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STRATEGIC USE OF CLIMATE FINANCE TO MAXIMIZE CLIMATE ACTION

A Guiding Framework

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EXECUTIVE SUMMARY

This paper proposes a framework for deciding how to use international public finance with a concessional component to maximize the impact of climate action. In a context of scarce concessional resources, the framework proposes an approach to prioritize interventions, and weighs the level of concessionality that is warranted to support mitigation and resilience-building programs and projects[1] in developing countries. [2] It is meant as a heuristic tool for ultimately informing operational recommendations and processes.

The framework adds clarity to the application of resources with a concessional component[3] intended to achieve climate change objectives—referred to as "climate finance." [4] On the one hand, the framework examines how to prioritize among climate-focused programs and projects for either mitigation or resilience building, irrespective of the concessionality needed to make those investments feasible. On the other hand, the framework helps to determine the appropriate level of concessionality (if any) that is warranted to make those projects viable.

The framework proposed in this paper aims to show how climate finance can be used to prioritize programs and projects for both mitigation- and adaptation-related investments. It is applicable to different scales, from assessing individual projects to assessing cross-country programs. However, it is not intended to help prioritize across mitigation and resilience-building projects or programs, but only within each of these two categories of activities. The framework is also not meant to be applied to the allocation of resources for non-climate objectives (e.g., through International Development Association and International Bank for Reconstruction and Development finance), even though it can be used to inform efforts to maximize any climate co-benefits generated by those resources. Nor is the framework intended to determine country allocations for a given fund or institution.

Climate change has been characterized as a market failure "on the greatest scale the world has ever seen" (Stern 2007). This particular market failure results from the fact that greenhouse gas (GHG) emissions are a negative externality: countries and people are not paying for the full cost of emitting GHGs, and therefore have invested less to reduce their emissions than would be optimal. As a result, costs from climate change will be experienced globally over the next decades and century, with poor countries and people—who in general have emitted less—disproportionately suffering from these impacts. As investments in emission reductions produce benefits that are *diffuse* (international) and/or accrue in the

[1] A program refers to engagements, including at the policy and project level, in a given sector or country. In principle, it is preferable to support programs rather than singular projects because programs are (by definition) more comprehensive and more likely designed with a long-term focus. Yet for simplification purposes, the term "project" is often used in this paper to refer to a program or project, depending on the context.

[2] This paper is not informed implicitly or explicitly by a position on historical responsibilities for climate change, nor does it discuss responsibility regarding sources of climate finance. Instead, it focuses on maximizing the contribution of available and future public finance with a degree of concessionality to combating climate change and its impacts.

[3] The degree of concessionality of public finance can be measured by its grant element. The framework presumes that climate finance can involve some degree of concessionality (a positive grant element) *without necessarily being "concessional,"* as might be defined relative to the regular pricing of the "non-concessional" window of a given development finance institution (DFI). There is a continuum of degree of concessionality—from loans at market conditions to pure grants—and consequently different usages of the term "concessional finance" (i.e., an agreed grant element threshold beyond which financing can be referred to as "concessional finance"). For this reason, this report talks about the "degree of concessionality" and "climate finance," but avoids use of the term "concessional finance."

[4] The term "climate finance" is defined here as international public finance that has the explicit objective of supporting mitigation and/or resilience-building activities, and which typically has some degree of concessionality.

future (intergenerational), GHG emissions are particularly difficult to internalize in today's decision-making frameworks.

Climate change adaptation, the adjustments of societies and economies to minimize the negative impacts of climate change and capture the opportunities it offers, also has a global externality dimension: reducing the global costs of the climate externality.[5] While the benefits of adaptation—subsumed here by "resilience building"[6]—are primarily *local* (concentrated), some secondary impacts of climate change that can be avoided thanks to resilience building (from peoples' displacement to impacts on trade) are also global in nature. Even if it comes at an increased cost due to climate change, enhanced resilience reduces poverty and helps achieve the Sustainable Development Goals (SDGs) by making developing countries less vulnerable to climate change.

Inadequate incentives for countries to fully consider the *global* costs of climate change in their development choices make mitigation and resilience building a global public good (GPG). While this feature is the prevailing rationale for public support behind climate change action, other barriers also lead to underinvestment in mitigation and resilience-building actions. Important constraints and obstacles include lack of data, planning tools, and capacity; non-climate market failures and externalities such as knowledge spillover gaps; public budget constraints and lack of access to capital markets; and institutional and political economy obstacles.

