income countries, but only for projects that meet the clear guidelines. First, the project must use the "best available technology" (BAT) for pollution control. The concept of BAT is widely used in national pollution control laws and generally means the most effective pollution control technology that is readily available and practically viable for installation. Best available technologies are designed to reduce SO₂, PM, and/or NO_x more effectively

than alternatives—although the speed of innovation in this sector means that “best available” is a moving target (Appendix 1 provides a catalogue of technologies currently considered “best available.”) Second, the retrofit project must not directly expand generation capacity, or total power, of the plant. Third, the project must include climate offsetting actions, such as investment in wind generation capacity or carbon securities and policies to offset the greenhouse gas emissions of a plant, which could include renewable portfolio standards or clean energy subsidies. These restrictions on coal retrofit projects go beyond the World Bank’s current approach in middle-income countries, which permits lending for retrofit projects that improve efficiency alone.⁸

Creating broader buy-in for new World Bank coal guidelines that include BAT retrofits for existing plants in middle-income countries with accompanying offsetting actions, similar to U.S. proposals, is controversial for several reasons. First, middle-income countries, like China, have opposed efforts by multilateral development banks to place restrictions on projects for specific groups of countries. Their long-standing position, and the World Bank’s general practice, has been to apply environmental and social safeguards equally across all countries. Second, environmentalists worry that continued World Bank financing of retrofit projects might extend the productive life of a coal-fired power plant and provide political cover for simultaneously increasing the generation capacity (and climate pollution) of existing coal plants. According to the International Energy Agency, substantial investments in retrofits can be cost-effective because they do in fact extend the life of a coal-fired power plant—and the associated emissions.⁹ In addition, in many countries, retrofits bring coal plants in line with air pollution standards, effectively prolonging the life of a plant by preventing regulatory shutdown. In Burshtyn, Ukraine, for example, a coal retrofit project using public finance from the United States would bring back online a number of coal units left unused due to their inefficiency and high pollution levels.¹⁰

Why Retrofits Matter

Retrofits, excluding carbon capture and sequestration technologies, are installed on coal-fired power plants to reduce common air pollutants (including SO₂, PM, and NO_x), which can be harmful to human health, agriculture and the environment. The World Health Organization estimates that some three million premature deaths each year are attributable to the adverse effects of air pollution, including soot and other fine particulate matter.¹¹ The vast majority of those adversely affected reside in Asia. In Beijing, for example, annual levels of soot in 2005 were over twice the level allowed by U.S. standards.¹² Across China, India, and Southeast Asia, coal power plants and industrial coal combustion are the largest source of air pollution emissions.¹³ In China, the government decision to provide free coal for winter heating in the north of the country is estimated to have reduced that region’s life expectancy by over five years.¹⁴ In agriculture, air pollutants can cause regional “dimming,” a reduction in the amount of sunlight that reaches the Earth’s surface. Dimming has detrimental effects on crop yields, farm incomes and food security. Soot might diminish maximum Asian crop yields by more than 10 percent each growing season,¹⁵ which could reduce the value of total Asian rice production by roughly int\$48.8 billion per year.¹⁶ In addition, air pollutants often increase the acidity of lakes and streams, change the nutrient balance of coastal waters and large river basins, deplete nutrients in soil, and affect the biodiversity of ecosystems.

Retrofits do not directly minimize greenhouse gas emissions that drive climate change,¹⁷ but some air pollution retrofits do have efficiency co-benefits that can help reduce greenhouse gas emissions. Low NOx burners, for example, improve combustion efficiency through conserving heat energy.¹⁸ This means that retrofitted coal plants, in addition to reducing air pollutants, can produce the same amount of energy while using less fuel.¹⁹

Consistent with Climate Mitigation?

Given that retrofits do not directly minimize climate pollution and in the context of the World Bank's growing emphasis on limiting climate change, the question of whether to use limited concessional finance in support of retrofit projects in middle-income countries—many of which are now major greenhouse gas emitters²⁰—is complicated. On the one hand, retrofit technologies for coal-fired power plants are designed to minimize toxic air pollutants, including soot and smog, which are dangerous for human health. On the other hand, installed retrofits can prolong the life of a nation's coal fleet, which globally are the single largest source of carbon dioxide emissions driving climate change.

