REINVENTING CLIMATE FINANCE

FOUR LEVERS TO DRIVE CAPITAL STOCK TRANSFORMATION

BY LUCY KESSLER, TYELER MATSUO, DARIUS NASSIRY, AND PAUL BODNAR

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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; Washington, D.C.; and Beijing.

ABOUT RMI'S GLOBAL CLIMATE FINANCE PROGRAM

RMI established a Global Climate Finance program in 2017 in recognition that the mobilization and smart allocation of finance is a critical enabler of the low-carbon transition globally. This program builds on RMI's legacy of working closely with disruptors, incumbents, and policymakers to forge business-led, market-based solutions to clean energy and climate change. We work to boost climate finance flows into developing countries through concrete initiatives, including by enhancing national capacity and deploying innovative financial instruments at the intersection of public and private finance. In advanced economies, our focus is on accelerating the retirement of fossil energy capital stock by managing the capital transition and avoiding stranded assets.

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SUMMARY

Finance represents a critical means for achieving a transition to a low-carbon, resilient economy within a timeframe that avoids catastrophic climate change. To date, however, climate finance goals have been narrowly framed in terms of volumes of clean or dirty financial flows. In this paper, we argue that a climate finance framework focused on flows is incomplete, as flows alone cannot determine alignment with the long-term goal of limiting the global average temperature increase to well below 2°C above preindustrial levels. Rather, achieving this goal will require a profound transformation of the global economy's *capital stock*—the underlying assets that produce the bulk of global greenhouse gas emissions. We outline a climate finance framework focused on driving capital stock transformation and propose a set of applications relevant to climate negotiators, policymakers, and private actors working to achieve the long-term objectives of the Paris Agreement.

INTRODUCTION

Over the past decade, progress on climate finance has predominantly been measured in annual estimates of clean finance flows: investments in climate-aligned projects or programs such as renewable energy capacity, energy efficiency, and adaptation efforts (see *Climate Finance Terminology*). This is exemplified in the commitment by developed countries to mobilize US$100 billion per year by 2020 from public and private sources to support climate action in developing countries,[1] which was adopted in the Copenhagen Accord of 2009, enshrined in the Cancun Agreement of 2010, and extended in the implementing decisions of the Paris Agreement.[i] The tracking of clean finance flows has also been utilized as a key indicator of progress—for instance, in the Biennial Assessments[2]—and fixation on clean flows has fed public debates surrounding the climate negotiations.

The Paris Agreement took a conceptual step forward, broadening the scope of climate finance beyond a singular measurement of clean flows. By stating the need to make "financial flows consistent with a pathway towards low greenhouse gas emissions (GHG) and climate-resilient development," Article 2.1c of the Agreement acknowledges the need to evaluate both sides of the ledger: not only scaling up clean investments, but also managing flows to emissions-intensive activities that run counter to the goals of the Agreement. Accounting for both clean and dirty flows indicates that, despite increased clean flows, finance continues to be heavily skewed toward dirty investments overall.[3,4]

Yet a framework that only focuses on the volumetric measurement of clean and dirty capital flows is limited. Just as annual GHG emissions drive marginal changes to atmospheric GHG concentrations, annual finance flows only contribute marginally to the composition of the capital stock[ii]—the underlying assets which are responsible for the bulk of global GHGs. These capital assets are also usually long-lived, so incremental additions to or subtractions of financial flows from an economy's capital stock result in a slow change to

CLIMATE FINANCE TERMINOLOGY

For the purposes of this paper, we define *clean finance flows* as investments in climate-aligned projects or programs such as renewable energy capacity, energy efficiency, and climate adaptation and resilience. *Dirty finance flows* are defined as investments in emissions-intensive activities, including finance for new fossil fuel plants, investments in oil and gas production, subsidies for fossil fuels, and investments in maladaptive infrastructure that reduce resilience.[5]

We recognize these definitions may be imprecise but adopt these terms as a heuristic technique to simplify the proposed framework. Additional research into this topic has determined more nuanced and detailed definitions that are instrument- and sector-specific, such as the OECD's "Rio Markers" that define climate-relevant development aid;[6] the Center for International Climate Research's (CICERO's) "Shades of Green" methodology, which employs a spectrum of green colors based on the degree to which the activity or technology supports a low-carbon and climate resilient society in the long-term;[7] and the Climate Bonds Initiative sector-specific criteria for projects and assets that represent eligible investments.[8]

Finally, in some cases, the definitions of "clean" and "dirty" may also be context-dependent, as well as evolve over time.

[i] Another example of treating clean financial flows as equivalent to climate finance is the US$30 billion "fast start finance" commitment, also in the Copenhagen Accord.

[ii] For the purposes of this paper, we define an economy's capital stock as the physical emitting assets within the energy, transport, buildings, and industrial sectors.

their overall composition and subsequent emissions. Instead, to create a more comprehensive approach, we propose a climate finance framework that not only includes an examination of (1) clean finance flows and (2) dirty finance flows, but also two additional components, namely: (3) the rate of retirement of high-carbon assets (capital stock turnover), and (4) the quantity of assets needed for the delivery of services such as light, heat, and mobility (capital stock efficiency). Incorporating all four of these factors can expand the set of solutions available to policymakers and investors for achieving the objectives of the Paris Agreement.

WHY FOCUSING ON FINANCE FLOWS IS INCOMPLETE

A climate finance framework positioned around finance flows may have been appropriate when climate goals were defined in terms of reducing future emissions below a business-as-usual trajectory. Similarly, goals such as the US$100 billion target were appropriate when climate impacts could be assumed to scale with the volume of clean flows. However, three developments challenge the robustness of a flows-focused framework in guiding climate finance for a 2050 vision of a low-emission, climate-resilient economy.

First, the Paris Agreement has redefined global climate objectives, shifting from a focus on reducing future emissions to an absolute limitation on global average temperature rise within a specific timeframe. Meeting the Agreement's temperature goals will likely require the trajectory of global emissions to begin declining by 2020 and reach net zero around 2050.[9] Without any efficiency improvements, this will *necessitate* the removal of existing high-emitting assets from capital stock prior to the end of their economic lifetimes.[10,11] Therefore, strategies for improving the efficiency or removal of these assets must be incorporated as key factors in climate finance.

Second, as costs of renewables and other low-carbon technologies continue to decrease, a volumetric measurement of clean flows does not directly correspond to impact. For example, despite the fact that 2016 was a record year for renewable energy capacity additions, total investments in renewable energy declined from 2015 to 2016 due to a decrease in investment cost per unit.[12] For this reason, a focus on an absolute volume of clean flows is misguided, as finance should be viewed as a means for achieving impact—not the ultimate objective.