At the COP21 in Paris in 2015, almost all countries committed to tackle these issues, by holding the increase in the global average temperature to well below 2°C above pre-industrial temperatures and pursuing efforts to limit the temperature increase to 1.5°C, and by increasing the ability to adapt and fostering resilience to the adverse impacts of climate change. Achieving the Paris objectives will require finance flows commensurate with this low GHG emissions trajectory and climate-resilient development. As all countries, many of them World Bank Group (WBG) client countries, act to meet their national development needs and SDGs, climate finance can facilitate and accelerate achievement of the Paris objectives. Public resources dedicated for climate finance with a high degree of concessionality are scarce and should therefore be used parsimoniously, reserved for the highest priority programs and projects.

This framework seeks to answer practical questions about how to maximize the impact of climate finance and has learned from past efforts. It aims to answer questions such as: Should higher concessionality in climate finance flow to mitigation investments with the lowest marginal cost of emissions abatement, or should they support higher-cost options that accelerate technological change, act as a key demonstration, or trigger structural change? Should higher concessionality for resilience-building investments be directed to areas most at risk of extreme events, or to areas with lower risk but larger populations? Importantly, the approach draws on key lessons learned from existing frameworks that use concessionality for climate action, namely, the Global Environment Facility (GEF) and the Climate Investment Funds (CIF). It also aligns with recent efforts on "blended finance," including the WBG approach to "Maximizing Finance for Development." Box 0-1 (page xv) briefly reviews these linkages.

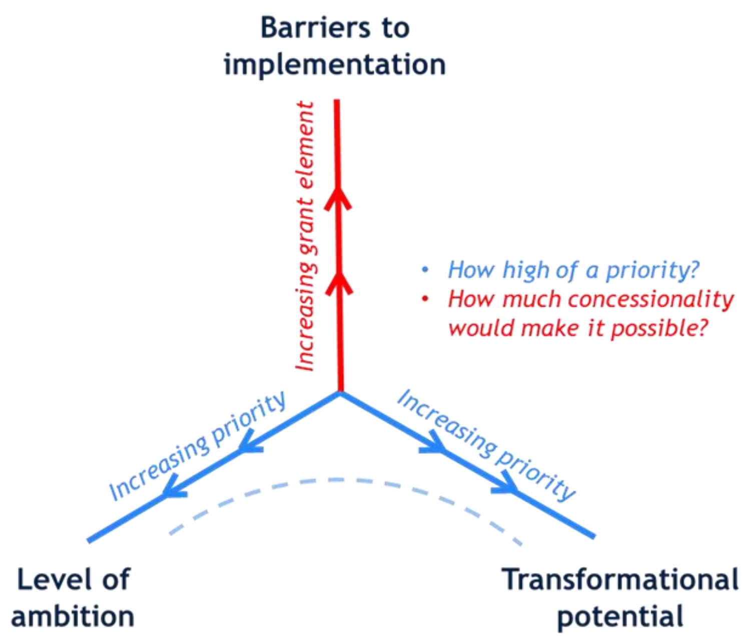
The framework addresses two parallel questions related to access to climate finance: (i) how to determine the priority of a program or project, in the context of scarce concessional resources? and (ii) how to quantify the grant element (if any) that a program or project should receive? While these

[5] Without support for resilience building, the objective of minimizing temperature changes, through emission reductions, would need to be even stricter than has been agreed in the Paris Agreement.

[6] The term resilience (building), rather than adaptation, is primarily used in this paper because it is a more comprehensive concept that reflects a desired pathway or trajectory for a country, community, ecosystem, etc. It not only involves the ability to adapt to changes, but also the ability to anticipate, absorb, and transform in the face of climate extremes and disasters.

questions are linked, their answers are largely independent: a program or project may be considered high-priority, regardless of whether it deserves a high degree of concessionality or none at all (in the latter instance, the project may be advanced with commercial capital, financial restructuring, or via upstream policy engagement). Similarly, regardless of whether a program or project requires a high or low degree of concessionality, it should not be pursued with climate finance if it is low-priority. However, the answer to these questions will be based on the characteristics of a given program or project, and especially on the barriers to implementation that the program or project faces (carefully identified and assessed); and how climate finance might address them. Figure 0-1 illustrates the basic elements of the framework, which are further elaborated below.

FIGURE 0-1. THE THREE DIMENSIONS CONSIDERED BY THE FRAMEWORK



Note: The three dimensions shown—barriers to implementation, level of ambition, and transformational potential—answer two parallel questions (grant element and priority). The **grant element** (or degree of concessionality) needed for a supported program/project *increases with the magnitude of the barriers to implementation*. The **priority** of a program/project *increases as the levels of ambition and the transformational potential increase*. The level of priority is approximately the same along any dotted contour or "indifference curve."