Taking time now to craft a sensible way forward for the World Bank that helps families and communities in middle-income countries—where the majority of the world's poor reside²¹—reap the considerable health benefits of a cleaner coal-fired fleet, while limiting global warming will help prepare World Bank policymakers for the coming years during which this is likely to become an issue for client countries. The following sections aim to inform early thinking and discussion on how to approach this complex dynamic.

ANALYSIS AND FINDINGS

As a starting point for this analysis, we identified coal-fired power plants with retrofits in operation using the 2013 Platts World Electric Power Plant Database. Each plant's retrofit technologies were then categorized as best available technologies (by developed country standards), or inferior technologies (see Appendix 1). We then surveyed World Bank lending for retrofit projects in middle-income countries over the past five years to determine whether any plant upgrades were co-financed with concessional funds.

Based on this landscape analysis of roughly 2,000 coal-fired power plants in middle income countries, we found that about 70 percent could need retrofit improvements to enhance air quality and plant efficiency in the coming decades based on installed technologies, as they are nearing the end of their expected lifetimes. Currently, the vast majority of coal-fired power plants in middle-income countries have not been retrofitted, let alone with best available technologies. Of the more than 700,000 megawatts (MW) from plants currently in operation in these countries, only about three percent have retrofit technologies in place (see map 1), and roughly 95 percent of these plants (or 99 percent of retrofitted generation capacity) were built between 1955 and 1979.

This is most likely a function of the fact that many middle-income countries do not enforce and, to a lesser extent, have in place stringent restrictions on air pollutants associated with coal-fired power. About 70 percent of middle-income countries have coarse particulate matter air quality standards, while all developed countries have them in place.²² Interestingly, aside from fine particulate matter (the smallest and most harmful type of

PM), air quality standards in middle-income countries are not significantly less stringent than U.S. standards. In fact, U.S. air quality standards allow higher concentrations (and therefore more polluting levels) of PM, NO_x, and SO₂ than the World Health Organization recommends—but the actual ambient air quality in the United States is easily in compliance with WHO guidelines, due to source performance standards, state-level policies, and other regulations driving down U.S. air pollutants. Evidence suggests that source performance standards in particular, which have regulated key air pollutants at the plant level since the 1970s, are a key driver in the adoption of pollution control technology for coal plants in the United States.²³