Third, achieving deep decarbonization will require attention to not only the volume, but also orientation of climate finance.[13] Incorporating capital stock transformation into a climate finance framework can help guide strategic thinking regarding the technologies and actors that may need to be supported or bought out in the pathway towards decarbonization. For example, while natural gas may be viewed as a lower-carbon alternative to coal-fired power, this new fossil fuel asset, which has a lifetime of 25 to 30 years, may inhibit the shift to a zero-emissions pathway or even become stranded during its expected economic lifetime. Instead, finance may be better positioned to help reduce the cost of solutions necessary for a fully decarbonized future energy system (e.g., renewable energy plus storage).[14,15]

CAPITAL STOCK AS A DRIVER OF GLOBAL EMISSIONS

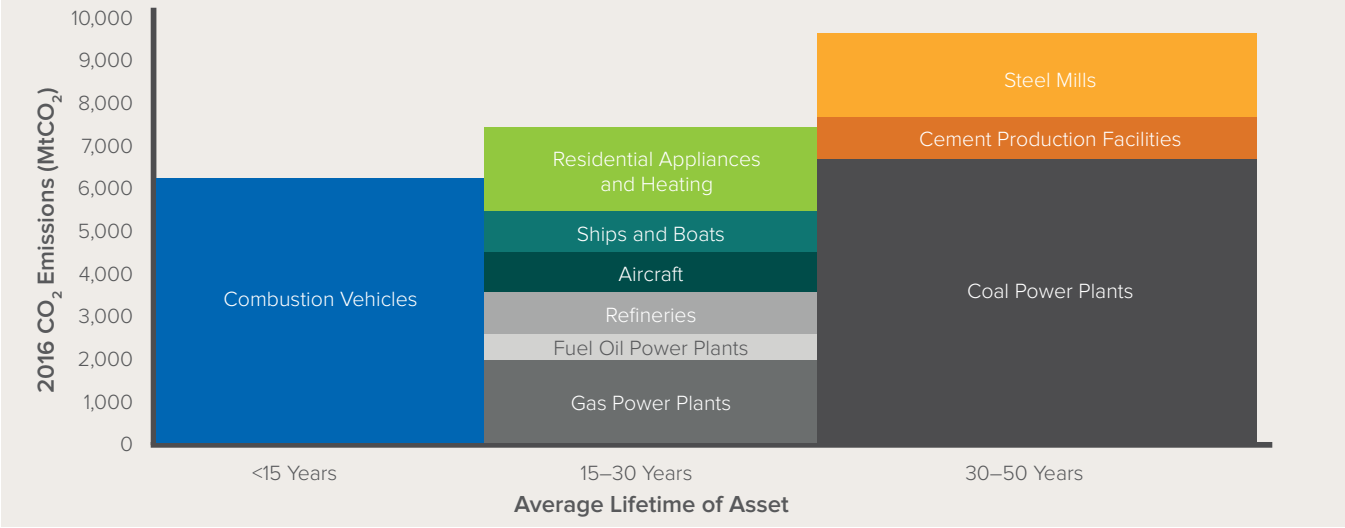
The global economy's capital stock and use of infrastructure is associated with an estimated 78 percent of GHGs.[16] Therefore, creating pathways compatible with the Paris Agreement will require a massive transformation in existing global infrastructure and deep decarbonization of existing sectors.[17] The idea of capital stock as a driver of global emissions is widely recognized. Indeed, the connection between capital stock and global emissions often forms the basis of long-term climate models[18,19] and has been central to systems thinking around "carbon lock-in," or "the tendency for certain carbon-intensive technological systems to persist over time, 'locking out' lower-carbon alternatives."[20,21]

Due to the long lifetimes of emissions-intensive assets, finance flows alone are often unable to quickly transform capital stock. Consider the recent wave of announcements by governments of bans on the sale of internal combustion engine vehicles beyond a certain date.[22] For example, in 2017, France announced a plan to ban the sale of gasoline and diesel vehicles by 2040.[23] However, even if *all* new vehicles sold in France *this year* were electric, those sales would represent only about five percent of the total vehicle fleet.[iii] Turning over the entire fleet would take approximately 15 years,[24,iv] leaving combustion vehicles on the road past 2030. This challenge of capital stock transformation is only magnified for assets with longer lifetimes, most notably coal-fired power plants, which can have average lifetimes of over 40 years.[25]

These long-lived assets also represent the largest contributors to global GHG emissions, as demonstrated in Figure 1, making them key determinants of climate outcomes. Limiting temperature rise to less than 1.5°C will not only require preventing the construction of the 1,600 *new* coal plants currently planned or under development,[26] but also the rapid phase out of *existing* coal-fired power.[27]

FIGURE 1

Global CO_2 Emissions of Various Assets by Average Asset Lifetime



[iii] In 2015, there were 38.5 million vehicles in use in France, according to the European Automobile Manufacturer's Association, and annual car sales in France were approximately 2 million in 2015, approximately 5 percent.

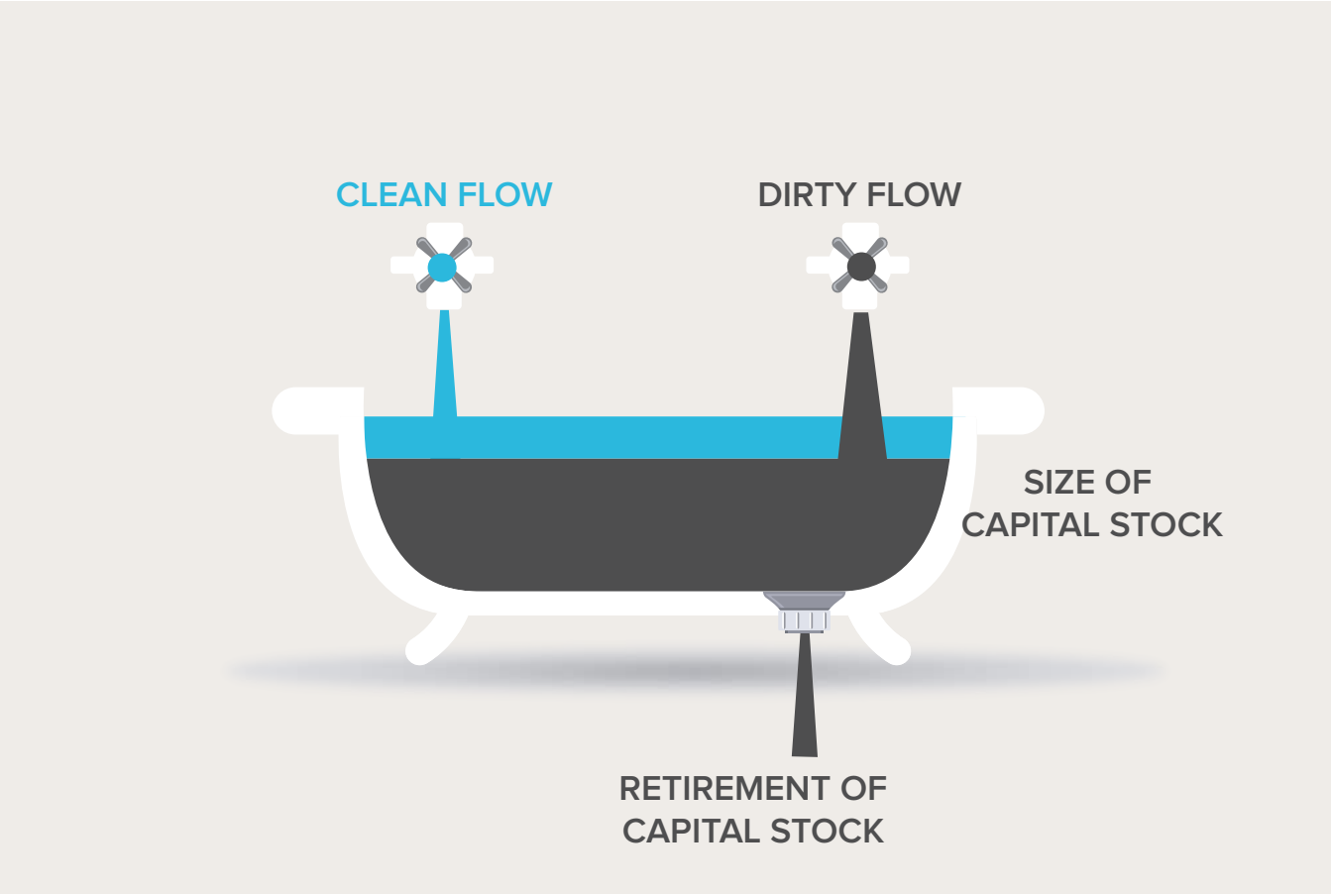
[iv] The average lifetime of a passenger vehicle is about 15 years.