DEGREE OF CONCESSIONALITY AND GRANT ELEMENT

To maximize the impact of climate finance, the degree of concessionality allocated to a program or project should be equal to what is needed to overcome the identified *barriers to implementation* and make the program/project viable.[7] Potential barriers to implementation include the climate externality (i.e., unpriced or underpriced GHG emissions), but also all other market failures (Box 2-1, page 16, Box

[7] It is useful to note that climate finance, as applied here, would not be equivalent to results-based grants that reward projects or programs based on the value of the GPG benefits they generate (thereby internalizing the global externality). Rather, in this framework, the grant element provided by climate finance to a mitigation project does not depend on the value of the tons of carbon emissions directly prevented by the project, but on the resources required to make the project viable. The scale of the project and its direct and indirect impact on emissions are considered in the prioritization context only, not in the determination of the degree of concessionality.

2-2-2, page 17) and non-market barriers. Climate finance should not support programs or projects that could be implemented without it. (Some would refer to this criterion as "additionality," but this term is voluntarily avoided here because it has a long history and specific interpretation in climate negotiation and finance.)

Barriers to implementation dimension

A program or project seeking climate finance support should provide evidence on *well-identified and significant barriers to its implementation that could be overcome by a certain degree of concessionality*. A condition for support would be that the barriers to implementation are clearly identified, and that the concessionality is high enough to overcome the barriers, but not higher than this level.

A typical case would be where the upfront cost of a project to enhance resilience or reduce emissions is higher than that of a lower-resilience or higher-emissions project. Or, the project may not be in the immediate financial interest of an investor or government because its lifecycle cost is higher when externalities are not internalized—for instance, the social cost of the carbon emissions (for a mitigation project) is not taken into account or the spillovers of infrastructure failure on economic activity (for a resilience project) are disregarded. A concessional element can help make a bridge more resilient or replace a fossil fuel power plant with renewable generation; however, it should be minimized to avoid creating a windfall for the investor in question.

Other market failures and non-economic barriers can be equally important: a more resilient option to build a dike, a new disaster-responsive social safety net, or a large renewable energy plan can be difficult to implement for various reasons: lack of knowledge and data, the resulting emergence of fairness or political economy issues that require compensation programs for those negatively affected, or biased risk perceptions regarding technologies that are new to a country. These non-financial barriers can also be efficiently overcome if the minimum degree of concessionality is made available.

However, the fact that a program or project is deemed to be in a country's own interest (or considered "least-cost") does not necessarily mean all substantive barriers are gone. The degree of concessionality would scale with the remaining political, financial, or practical obstacles to implementation, provided they are well characterized by the program or project document and can be lifted or attenuated using concessionality support. For instance, countries with high poverty, low capacity, or limited access to capital markets will use concessionality to relax their financial constraints and implement projects that serve their own interest but could nevertheless not be implemented without this support.

Possible operationalization of the barriers to implementation metric for mitigation/ resilience building

For both mitigation and resilience, the magnitude of the barriers to implementation can be measured qualitatively, based on the program or project characteristics, using four levels:[8]

- *High*: The program or project is more expensive over its entire lifetime than alternative (higher-emission or lower-resilience) options (e.g., investment in a promising but frontier technological solution; renewable energy that is more expensive than the alternatives; costly investments to make infrastructure or buildings more resilient, etc.), or is opposed by interest groups that will be permanently affected (e.g., miners opposing the closure of coal mines).
- *Moderate*: Due to increased efficiency or reduced disaster-related losses, the program or project is less expensive over its entire lifetime than alternative (higher-emission or lower-resilience) options, but it has significantly higher upfront costs (e.g., most energy efficiency programs; stricter

[8] One option to operationalize this framework is to link these qualitative measures of the barriers to implementation to different degrees of concessionality.

building codes for new buildings and infrastructure; many renewable energy generation projects), requires much higher institutional or technical capacity than what is present in the country, or creates significant transition costs or political opposition (e.g., those associated with fossil fuel subsidy reform and flood zoning that significantly affects land values).

- *Low*: The program or program is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher-emission or lower-resilience) options, but it is not a policy priority in the country (e.g., reforms in energy markets; renewable power that is competitive with fossil fuels; demonstrating the value of information on natural risks and climate change to the population and investors).
- *None*: The program or project is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher-emission or lower-resilience) options, and could be implemented even if concessional support is not available.

PRIORITIZATION

Here, the framework complements the usual appraisal that assesses the program's or project's overall desirability, viability, and sustainability, and focuses on its prioritization in terms of climate finance.

To maximize the impact on climate change challenges, the framework prioritizes programs or projects that are: (i) *ambitious* (i.e., contribute significantly to achieving the objectives of the Paris Agreement); and (ii) *transformational* (i.e., reduce in a meaningful manner the barriers to implementation faced by future climate-related programs or projects). These two dimensions are discussed below, with illustrative examples of how the dimensions might be measured in practice.

Level of ambition dimension

Ambitious: the framework prioritizes programs or projects that contribute significantly to achieving the objectives of the Paris Agreement. DFIs should support the achievement of the Paris objectives and, as such, should prioritize projects that are consistent with these objectives. They should particularly favor programs (covering countries, sectors, policies, and technological solutions) and projects that could best put countries on pathways to deep decarbonization and/or system-level resilience to climate shocks.