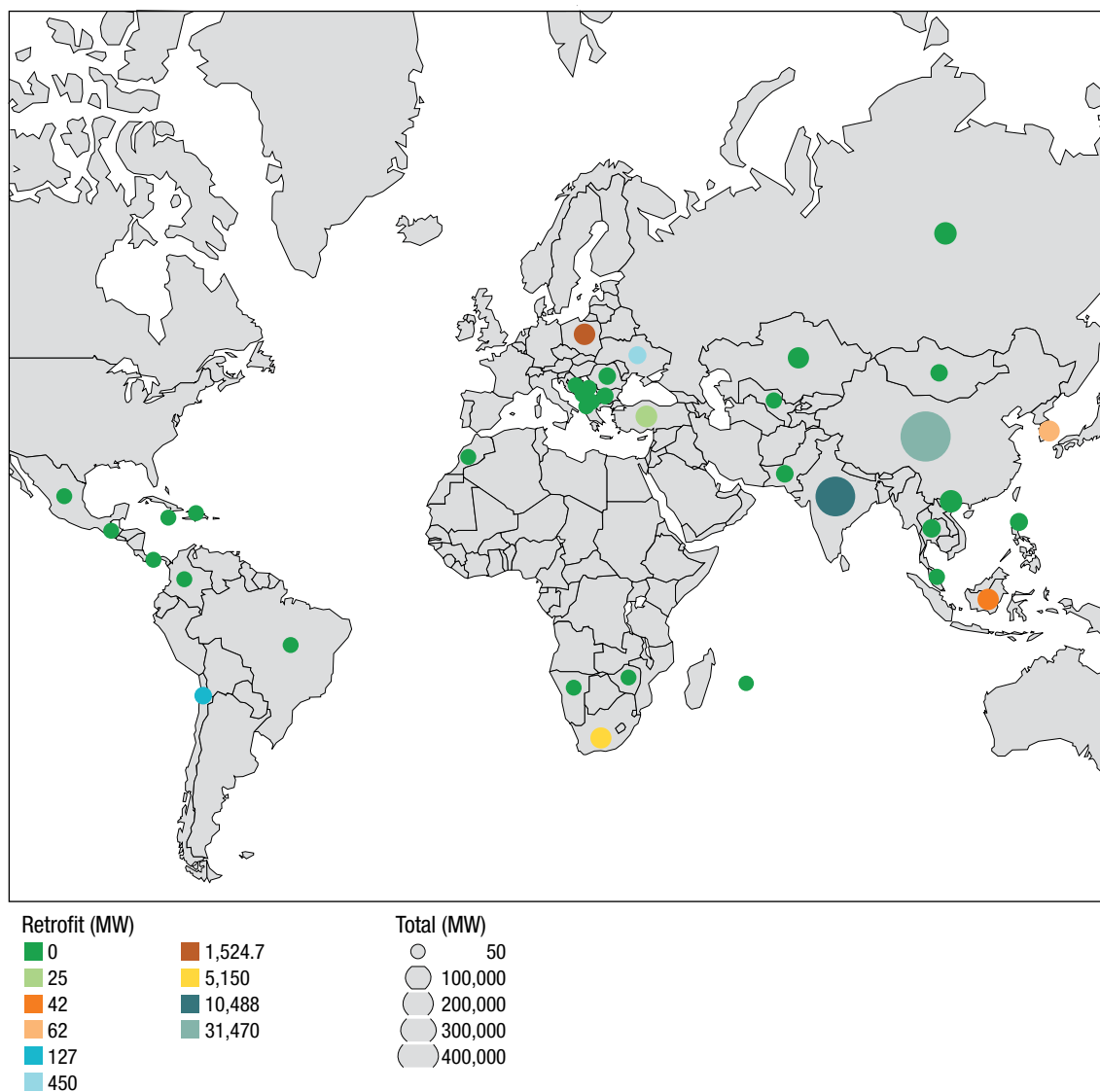
On the other hand, few middle-income countries are able to meet their own air quality standards, perhaps in part because most lack source performance standards that provide regulatory guidance over how to comply with air quality standards.²⁴ In China, for example, only three out of the 74 largest cities meet national air quality standards.²⁵ Other middle-income countries whose average coarse PM pollution is above national standards include Egypt and India. Thus it appears that the enforcement of air quality standards and accompanying regulations, rather than their presence, is the key driver of air pollution control technology deployment.

Without widespread enforcement of air quality standards, the private sector has little incentive to add both to the capital and operation and maintenance costs of a plant. This means that inefficient, harmful existing coal plants are unlikely to be retrofitted at this time.

Of these retrofit improvements (covering three percent of coal-fired power in middle-income countries), nearly 70 percent use best available technologies, and 100 percent of these were financed with private finance alone. Two conditions are likely driving the low amount of retrofitting, neither of which is access to finance. First, middle-income countries are potentially leapfrogging developed country counterparts, and are installing pollutant controls during construction. Data suggest that this is partly true: 35 percent of installed, non-retrofitted capacity was initially built with these same pollutant controls in place. These newer plants make up a large proportion of generation capacity. Secondly, as described above, middle-income countries do not enforce restrictions in place on air pollutants associated with coal-fired power. Without enforcement, there is little incentive for plant operators in middle-income countries to install retrofits.

Only one World Bank project over the last five years included support for retrofitting a coal-fired power plant (in India), and even then it did not apply best available technologies as defined in this analysis. Rather, this project supported modifying and replacing generation equipment to increase fuel efficiency.²⁶ While retrofit projects have only been a minor part of the World Bank lending portfolio to middle-income countries to date, this is likely to change. Why? First, high levels of local air pollution are driving social unrest, prompting new focus within governments across middle-income countries to prioritize air quality policies and regulation.²⁷ In fact, China has recently declared a “war on pollution,”²⁸ enacting new policies and emphasizing air quality in its Five Year Plan. Given the World Bank’s client driven model, it is presumable that countries will look to the lender to help support this new priority area. Second, as noted above, our data suggests that about 70 percent of coal-fired power plants across middle-income countries could need retrofit improvements in the coming decades. These plants have neither been retrofitted to date, nor are they among the 35 percent of plants built with pollutant controls in place. So while retrofit projects have not been a major part of World Bank engagement with middle-income countries in the energy sector, they could conceivably become a greater focus going forward.