A "STOCKS AND FLOWS" FRAMEWORK

Climate scientists distinguish between annual incremental *flows* of greenhouse gas emissions into the atmospheric *stock* of greenhouse gases, which is the underlying indicator of climate change dynamics and effects. To illustrate this distinction, climate scientists have used the analogy of a bathtub.[28] This paper borrows the analogy, making a distinction between annual financial *flows* and the economy's capital *stock*, represented as water in a bathtub, as demonstrated in Figure 2. At present, the global "bathtub" is largely filled with "dirty" water—capital stock comprised of CO_2-intensive assets such as fossil-fueled power plants, inefficient buildings, and internal combustion engine vehicles—and is gradually adding "clean" water, or Paris-aligned investments, although not quickly enough to meet the goals of the Paris Agreement.

Previously, policymakers, negotiators, and investors have tended to focus on adjusting the two faucets flowing into the bathtub: *increasing* the flow of clean water by scaling up finance for low-carbon technologies and climate-resilient infrastructure; and *reducing* the flow of dirty water by decreasing investments in new fossil fuel generation or phasing out subsidies for fossil fuels. However, while making incremental adjustments to the two faucets, these actors have largely ignored the contents of the bathtub itself.

FIGURE 2
An Expanded Climate Finance Framework



While tracking the volumes and rates of flow from the two faucets can demonstrate investment priorities, it ignores two additional factors key to achieving climate objectives. **First, decarbonizing global capital stocks will require significantly increasing the rate at which dirty water drains out of the bathtub.** This would involve the early retirement of coal-fired power plants, fossil fuel vehicles, and other emissions-intensive assets. Even though economic trends are slowing the growth of certain CO_2-intensive stock (e.g., inefficient coal-fired power plants), retirement, decommissioning, and mothballing of these heavily emitting assets is not occurring fast enough to achieve global climate objectives.

A climate finance framework that positions climate finance to accelerate the decommissioning and removal of emissions-intensive assets and replace them with clean alternatives would provide a more complete and effective set of interventions. Such interventions might include a "pay-to-close" scheme that provides an economic incentive to retire coal-fired power plants ahead of their expected use-life.[29] At the individual-asset level, an effort similar to the Cash for Clunkers program could remove inefficient, high-emitting assets and complement other emissions reduction measures.[v] At the portfolio level, this could include a program similar to the Troubled Asset Relief Program (TARP) that would provide aggregated financial compensation to a set of asset owners and their employees.

Second, improving the efficiency of existing capital stock presents an opportunity to help meet climate goals by reducing the total amount of water in the bathtub. While G20 economies are becoming more efficient—experiencing a 30 percent reduction in energy intensity between 1990 and 2014—this is not occurring fast enough to reduce overall emissions due to the counter-trends of economic growth and energy consumption.[30] This framework presents an opportunity for finance to support major technology and business model innovations to fundamentally change how capital stock is utilized in key emitting sectors. For example, the amount of centralized power capacity can be reduced through energy efficiency measures and by improved utilization of demand-side resources.[31,32] Similarly, a transition to autonomous, shared mobility solutions that optimize vehicle utilization can reduce the volume of cars needed to meet mobility demands.[33]

A framework that includes these two additional levers is not only necessary in terms of achieving the emissions reductions required to achieve global climate goals, but also provides an opportunity to develop more effective climate finance strategies. From a cost standpoint, this expanded framework provides more degrees of freedom for the planning and implementation of least-cost climate action. From a political standpoint, the bathtub analogy can potentially inform climate action strategies by revealing the interaction between stocks and flows. For example, dirty capital stock can induce a strong demand for additional dirty flows (e.g., fossil fuel subsidies), and opposition to the removal of these flows (e.g., subsidy reform). Instead of exclusively focusing on turning off the dirty faucet, solutions designed to first reduce dependence on dirty capital stock (e.g., through efficiency improvements and increasing clean flows) could make the subsequent removal of dirty flows more feasible.

[v] The Car Allowance Rebate System, informally known as Cash for Clunkers program, was one of several stimulus programs signed into law under the Obama administration.

ILLUSTRATION OF THE CAPITAL STOCK FRAMEWORK USING THE EXAMPLE OF THE US ELECTRICITY SECTOR.[34,35,36]

Figure 3A depicts a climate finance framework focused on *clean flows*: investments in clean energy and the resulting capacity additions increased steadily from 2013 to 2016, presenting a positive view of climate progress.

FIGURE 3A

Clean Energy Investments and Capacity Additions in US Electricity Generation

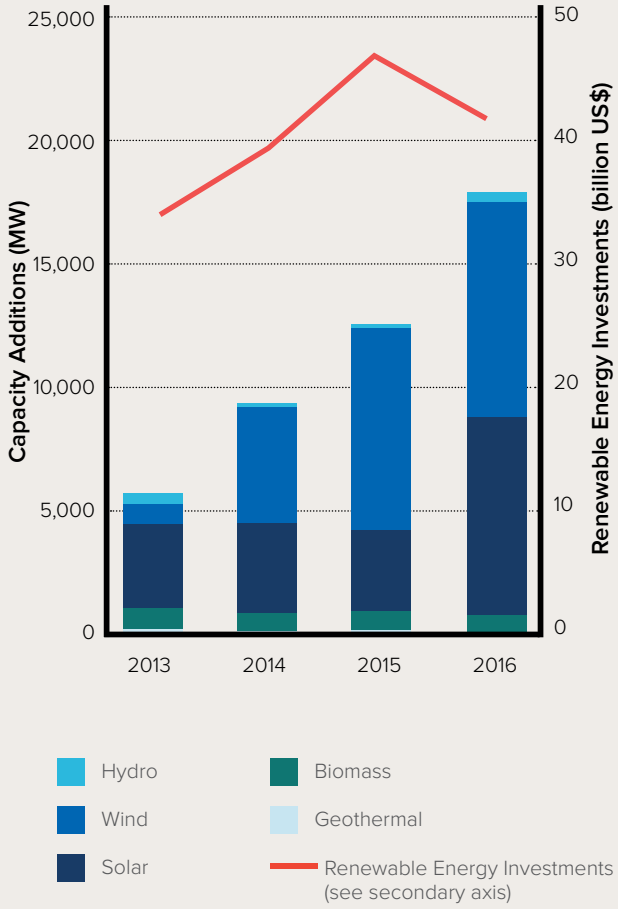
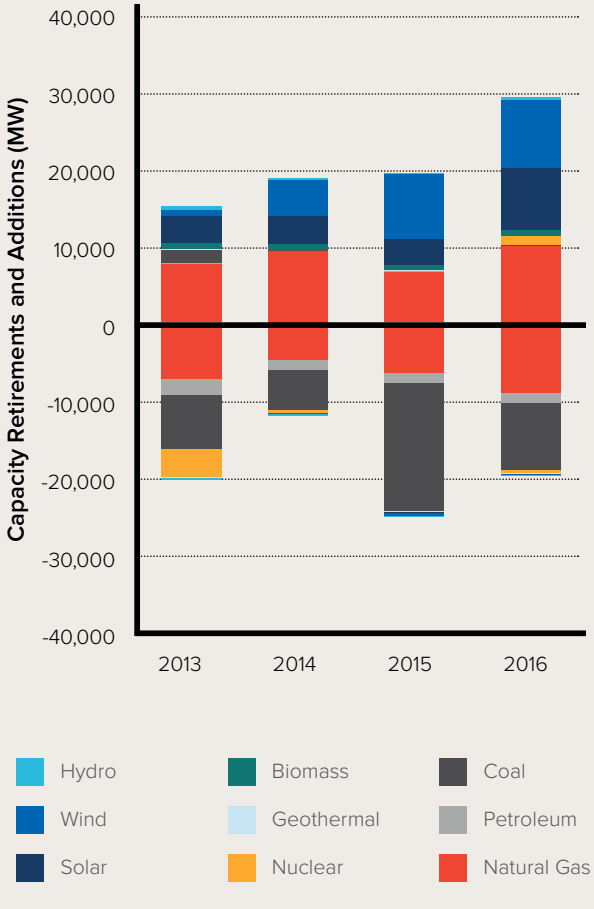