Considering the immediate and direct impact of a program or project on emissions is insufficient to estimate its contribution to the long-term objectives of the Paris Agreement. Some programs or projects that reduce GHG emissions in the immediate term may still be inconsistent with the Paris objectives. For instance, replacing existing coal power plants in a country by more efficient ones may reduce emissions at a very low cost, when expressed in dollars of investment per avoided ton of GHG emissions. But considering the lifetime of a new coal power plant, such an action could also lock the country into a high-emissions trajectory that is not consistent with a cost-efficient pathway toward meeting the Paris objectives.[9] In a dynamic setting, it is preferable to select options that may be more expensive per ton of avoided GHG emissions but are fully consistent with the long-term mitigation objective of the Paris Agreement (e.g., shifting directly to renewables instead of high-efficiency coal).

Similarly, an adaptation intervention in one location may help over the short term but increase long-term risks by attracting more investment and boosting population growth in an area that cannot be durably protected (maladaptation); or it can improve the situation in one place but make another location

[9] This problem also explains why the framework does not recommend prioritizing projects or programs based on the value of the generated GPGs per dollar of grant element required to make the project viable. Doing so would favor "easy" projects that are almost commercially viable, are unlikely to be transformational, and may not be ambitious enough to contribute to achieving the objectives of the Paris Agreement. The optimal timing of mitigation investments is discussed in Vogt-Schilb, Meunier, and Hallegatte (2018).

less resilient. For these reasons, good short-term solutions may not contribute to the global objectives of the Paris Agreement in terms of overall resilient pathways.

Hence, one must determine whether the program or project is sufficiently ambitious to contribute meaningfully to achieving the long-term objectives of the Paris Agreement (in contrast to merely reducing emissions or enhancing resilience). Only programs and projects that contribute enough and durably to these objectives should be prioritized for climate finance support. Programs or projects that are inconsistent with the Paris objectives should not be supported.

There will be some subjectivity in this criterion, since the Paris Agreement provides a quantified mitigation objective only at the global scale (the 2°C and 1.5°C objectives, and the balance of carbon sources and sinks), not at the country level, and no quantified objective in terms of adaptation and resilience building. For countries with long-term plans—such as those involved in the 2050 Pathway Platform or the members of the "Towards Carbon Neutrality" coalition announced at the One Planet Summit—these long-term pathways can be used to assess how a project contributes to the long-term objectives of the Paris Agreement. For others, the consistency of their development plans and Nationally Determined Contributions (NDCs) with the global objectives of the Paris Agreement needs to be considered.

Possible operationalization of the ambition metric for mitigation and resilience building

For mitigation: It is possible to design an index measuring qualitatively how ambitious the program or project is with respect to the mitigation objectives of the Paris Agreement, using four levels:

- *High:* The program or project is *necessary* to achieve the mitigation objectives of the Paris Agreement. Here, it can be demonstrated that a country or region cannot realistically achieve a development pathway compatible with the Paris Agreement if this (or a similar) program or project is not implemented (e.g., fossil fuel subsidy reform; energy reforms to increase investment in renewables; investment in the grid to allow for a higher renewable share in the energy mix; ambitious energy efficiency program for buildings; carbon pricing; etc.).
- *Moderate:* The program or project may not be necessary, but does contribute significantly to the achievement of the Paris Agreement (e.g., a new public transit system to reduce emissions from transport), or is included in a long-term decarbonization pathways analysis (such as one produced in the context of the 2050 Pathway Platform or the "Towards Carbon Neutrality" coalition announced at the One Planet Summit).
- *Low:* The program or project reduces emissions, but only marginally, and does not significantly change the scale of the problem in a country (e.g., slightly more efficient automotive standards).
- *None:* The program or project is inconsistent with the Paris objectives, even if it reduces emissions, and risks creating a carbon lock-in in terms of emissions (e.g., new high-efficiency coal power plants).

For resilience building: The Paris Agreement does not provide explicit objectives regarding adaptation and resilience, but a qualitative level of ambition for resilience and adaptation can nevertheless be attributed:

- *High*: The program or project is a component of a climate change adaptation, resilience, or risk-reduction plan or strategy (e.g., included in the NDC). It is *necessary* for increasing resilience and has an explicit objective in terms of resilience building or climate change adaptation that is included in a solid monitoring and evaluation (M&E) framework with dedicated quantified outcome indicators (e.g., reduced number of people living in the flood zone; or decreased

damages in case of a hurricane). The program or project is explicitly designed to be *robust* (i.e., able to cope with many different environmental and economic conditions, including long-term climate change and its large associated uncertainties).