MAP 1. TOTAL COAL-FIRED CAPACITY IN REPRESENTATIVE MIDDLE-INCOME COUNTRIES



Source: Author calculations based on Platts dataset.

RECOMMENDATIONS FOR POLICYMAKERS

Data show ample opportunities to reduce pollution in middle-income countries through retrofit improvements to coal-fired power plants. However, such improvements are not being funded by private capital to any significant extent. Given the enormous development benefits of these plant upgrades, the World Bank should consider financing retrofits as part of an overall policy to clean up the fossil fuel-based power sector.

Given the risk that retrofit improvements extend the life of the plant and thus increase climate pollution, all World Bank supported retrofit projects in middle-income countries should be pursued within the context of broader policy efforts to abate national and local climate pollution—in line with the U.S. Treasury's revised

guidance to the World Bank. Data suggest that this risk is in fact quite real. For instance, 95 percent of plants currently in operation that have been retrofitted were built between 1955 and 1979. If one considers the average life of a plant to be around 40 years, most plants built during this period are beyond the average retirement age and have prolonged their lifespan, at least in part due to retrofit improvements. While the policy context would vary from country to country and could take a number of forms—including everything from national energy intensity targets, to plans to introduce pollution monitoring systems, to carbon markets—ensuring offsetting actions and policies accompany retrofit projects will minimize concerns about the net impact of projects on the climate.

Additionally, when the World Bank does finance retrofits it should always insist on best available technologies, since most privately financed retrofits already meet this benchmark. Of course, the World Bank does not have a technology standard for its energy lending, nor should it have a single preferred retrofit technology for use across all middle-income countries as human capital and infrastructure vary. However, requiring that projects include a series of best available technologies is consistent with principles of World Bank guidelines for emissions standards. Specific guidelines for PM, NO_x and SO₂, for example, already recommend the most cost-effective technologies that produce the greatest emissions reductions.²⁹ Similar principles guide World Bank recommendations on refrigeration technologies, aluminum manufacturing, and the like. Rather than requiring a specific technology in its projects, the World Bank should require that projects include at least one in a series of best available retrofit technologies to ensure that World Bank supported projects are no dirtier than those being financed privately now. This outcome-oriented approach will ensure flexibility in choosing a technology.

Taken together, retrofit projects done in this way could help secure outsized health gains to the millions of people living in extreme poverty across middle-income countries without putting the planet in greater jeopardy.

APPENDIX 1. LIST OF RETROFIT TECHNOLOGIES

For each type of pollutant (NO_x, PM, or SO₂), several types of retrofit technologies exist. Coal plants typically use low-NO_x burners to remove nitrogen oxides. These burners can be combined with other arrangements, such as overfired air, to remove up to 70 percent of NO_x. Another common NO_x control technology is selective reduction, which injects ammonia into flue gases to reduce NO_x. With a catalyst, selective reduction can reduce 90 percent of NO_x emissions. Particulate matter is typically removed with fabric filters or electrostatic precipitators. A combination of the two can reduce nearly all particulate matter emissions. And various types of scrubbers can remove more than 90 percent of SO₂.³⁰