FIGURE 3B

Clean and Dirty Capacity Additions and Retirements in US Electricity Generation



However, Figure 3B compares the clean capacity additions with dirty capacity additions and capacity retirements. This figure provides a more comprehensive depiction, illustrating three trends: (1) support for new fossil fuel investments (*dirty flows*) is strong, (2) retirements of fossil fuel plants have remained steady (*capital stock turnover*), and (3) capacity additions have generally outpaced capacity retirements (*the size of the capital stock* is growing).

FIGURE 3C

Installed Capacity and Related CO_2 Emissions in US Electricity Generation

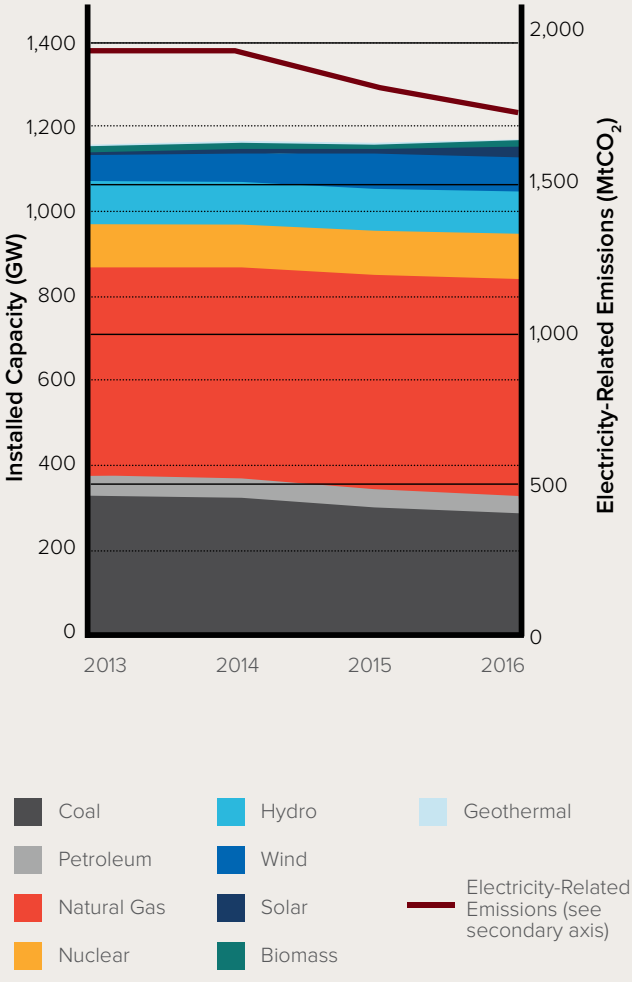


FIGURE 3D

A Comprehensive Framework for Capital Stock Transformation

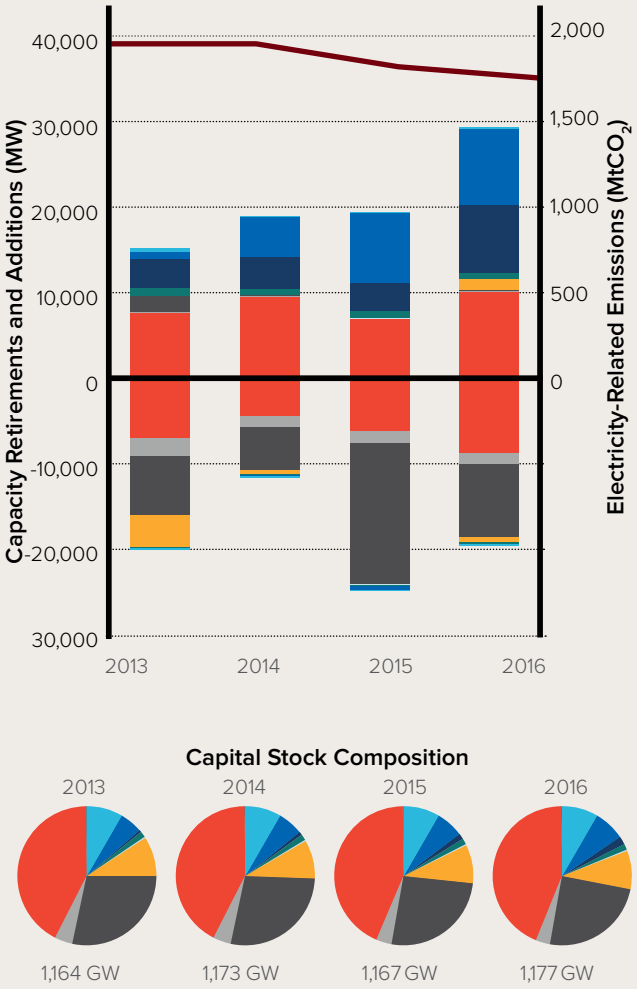


Figure 3C depicts the installed generation capacity over the same period (*composition of the bathtub*), highlighting the small impact of capacity additions and retirements overall. Given the slow rate of change of capital stock, electricity sector emissions have remained relatively flat.

Finally, Figure 3D depicts the stocks and flows framework presented here, providing an integrated way of viewing and tracking capital stock transformation over time. This graph includes all four levers outlined in the stocks and flows framework including: (1) clean flows (renewable energy capacity additions), (2) dirty flows (fossil fuel capacity additions), (3) the rate of retirement of high-carbon assets (fossil fuel capacity retirements), and (4) the quantity of assets needed (gigawatts [GW] installed, as shown in pie charts).

IMPLEMENTING A STOCKS AND FLOWS FRAMEWORK

A framework focused on driving capital stock transformation could be implemented within the public sector at the multilateral and national levels, as well as in the private sector through innovative financial mechanisms. In this section, we highlight the implications of this framework for the measurement and tracking of climate finance, as well as for national policymakers and the private sector.