- *Moderate*: The program or project contributes significantly to adapting to climate change by increasing resilience or reducing risks. It has an explicit objective in terms of resilience building or climate change adaptation, which is included in a solid M&E framework with dedicated quantified indicators (e.g., reduced number of people living in the flood zone; or decreased damages in case of hurricane). However, the program or project may not consider the long-term repercussions of its implementation, focusing more on short-term needs.
- *Low*: The design of the program or project has been altered to account for natural risks or climate change, contributes to societal preparedness for specific changes, or avoids the creation of specific additional risks.
- *None*: The program or project does not have an explicit objective in terms of resilience building or climate change adaptation, and its design has not been altered to account for future climate change impacts (or has been based on a single climate scenario, without considering the associated uncertainties).

Transformational potential dimension

Transformational: the framework prioritizes programs or projects that reduce in a meaningful manner the barriers to implementation faced by future climate-related programs/projects. In economic terms, such projects offer increasing returns to scale by reducing future costs. A program or project is *transformational* if it not only delivers climate benefits, but also makes it easier to implement future programs or projects that will reduce emissions or boost resilience.[10]

Mitigation projects are transformational when, once implemented, the identified barriers to implementation have been reduced for subsequent mitigation projects, thereby also reducing future needs for climate finance support. This is generally the case if the program or project fixes market failures (e.g., removes disincentives created by distortive tax systems that promote fossil fuels), builds institutional capacity (e.g., creates a functioning regulator for energy markets), or generates information or innovative spillovers (e.g., demonstrates the viability of a technology in a country, or reduces the cost of a given technology through learning-by-doing or economies of scale). For transformational projects, the cost of the project per (directly) abated ton of carbon can be much larger than the climate externality, making the social cost of carbon a poor metric to measure the desirability of a mitigation project.[11] In some cases, transformational projects can help reach a "tipping point" beyond which similar future mitigation projects will not require further support (i.e., a situation in which a low-carbon option becomes least-cost and can attract commercial finance).[12]

Similarly, resilience projects are transformational if they make it significantly easier and cheaper to adapt to climate change and reduce future climate and disaster risks, and if they reduce future needs

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[10] For World Bank experience with transformational projects, see IEG (Independent Evaluation Group). 2016. *Supporting Transformational Change for Poverty Reduction and Shared Prosperity: Lessons from World Bank Group Experience,* available at: http://ieg.worldbankgroup.org/sites/default/files/Data/Evaluation/files/WBGSupportTransformationalEngagements.pdf.

[11] Mitigation benefits linked to accelerated technological progress, economies of scale, or capital accumulation can be much larger than the direct impact of the project on emissions. Stern (2015) and Vogt-Schilb et al. (2018) discuss this point.

[12] Past support to photovoltaic (PV) solar energy has driven costs down and helped reach such a tipping point in many countries—where solar energy is now less expensive than fossil fuel options. Removing fossil fuel subsidies or improving access to borrowing also makes investors prefer higher energy efficiency options, and thus reduces emissions even in the absence of explicit climate policies. Furthermore, creating new markets can attract commercial finance, making public resources less important.

for climate finance support. As with mitigation, this happens when a program or project fixes market failures (e.g., removes incentives to build housing in flood plains), builds institutional capacity (e.g., creates a land-use plan that takes risks into account or improves building regulations), or generates information or innovative spillovers (e.g., develops a hazard map that can be used for all future investments).

Thus, which program or project to prioritize will depend on the extent to which the program or project will reduce future costs of (or barriers to) emission reductions or resilience building. For instance, a project document can explain through a causal process how the project changes the context such that (re)doing a similar project in the future would require less concessionality.

Like the previous criterion, this question does not have a simple answer: *the more the program or project is transformational, the more it should be prioritized*. Embedded in this criterion is the idea that concessionality should support programs and projects that are efficient (when indirect effects beyond the direct scope of the project are included in the analysis[13]) and have a material impact on emissions and vulnerability (conversely, cheap but inconsequential emissions and vulnerability reductions should not be prioritized).[14]

Possible operationalization of the transformational metric for mitigation and resilience building

The transformational potential of the program or project can be evaluated, ex ante, based on its impacts on barriers to implementation that future programs or projects will face (e.g., the effects on future prices of a key technology, or on implementation capacity in a country). A qualitative metric can again be proposed using four levels:

- *High:* The program or project expects to durably improve government processes, economic incentives, or price signals; significantly improve access to finance for long-term, low-carbon, or resilience projects; or reduce the cost of technologies (e.g., carbon pricing and fossil fuel subsidy reforms, large-scale feed-in tariff for renewable power in a large country, major change in land-use planning or building regulations, demonstration project with new technologies for resilience or emission reductions, changes in bank regulations to facilitate the financing of low-carbon or resilience projects, a policy to make social protection more reactive to climate shocks, etc.). If this program or project is implemented, future mitigation or resilience-building projects or programs will become viable with a degree of concessionality that is lower than today, and this difference is articulated in the project document.
- *Moderate:* The program or project expects to provide important foundations for future investments, programs, or projects that reduce emissions (e.g., investment in power transmission and smart grids) or increase resilience (e.g., creation of a household registry to provide post-disaster support to populations); build technical and institutional capacity that will facilitate future action (e.g., support to planning and implementation of NDCs, create capacity for risk assessment or climate change modeling, implement a law to make land-value capture available as a way of financing low-carbon or resilience projects); or improve the incentive structure (changes in tax structure, reduction in fossil fuel subsidies, valuing water to facilitate more efficient use and delivery, reform of insurance markets, etc.). If this program or project is

[13] The OECD assesses "efficiency" by measuring the qualitative and quantitative outputs in relation to the inputs (for details, see "DAC Criteria for Evaluating Development Assistance" at http://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm). In this context it is suggested that efficiency be defined to include the broadest possible impacts of programs or projects, including their spillover effects on future projects.

[14] This criterion will particularly support action in countries with emissions that are either large today or will become large in the absence of action, and thus is consistent with the idea of "following the carbon."

implemented, future mitigation or resilience-building projects or programs will become viable with a degree of concessionality that is lower than today, and this difference is articulated in the project document.

- *Low:* The program or project helps build momentum, without affecting the basic incentives or costs in the country (e.g., a large-scale renewable power plant in a country where a similar plant already exists or a large flood management project).
- *None:* The program or project may reduce emissions or increase resilience but does not trigger any structural change or improvement in incentives or barriers to implementation for future projects (e.g., a small renewable power plant or a small drainage project). Such projects are not prioritized for climate finance.

Prioritized programs or projects along the dimensions of *ambition* and *transformational potential* select the most impactful actions. These criteria are better suited than focusing on the cheapest mitigation opportunities based on the marginal cost (in dollars per ton of avoided carbon emissions, for instance), since doing the latter would favor marginal interventions that may not meaningfully influence long-term development pathways. In the case of resilience-building projects and programs, the prioritization dimensions are also better suited than, for instance, focusing only on the maximum avoidable losses, since doing so would favor highest-value interventions that tend to lie in the richest and less vulnerable areas.

This framework creates the right incentives for governments, DFIs, and the private sector. The allocation of a grant element that is not larger than what is necessary for the project to be implemented—as determined from the identification of the barriers to implementation—limits the risk that climate finance is used for relatively easy projects in high-capacity contexts, where low-emissions or more-resilient options are viable with little or no support.

Furthermore, requiring that a program or project not only face barriers to implementation, but also contribute to removing these barriers, prevents moral hazard[15] in the use of concessionality. The need to demonstrate that an engagement in question would be *transformational* implies that the government would have to realign unhelpful policies (e.g., a reform of fossil fuel subsidies), thereby reducing the likelihood of a situation where a country has an incentive to maintain existing barriers in anticipation of receiving support to overcome them. In addition, concessionality under the framework would only be provided to *complement* and crowd in domestic climate action and available domestic financial resources, not to *substitute* for them.

The framework translates into a few "rules of thumb," which serve as cross-check considerations to ensure it is operationalized in the manner intended:

- **Concessionality should support policy-enabling environments**. Changes in national policies tend to be the most transformational actions. National policies can create the kind of environment that allows concessionality to have larger, catalytic effects on mitigation and resilience building. Moreover, such policies may help mobilize additional domestic and international capital to address climate change. When market or government failures result from domestic regulatory and institutional barriers, perverse and conflicting incentives should be addressed as a matter of urgency. Climate finance should be used to encourage and support policy and regulatory changes that remove institutional and market barriers to transformational programs or projects.

[15] In this context, *moral hazard* refers to the risk that client countries may come to expect concessionality for any investment merely based on lack of capital access and market failure.

- **Concessionality should "maximize finance for development."** Commercial finance should be mobilized for climate projects whenever feasible and cost-effective. Where perceived or real risks deter commercial financing for low-carbon, climate-resilient projects, interventions should address policy, regulatory, and institutional reforms. If consumers have insufficient capacity to pay for externalities, the use of climate finance should be considered to reduce (perceived or actual) risks through credit enhancements and other risk-sharing instruments. If commercial finance remains elusive, directly applying a sufficient degree of concessionality to enable the investment in question should be considered. To avoid unwanted market distortions and maximize the impact of concessionality, the degree of concessionality should equal what is necessary to enable the intended investment and address any barrier to implementation that has been identified.
- **The effectiveness of concessionality is improved by sending strong, consistent, and coordinated signals.** Triggering systemic, low-carbon, and climate-resilient transformations, and providing predictable incentives for crowding in commercial finance both require long-term, programmatic engagements. In using concessionality, DFIs should be prepared to stay the course to support a change in trajectory up to the tipping point, where the targeted barriers to implementation are overcome and commercial finance can take over. DFIs should signal that concessionality is timebound, delimited by a clear exit strategy, and meant to encourage and support policy changes that promote the adoption of nascent technologies and solutions. Sending clear signals may require coordination within and among DFIs to enable market transformation through scale, and to exploit comparative advantages in addressing complex, system-level changes.