Best available technologies		
Year Deployed	Control Type	Technology
1960	PARTCTL	Cold side ESP (downstream of air preheater)
1968	SO2CTL	Seawater FGD scrubber
1970	PARTCTL	Water-film venturi particulate scrubber
1970	PARTCTL	Water-film venturi particulate scrubber/unspecified type of electrostatic precipitator (elektrofilter) (ESP)
1975	PARTCTL	Baghouse (fabric filter)
1975	SO2CTL	FGD scrubber (unspecified)
1975	SO2CTL	Wet limestone FGD scrubber
1978	NOXCTL	Selective catalytic reduction
1980	SO2CTL	Wet FGD (unspecified)
1980	SO2CTL	Wet lime FGD scrubber
1983	SO2CTL	Spray dry FGD scrubber (typically using lime reagent)
1983	SO2CTL	Spray dry FGD scrubber system
1983	SO2CTL	Semi-dry lime FGD or other semidry gas cleaning system
1985	NOXCTL	Selective non-catalytic reduction
1991	SO2CTL	Ammonia FGD scrubber
1992	PARTCTL	Compact hybrid particulate collector
1993	SO2CTL	Lime injection
1993	SO2CTL	Limestone injection
1994	SO2CTL	Semi-dry circulating fluidized-bed FGD scrubber (aka Turbosorp)
1995	NOXCTL	Low-NOX burners
1995	NOXCTL	Low-NOX burners/staged combustion
1995	PARTCTL	Wet particulate scrubber
1995	SO2CTL	Circulating-bed FGD scrubber, aka Circoclean
1995	SO2CTL	Dry lime FGD scrubber, hydrated lime injection
2000	NOXCTL	Low-NOX burners/overfire air/SCR
2000	NOXCTL	Low-NOX burners/overfire air
2000	NOXCTL	Low-NOX burners/selective catalytic reduction (SCR)
2000	NOXCTL	Rotating overfire air system for Nox control
2000	PARTCTL	Combination particulate control (usually ESP preceded by multiclones or cyclone collector)

2001	SO2CTL	Reflux circulating fluidized bed FGD scrubber (semi-dry design)
2002	PARTCTL	Unspecified type of electrostatic precipitator (elektrofilter) (ESP)/baghouse (fabric filter)
2002	PARTCTL	Hybrid particulate filters (combination electrostatic precipitator (ESP) and baghouse (fabric filter))
2002	SO2CTL	CANSOLV (regenerable aqueous amine FGD system)
2005	NOXCTL	Hybrid SNCR/SCR Nox control system
2005	SO2CTL	Wet limestone bubbling reactor FGD system developed by Chiyoda Corp, licensed elsewhere
2008	SO2CTL	Wet limestone FGD scrubber design
2010	SO2CTL	Novel integrated desulphurization scrubber (dry lime)

Inferior technologies

Year Deployed	Control Type	Technology
1930	PARTCTL	Multiclone particulate collector
1950	NOXCTL	Staged combustion
1950	PARTCTL	Unspecified type of electrostatic precipitator (elektrofilter)
1950	PARTCTL	Hot side ESP (upstream of air preheater)
1970	NOXCTL	Flue gas recirculation (particulate and NOX control)
1975	PARTCTL	Mechanical particulate control device
1980	PARTCTL	Cyclone particulate removal
1980	SO2CTL	Double alkali FGD scrubber
1980	SO2CTL	Double alkali/dual alkali FGD scrubber or sodium-limestone FGD scrubber
1980	SO2CTL	Dry FGD scrubber (unspecified)
1990	NOXCTL	Gas reburn
1990	NOXCTL	Over-fire air/concentric auxiliary air
1995	NOXCTL	Overfire air (NOX control methodology)
1995	NOXCTL	Staged combustion/ammonia injection
1995	SO2CTL	Limestone injection into furnace with CAO activation
1997	NOXCTL	Separated overfire air (NOX control method)

ACKNOWLEDGEMENTS

We would like to thank Joshua Meltzer at the Brookings Institution and our Climate Advisers colleague Andreas Dahl-Joergensen for valuable comments and suggestions on earlier drafts. We also benefited from the expertise and insights of several U.S. Treasury officials including Alex Severens and Katie Berg. Thanks also to the Climate-Works Foundation for their support. Any omissions, inaccuracies, or errors in this analysis are our own.

ENDNOTES

1. Following World Bank country groupings by lending category, middle-income countries are here defined as creditworthy nations that can access loans, guarantees, and other services from the International Bank for Reconstruction and Development (IBRD) or are so-called blend countries that are also eligible for loans from the International Development Assistance (IDA) arm, which provides interest-free loans and grants to low income countries. IBRD/IDA blend countries are eligible for IDA loans because of their low per capita incomes, but are also eligible for IBRD loans because they are financially creditworthy.
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