IMPLICATIONS FOR GLOBAL TRACKING OF CLIMATE FINANCE

As policymakers examine implementation pathways for Article 2.1c—one of the cardinal objectives of the Paris Agreement—they could consider the measurement of capital stock transformation, in addition to climate finance flows. This will necessitate a broader framing of climate finance, potentially considering incentive programs focused on accelerating capital turnover (e.g., via early closure of coal-fired power plants) to qualify as a form of climate finance. However, the stranding of assets can lead to negative economic consequences,[vi] not only for investors in those assets, but also for impacted workers and communities. Policymakers must carefully manage this process in order to minimize capital destruction and economic destabilization in countries that are committed to a low-carbon, climate-resilient economy. Consequently, transfers to facilitate the "just transition" of labor to help communities adjust to the decline of the fossil fuel industries that previously served as significant employers or elements of the tax base could be considered to be within the scope of climate finance as well.

Beyond such specific innovations, climate finance tracking needs to evolve beyond the assumption that more is better. The reasons have been elaborated above and include steep reductions in clean technology costs, as well as the desirability of capital stock efficiency, which enables the delivery of increased services (e.g., energy) with less total capital stock (e.g., installed capacity). Figure 3D offers an integrated approach to tracking capital stock transformation in a given sector within a given country, simultaneously showing the impact of clean flows, dirty flows, capital stock retirement, and trends in capital stock efficiency.

While metrics for clean and dirty flows are relatively well established,[37] tracking the other two factors will require converting the units of physical assets (e.g., GW of electricity, numbers of vehicles and inefficient appliances) to a comprehensive and comparable financial metric—such as the economic value of dirty assets that will need to be stranded to adhere to a 1.5°C or 2°C scenario—with the goal of driving this value to zero within the relevant time frame for action.

Operationalizing these metrics could raise methodological challenges regarding the quantification of dirty capital assets. First, while several valuation metrics exist, including net book value, net present value, and the market value of assets,[38] the applicability of each is likely to vary across sectors and assets. Second, even if consensus were reached regarding a specific metric, discrepancies in valuation may arise. Third, all of the proposed metrics require significant asset-level data and analysis. While a lack of data availability, both sectorally and geographically, may impede implementation in the near term, a mandate to widen the focus in this area will induce the development of the necessary data in the long run. Finally, accounting challenges regarding the scope of dirty capital stock may prove difficult to resolve. For example, certain upstream infrastructure, such as gas pipelines or high-voltage transmission networks, may not be directly responsible for energy sector emissions themselves, but represent committed capital stock that perpetuates the utilization of fossil fuel power plants.

[vi] Defined as the retirement of assets that, at some time prior to the end of their economic life, are no longer able to earn a return, due to changes related to the transition to a low-carbon economy.

IMPLICATIONS FOR NATIONAL POLICYMAKERS

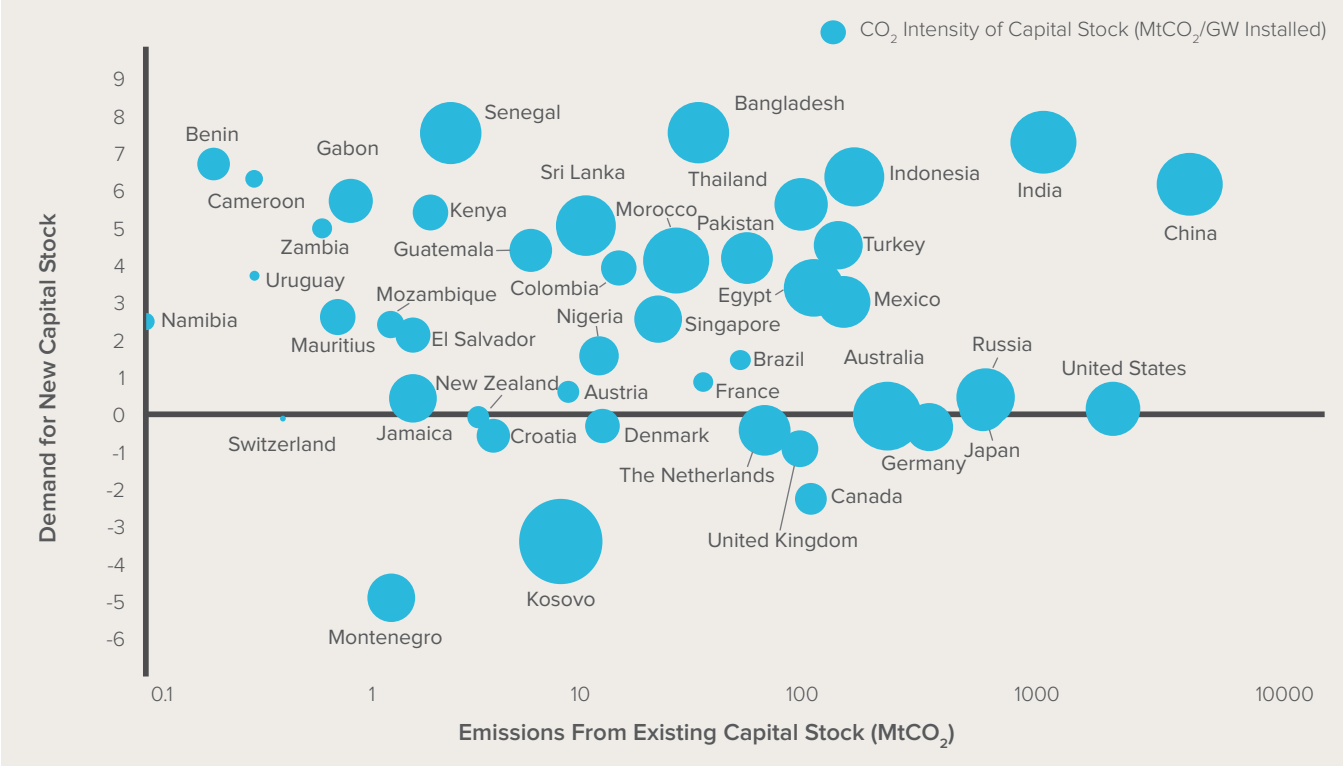
A framework focused on climate finance flows leads to relatively narrow policy objectives for mobilizing clean finance flows and reducing dirty finance flows. By contrast, a framework organized around capital stock transformation provides a broader set of recommendations for national policymakers.