Box 0-1. Lessons from and Links with Efforts of the CIF, GEF, and Blended Finance Principles

How does this framework relate to past and current climate finance experience?

The Climate Investment Funds (CIF) prioritized transformational change in its investment criteria and guidelines when it was created in 2008. Past analyses have identified successes and lessons learned on the ways in which this focus has manifested itself in program and project design, and in implementation pathways that can empower wider systemic transformation.[a, b] Currently, the CIF Evaluation and Learning (E&L) Initiative is undertaking a comprehensive review of transformational change in the CIF context across its four programs (CTF, SREP, PPCR and FIP).[c] The CIF working definition of transformational change for the purposes of the evaluation is the following: "*Strategic changes in targeted markets and other systems with large-scale, sustainable impacts that accelerate or shift the trajectory toward low-carbon and climate-resilient development.*" The four key dimensions of Relevance, Systemic Change, Scale, and Sustainability underpin this definition. Together with additional concepts—including enabling conditions, barriers, and arenas of intervention—the key dimensions help to establish the CIF's approach to "Transformational Change." These CIF dimensions map tangibly to the prioritization criteria of ambitious and transformational potential presented in this framework, as shown in Table 0-1.

Table 0-1. Linking CIF Transformational Dimensions to This Framework

CIF "Transformational Change" dimensions	***Links with this framework***
Relevance: Affecting low-carbon and climate-resilient development, with sustainable development co-benefits.	This relates to the **Ambitious** criterion linking to the goals of the Paris agreement.
Systemic change: Fundamental shifts in system structures and functions.	Systemic changes address the same types of barriers in the **Transformational** criterion.
Scale: Contextually large-scale transformational processes and impacts.	Achieving scale is an outcome of the **Ambitious** and **Transformational** criteria.
Sustainability: Robustness and resilience of changes.	Sustainability relates to the **Transformational** criterion with regard to declining costs, increasing market viability, and alignment of political incentives.

As part of this E&L Initiative in the CIF, a Phase 1 Portfolio Analysis was conducted—based on a review of design and results documentation for roughly half of the CIF portfolio of country programs and projects—seeking to assess design considerations and early signals of transformational change results. Examples from the CIF work will be cross-analyzed from the perspective of the climate finance criteria to evaluate the viability and usefulness of applying the framework to World Bank programs and projects. The findings from this analysis will inform subsequent work on whether and how the framework might inform WBG decision making and policy.

The Global Environment Facility (GEF) guidelines focus on the "incremental cost principle" (GEF/C.3.12) to provide "new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve agreed global environmental benefits." Since the GEF published its guidelines (over 20 years ago), the practice of calculating a baseline or business-as-usual scenario to measure project impacts to identify incremental costs has proven limiting and challenging (a practice that the GEF has moved away from in recent years). Also, subsequent work has highlighted the challenges with applying this principle as it relates to behaviors, norms, and/or political economy obstacles. Accordingly, the framework presented in this report suggests a more expansive concept of "incremental cost," one that includes the need for additional financing of more expensive technologies (particularly related to externalities), but also incorporates other barriers such as policy framework, risk, institutional failures, and political incentives. This broad view favors interventions that target barriers to implementation other than cost-related ones, and that help tackle policy and capacity constraints.

The GEF also defines transformational change as "engagements that help achieve deep, systemic, and sustainable change with large-scale impact in an area of global environmental concern." This definition is aligned both with the CIF approach discussed above and with this framework's focus on barriers to implementation.

The DFI Working Group on Blended Finance for Private Sector Projects recently updated the principles for the use of concessionality in private sector operations, originally agreed by the DFIs in October 2013, to a set of "Enhanced Principles" in 2017. The framework presented in this paper is entirely consistent with and complements these Enhanced Principles, with a larger role given in this framework to the role of "ambition." The five enhanced principles are:

- *Principle 1. Additionality/Rationale for Using Blended Finance:* This principle is fully consistent with a grant element based on the identification and quantification of barriers to implementation, and the idea that climate finance should not support projects or programs that can be implemented without such support.
- *Principle 2. Crowding-in and Minimum Concessionality:* The objective of one of the two parallel questions addressed by this framework is to identify the smallest possible grant element that makes a given project viable, which is again fully consistent with this principle.
- *Principle 3. Commercial Sustainability*: It is important that the supported programs and projects be viable. This framework does not have an explicit view on immediate commercial viability; instead, it argues for supporting ambitious and transformational programs/projects that are inherently not commercially sustainable without strategic use of concessionality. This framework is thus complementary to Principle 2.
- *Principle 4. Reinforcing Markets:* This is one of the main points highlighted in the transformational criterion, as one of the market failures that can be corrected.
- *Principle 5. Promoting High Standards:* The framework presented in this paper does not address this issue explicitly, but this notion is related to ambition relative to the Paris Agreement, and the importance of international coordination in climate transitions, discussed further below.