While the four levers described here are likely to play some role in capital stock transformation in every country, the relevance and cost-effectiveness of each lever will likely depend on specific national circumstances. In this section, we look at how two characteristics—the level of emissions from existing capital stock (represented by the x-axis in Figures 4A and 4B) and demand for new capital stock (represented by the y-axis in Figure 4A and 4B)—can influence national strategies.[39,40,vii]

Although the strategies outlined below are tailored to the economic profile of the country, all countries should consider assessing the compatibility of their current and planned capital stock against long-term emissions

FIGURE 4A

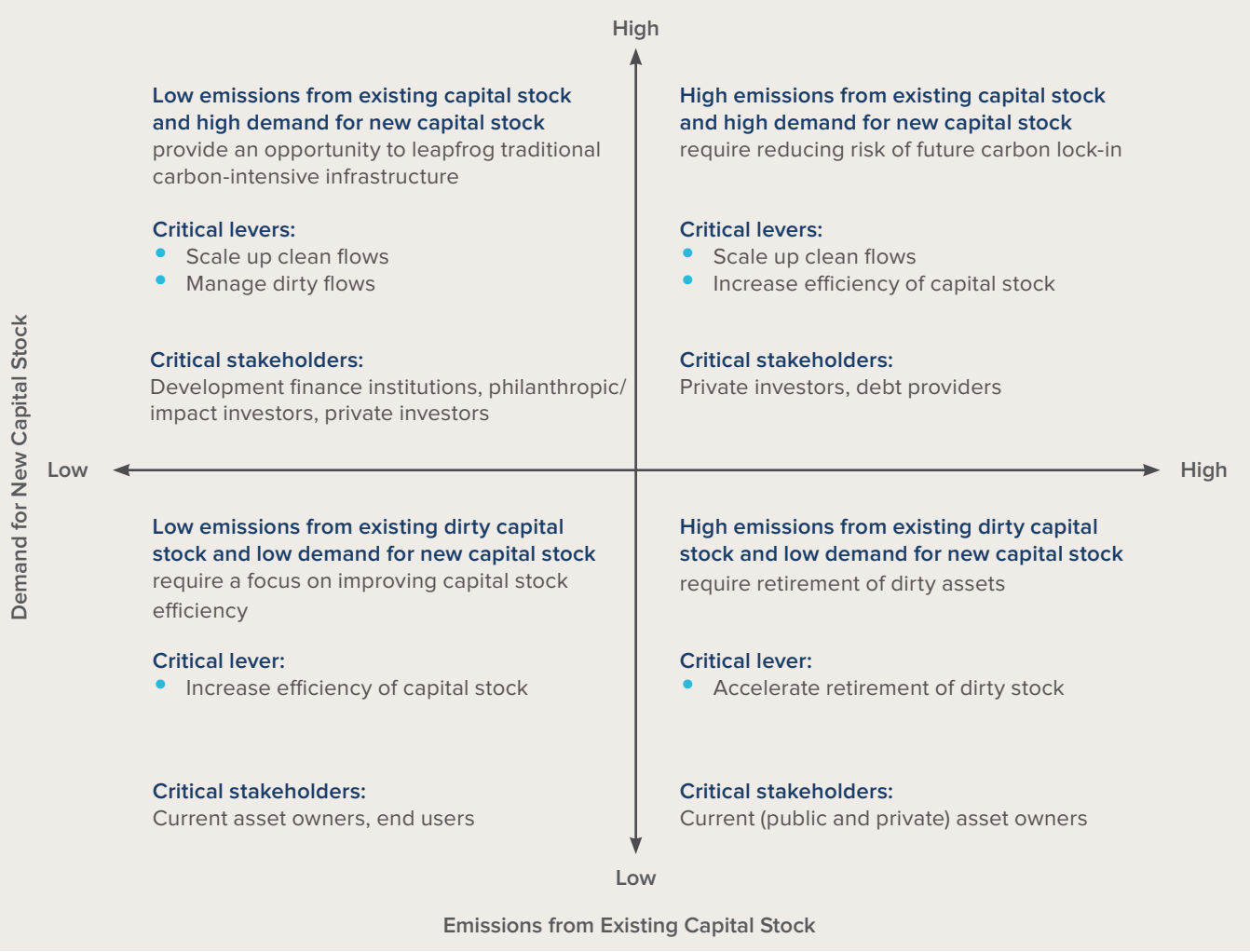
Mapping of the Electricity Sector in Selected Countries According to the Emissions From Existing Capital Stock and Their Demand for New Capital Stock



[vii] In Figure 4A, the level of emissions from existing capital stock is measured in total electricity-related emissions and demand for new stock is measured as the five-year cumulative annual growth rate of electricity consumption in each country from 2011 to 2016. Note that electricity emissions are shown on a logarithmic scale on the x-axis in Figure 4A and the carbon-intensity of capital stock is depicted by the size of the bubble.

FIGURE 4B

A Heuristic to Guide Capital Stock Transformation in Different Country Contexts Based on (1) the Level of Emissions From Existing Capital Stock and (2) Demand for New Capital Stock



reduction plans.[41] For example, the United Kingdom has set a goal to reduce emissions 80 percent by 2050, which will be translated into a carbon budget for each sector to guide infrastructure planning.[42]

Developing economies

In fast-growing developing countries with low emissions from existing capital stock and a high demand for new capital stock (upper left quadrants of Figures 4A and 4B), it will be important to continue prioritizing the adjustment of the two faucets—maximizing clean flows and minimizing dirty flows. These countries present both a challenge and opportunity for ensuring that capital stock is built clean from the outset. In this context, developing financing solutions to ensure that low-carbon technologies are a viable and affordable alternative to traditional carbon-intensive economic growth will be critical.

Advanced emerging economies

In countries with both high emissions from existing capital stock and continuing pressure for new capital

stock (top right quadrants in Figures 4A and 4B), it is crucial to avoid further carbon lock-in from new long-lived assets that could last several decades.[43,44,viii] In these countries, which typically include advanced emerging economies such as China and India (see Figure 4A), near-term climate finance strategies should employ two levers: massively increase clean investment and promote efficiency to help reduce the scale of investment needed to fuel their economic growth. Financing strategies will require private-sector engagement due to the scale of investment needed.

Large industrialized economies

In large, high-emitting countries with lower demand for new capital stock, such as the United States, Germany, or Canada (bottom right quadrants of Figures 4A and 4B), accelerating the early retirement of carbon-intensive assets is a key lever to capital stock transformation. Removing these dirty assets may also prove more cost-effective in reducing emissions than investing in new low-carbon assets. In these countries, climate finance strategies should be designed to incentivize current asset owners—both public and private[ix]—rather than new investors.[45,46]

Small low-growth economies

Finally, for countries with both low emissions from existing capital stock and low expected future demand for new capital stock, which could include, for example, small island developing states (SIDS) or smaller industrialized countries (bottom left quadrants of Figures 4A and 4B), capital stock transformation will likely take yet another form. Given a slower growth rate, capital stock transformation could be achieved by improving stock efficiency and, where possible, replacing dirty capital stock with clean. For example, although SIDS contribute a small portion of emissions on a global level, replacing their existing centralized diesel-powered infrastructures with distributed renewables could improve resilience to climate-related shocks (e.g., natural disasters and resulting power outages).

IMPLICATIONS FOR PRIVATE INVESTORS AND FINANCIAL REGULATORS

Private investment in clean activities has experienced rapid growth, increasing 25 percent in 2015 and 2016 as compared to 2013 and 2014.[47] In addition to continuing to increase clean investments, there are new regulatory policies, information campaigns, and business model innovations that are mobilizing the private sector to reduce dirty flows, accelerate the early retirement of high-carbon capital stock, and improve the efficiency of the economy's physical assets.

A number of new initiatives have emerged that are designed to reduce the flow of the dirty faucet by means of exposing regulatory risks, physical risks, and economic risks associated with investing in high-carbon assets, such as the Task Force on Climate-related Financial Disclosures (TCFD). Additionally, several major European insurance companies have announced their refusal to insure the construction of new coal mines or plants, and to accept any coal companies as new clients.[48]

Beyond reducing the flow of the dirty faucet, insurers such as Allianz, AXA, and Zurich Insurance Group have implemented policies that preclude insuring existing coal-fired power plants,[49] which will likely lead to asset retirement, increasing the rate of drain from the bathtub. Further, in a growing number of countries, investors and fossil fuel-asset owners are proactively negotiating their capital exit from existing assets that have been—or could be—stranded. While this is indicative of the increasingly risky nature of high-carbon assets, the

[viii] This includes, for example, preventing the build-out of new coal-fired capacity, 73 percent of which is planned in five emerging economies.

[ix] The vast majority of the value at risk of stranding in the oil and gas sectors is actually held by the public sector.

scale of capital stock transformation needed will require the development of financial models that can deliver risk-adjusted returns to investors in order to mobilize capital markets to retire high-emitting assets in line with a global carbon budget.

In addition, innovations in business models and regulations are enabling companies to profit from efficiency improvements, not just generation capacity. For example, nearly half the states in the United States have enacted decoupling policies whereby revenue is decoupled from sales volume, reversing the present rate structure, which rewards utility companies for increasing generation, and instead incentivizing utilities to invest in energy efficiency.[50] The state of California's policy combines a revenue-decoupling program with a Risk/Reward Incentive Mechanism that provides financial rewards and/or penalties to investor-owned utilities for meeting or exceeding energy efficiency targets.[51]

Given that over 60 percent of total climate finance is provided by the private sector,[52] its involvement in all aspects of this framework will be critical. Already, efforts to expose and price climate risk are increasing the decommissioning of high-emitting capital stock and incentivizing efficiency improvements. As financial institutions look to align their portfolios with climate goals, the stock and flows framework presented here can help ensure their effort to align with the Paris Agreement will be comprehensive.

CONCLUSION

While the US$100 billion goal and Article 2.1c of the Paris Agreement are critical to achieving global climate objectives, these frameworks have focused solely on the volume of financial flows. Since GHG emissions are driven by the composition of carbon-intensive assets for most sectors (e.g., energy, industry, transportation), an exclusive focus on finance flows does not provide a comprehensive indicator to fully measure alignment between finance and global climate objectives. A climate finance framework that includes increasing clean flows, decreasing dirty flows, accelerating the turnover of dirty assets, and improving the efficiency of capital stock can more effectively drive action toward the ultimate goal of limiting temperature rise to well below 2°C. However, in order to bring this forward in practice, additional work will be required.

First, if an expanded framework is to be integrated into the United Nations Framework Convention on Climate Change (UNFCCC) process or to climate finance tracking more broadly, each of the four levers will require a proper accounting framework. This will necessitate assessing data availability and developing methodologies for each of the relevant sectors. Second, we must develop additional instruments to accelerate change for each of these levers. Transitioning this theory into practice may be challenging but achieving the emissions reductions needed to avoid the most dangerous effects of climate change will require ambitious approaches and innovative frameworks capable of not only increasing or restricting incremental finance flows but mobilizing a systemic transformation of the global economy's capital stock.

ENDNOTES

[1] OECD and Climate Policy Initiative. 2015. "Climate Finance in 2013-14 and the USD 100 Billion Goal." **http://www.oecd.org/environment/cc/OECD-CPI-Climate-Finance-Report.htm** Acknowledgments.

[2] UNFCCC. 2018. "Summary and Recommendations by the Standing Committee on Finance on the 2016 Biennial Assessment and Overview of Climate Finance Flows." Bonn. **https://unfccc.int/sites/default/files/resource/51904 - UNFCCC BA 2018 - Summary Final.pdf**.

[3] Bodnar, Paul, Caroline Ott, Joe Thwaites, Laetitia De Marez, and Bianka Kretschmer. 2017. "Net Climate Finance." Boulder, CO: Rocky Mountain Institute. **https://rmi.org/wp-content/uploads/2017/07/RMI_Net_Climate_Finance_Discussion_Paper_2017-1.pdf**.

[4] Whitley, Shelagh, Joe Thwaites, Helena Wright, and Caroline Ott. 2018. "Making Finance Flows Consistent with Climate Goals: Insights for Operationalizing Article 2.1c of the UNFCCC Paris Agreement." London: ODI, WRI, E3G, RMI.

[5] Bodnar, Paul, Caroline Ott, Joe Thwaites, Laetitia De Marez, and Bianka Kretschmer. 2017. "Net Climate Finance." Boulder, CO: Rocky Mountain Institute. **https://rmi.org/wp-content/uploads/2017/07/RMI_Net_Climate_Finance_Discussion_Paper_2017-1.pdf**.

[6] OECD. 2016. "OECD DAC Rio Markers for Climate Change Handbook." Paris. **http://www.oecd.org/dac/environment-development/rioconventions.htm**.

[7] CICERO. 2016. "Framework for CICERO's 'Second Opinions' on Green Bond Investments." Oslo.

[8] Climate Bonds Initiative. 2017. "Climate Bonds Standard & Certification Scheme."

[9] IPCC. 2018. "IPCC Special Report on the Impacts of Global Warming of 1.5°C." **http://www.ipcc.ch/report/sr15/**.

[10] IPCC. 2018. "IPCC Special Report on the Impacts of Global Warming of 1.5°C." **http://www.ipcc.ch/report/sr15/**.

[11] Pfeiffer, Alexander, Cameron Hepburn, Adrien Vogt-Schilb, and Ben Caldecott. 2018. "Committed Emissions from Existing and Planned Power Plants and Asset Stranding Required to Meet the Paris Agreement." Environmental Research Letters 13 (5). **https://doi.org/10.1088/1748-9326/aabc5f**.

[12] REN21. 2017. "Global Status Report." Paris. **https://doi.org/10.1016/j.rser.2016.09.082**.

[13] Brown, Jessica, and Ilmi Granoff. 2018. "Deep Decarbonization by 2050: Rethinking the Role of Climate Finance." **https://climatepolicyinitiative.org/wp-content/uploads/2018/07/Deep-decarbonization-by-2050-rethinking-the-role-of-climate-finance.pdf**.

[14] Brown, Jessica, and Ilmi Granoff. 2018. "Deep Decarbonization by 2050: Rethinking the Role of Climate Finance." **https://climatepolicyinitiative.org/wp-content/uploads/2018/07/Deep-decarbonization-by-2050-rethinking-the-role-of-climate-finance.pdf**.

[15] Mazzucato, Mariana, and Gregor Semieniuk. 2018. "Financing Renewable Energy: Who Is Financing What and Why It Matters." Technological Forecasting and Social Change 127 (June 2017): 8–22. **https://doi.org/10.1016/j.techfore.2017.05.021**.

[16] IPCC. 2014. "Climate Change 2014, Mitigation of Climate Change (WGIII)." In Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, UK; New York, NY: Cambridge University Press.

[17] SDSN and IDDRI. 2015. "Pathways to Deep Decarbonization." **https://doi.org/10.1016/0269-7491(87)90209-0**.

[18] IPCC. 2018. "IPCC Special Report on the Impacts of Global Warming of 1.5°C." **http://www.ipcc.ch/report/sr15/**.

[19] Rogelj, Joeri, Michel den Elzen, Niklas Höhne, Taryn Fransen, Hanna Fekete, Harald Winkler, Roberto Schaeffer, Fu Sha, Keywan Riahi, and Malte Meinshausen. 2016. "Paris Agreement Climate Proposals Need a Boost to Keep Warming Well below 2 °C." Nature 534 (June): 631. **http://dx.doi.org/10.1038/nature18307**.

[20] Unruh, Gregory C. 2000. "Understanding Carbon Lock-In." Energy Policy 28: 817–30. **https://doi.org/10.1016/S0301-4215(01)00098-2**.

[21] Erickson, Peter, Sivan Kartha, Michael Lazarus, and Kevin Tempest. 2015. "Assessing Carbon Lock-In." Environmental Research Letters 10 (8). **https://doi.org/10.1088/1748-9326/10/8/084023**.

[22] Climate Transparency. 2018. "Brown to Green: The G20 Transition to a Low-Carbon Economy." Berlin.

[23] Gouvernement.fr. 2018. "Climate Plan." https://**www.gouvernement.fr/en/climate-plan**.

[24] Erickson, Peter, Sivan Kartha, Michael Lazarus, and Kevin Tempest. 2015. "Assessing Carbon Lock-In." Environmental Research Letters 10 (8). **https://doi.org/10.1088/1748-9326/10/8/084023**.

[25] Philibert, Cédric. 2007. "Technology Penetration and Capital Stock Turnover: Lessons from IEA Scenario Analysis." OECD/IEA Information Paper, 1–22. **https://www.iea.org/publications/freepublications/publication/capital_stock.pdf%0Ahttp://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=1913**.

[26] Coal Exit. 2016. "Investors vs. The Paris Climate Agreement." **https://coalexit.org/sites/default/files/download_public/Investors vs. Paris_web.pdf**.

[27] IPCC. 2018. "IPCC Special Report on the Impacts of Global Warming of 1.5°C." **http://www.ipcc.ch/report/sr15/**.

[28] Sweeney, Linda Booth, and John D Sterman. 2000. "Bathtub Dynamics: Initial Results of a Systems Thinking Inventory." System Dynamics Review 16 (4): 249–86.

[29] Benn, Annie, Paul Bodnar, James Mitchell, and Jeff Waller. 2018. "Managing the Coal Capital Transition: Collaborative Opportunities for Asset Owners, Policymakers, and Environmental Advocates." Boulder, CO: Rocky Mountain Institute, **https://www.rmi.org/insight/managing-coal-capital-transition/**.

[30] Climate Transparency. 2018. "Brown to Green: The G20 Transition to a Low-Carbon Economy." Berlin.

[31] Dyson, Mark, Jamil Farbes, and Alexander Engel. 2018. "The Economics of Clean Energy Portfolios: How Renewable and Distributed Energy Resources Are Outcompeting and Can Strand Investment in Natural Gas-Fired Generation." Boulder, CO: Rocky Mountain Institute. **www.rmi.org/insights/reports/economics-clean-energy-portfolios**.

[32] Lovins, Amory B. 2018. "How Big Is the Energy Efficiency Resource?" Environmental Research Letters 13 (9): 090401. **https://doi.org/10.1088/1748-9326/aad965**.

[33] Johnson, Charlie, and Jonathan Walker. 2016. "Peak Car Ownership: The Market Opportunity of Electric Automated Mobility Services." Boulder, CO: Rocky Mountain Institute. **https://rmi.org/insight/peak-car-ownership-report/**.

[34] U.S. Energy Information Administration. 2018. "Electric Power Manual." Washington D.C.: EIA.

[35] IEA. 2018. "CO_2 Emissions from Fuel Combustion." Paris. **https://doi.org/10.1787/co2_fuel-2014-en**.

[36] REN21. 2018. "Global Status Report." Paris. **https://doi.org/978-3-9818911-3-3**.

[37] Buchner, Barbara, Padraig Oliver, Xueying Wang, Cameron Carswell, Chavi Meattle, and Federico Mazza. 2017. "Global Landscape of Climate Finance 2017." Climate Policy Initiative. **https://climatepolicyinitiative.org/wp-content/uploads/2017/10/2017-Global-Landscape-of-Climate-Finance.pdf**.

[38] Benn, Annie, Paul Bodnar, James Mitchell, and Jeff Waller. 2018. "Managing the Coal Capital Transition: Collaborative Opportunities for Asset Owners, Policymakers, and Environmental Advocates." Boulder, CO: Rocky Mountain Institute, **https://www.rmi.org/insight/managing-coal-capital-transition/**.

[39] IEA. 2018. "CO_2 Emissions from Fuel Combustion." Paris. **https://doi.org/10.1787/co2_fuel-2014-en**.

[40] IEA. 2018. "IEA World Energy Statistics." Paris.

[41] OECD, World Bank, and UNEP. 2018. "Financing Climate Futures: Rethinking Infrastructure." **http://www.oecd.org/environment/cc/climate-futures/synthesis-financing-climate-futures.pdf**.

[42] OECD. 2018. "Developing Robust Project Pipelines for Low-Carbon Infrastructure." Paris. **https://doi.org/https://doi.org/10.1787/9789264307827-en**.

[43] Fouquet, Roger. 2016. "Path Dependence in Energy Systems and Economic Development." Nature Energy 1 (8). **https://doi.org/10.1038/nenergy.2016.98**.

[44] Edenhofer, Ottmar. 2018. "Reports of Coal's Terminal Decline May Be Exaggerated." Environmental Research Letters 13 (024019).

[45] Benn, Annie, Paul Bodnar, James Mitchell, and Jeff Waller. 2018. "Managing the Coal Capital Transition: Collaborative Opportunities for Asset Owners, Policymakers, and Environmental Advocates." Boulder, CO: Rocky Mountain Institute, **https://www.rmi.org/insight/managing-coal-capital-transition/**.

[46] The New Climate Economy. 2014. "Finance." In Better Growth, Better Climate: The New Climate Economy Report.

[47] Buchner, Barbara, Padraig Oliver, Xueying Wang, Cameron Carswell, Chavi Meattle, and Federico Mazza. 2017. "Global Landscape of Climate Finance 2017." Climate Policy Initiative. **https://climatepolicyinitiative.org/wp-content/uploads/2017/10/2017-Global-Landscape-of-Climate-Finance.pdf**.

[48] Moorcraft, Bethan. 2018. "Generali Becomes Latest Insurer to Reject Coal." Insurance Business, November 2018.

[49] Moorcraft, Bethan. 2018. "Generali Becomes Latest Insurer to Reject Coal." Insurance Business, November 2018.

[50] C2ES. n.d. "Decoupling Policies." Accessed November 21, 2018. **https://www.c2es.org/document/decoupling-policies/**.

[51] Chandrashekeran, Sangeetha, Julia Zuckerman, Jeff Deason. 2014. "Raising the Stakes for Energy Efficiency: California's Risk/Reward Incentive Mechanism." Climate Policy Initiative. **https://climatepolicyinitiative.org/wp-content/uploads/2014/01/Raising-the-Stakes-for-Energy-Efficiency-Californias-Risk-Reward-Incentive-Mechanism.pdf**.

[52] Buchner, Barbara, Padraig Oliver, Xueying Wang, Cameron Carswell, Chavi Meattle, and Federico Mazza. 2017. “Global Landscape of Climate Finance 2017.” Climate Policy Initiative. **https://climatepolicyinitiative.org/wp-content/uploads/2017/10/2017-Global-Landscape-of-Climate-Finance.pdf**.

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