One notable difference between the Enhanced Principles and the framework proposed in this report is that the objectives are different: while the former mainly aims to avoid poor investments backed by concessional resources, the latter attempts to identify the best programs and projects (since higher-concessionality finance is very scarce). Thus, both approaches are important, serve slightly different purposes, and are highly complementary.

The relatively recent WBG approach called "Maximizing Finance for Development" (MFD) goes even further in institutionalizing blended finance. MFD directs WBG teams to "help countries maximize their development resources by drawing on private financing and sustainable private sector solutions to provide value for money and meet the highest environmental, social, and fiscal responsibility standards, and reserve scarce public financing for those areas where private sector engagement is not optimal or available." The framework proposed here is fully aligned with the MFD approach.[d]

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a. A 2015 analysis identified five key pathways for empowering transformation—that is, institutions, policies, markets, technologies, and behavior change (CIF 2015. *Climate Investment Funds: Accomplishments, Transformational Impact, and Additionality in the Climate Finance Architecture*. Joint CTF-SCF/TFC.15/3).

b. ICF International. 2014. *Independent Evaluation of the Climate Investment Funds*.

c. CTF = Clean Technology Fund; SREP = Scaling up Renewable Energy Program; PPCR = Pilot Program for Climate Resilience; FIP = Forest Investment Program.

d. See World Bank Group. 2017. *Maximizing Finance for Development: Leveraging the Private Sector for Growth and Sustainable Development*. Development Committee.

List of Acronyms

CCS	Carbon capture and storage
CIF	Climate Investment Funds
CO_2	Carbon dioxide
CTF	Clean Technology Fund (of the CIF)
DFI	Development finance institution
FIP	Forest Investment Program (of the CIF)
FIT	Feed-in tariff
GEF	Global Environment Facility
GHG	Greenhouse gas
GPG	Global public good
IBRD	International Bank for Reconstruction and Development (of the World Bank Group)
IDA	International Development Association (of the World Bank Group)
IPCC	Intergovernmental Panel on Climate Change
M&E	Monitoring and evaluation
MFD	Maximizing finance for development
$MtCO_2$	Millions of (metric) tons of carbon dioxide
NDC	Nationally Determined Contribution
NPV	Net present value
ODA	Official development aid
PPCR	Pilot Program for Climate Resilience (of the CIF)
PV	Photovoltaic
RBCF	Results-Based Climate Finance
RBF	Results-Based Financing
RE	Renewable energy
SDG	Sustainable Development Goal
SREP	Scaling up Renewable Energy Program (of the CIF)
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change

All dollar amounts are U.S. dollars unless otherwise indicated.

1. THE CLIMATE CHALLENGE AND ROLE FOR CONCESSIONALITY

1.1 The Financing Challenge of Meeting the Paris Agreement

To achieve the global objective of climate stabilization, *deep decarbonization* of the global economy will be essential. The Paris Agreement aims to "achieve a balance between anthropogenic emissions by sources and removals by sinks[16] of greenhouse gases in the second half of the century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty." [17] Deep decarbonization, which describes measures and actions consistent with a development pathway marked by global warming well below 2°C above pre-industrial levels, requires economies to finance transformational changes. Delaying action will raise the future costs of mitigation (IPCC 2014).

It is necessary to invest in both mitigation and resilience building.[18] Global leaders have agreed to the Paris temperature target with the intention to avoid potentially irreversible and dangerous global climate shifts. However, since climate impacts are already being felt, and future impacts will almost certainly increase in severity and variability, the Paris Agreement also aims at "increasing the ability of countries to adapt to the adverse impacts of climate change and foster climate resilience."

To achieve deep decarbonization, it is essential to take an integrated approach to climate finance, climate markets, domestic carbon pricing, and other domestic policies (Fay et al. 2015). The *State and Trends of Carbon Pricing 2017* report shows how climate finance with a concessional component, as part of such an integrated approach, can help catalyze the development of climate markets. These will, in turn, play an increasing role in the mobilization of resources for low-carbon investments as they develop.

Reaching a Paris-consistent trajectory will require significant changes in the allocation of capital across the economy (much of it misallocated because climate externalities have historically not been considered). An annual level of incremental low-carbon investments on the order of $700 billion will be required by 2030. These incremental investments will have to be mobilized through a combination of policy reforms, climate markets, and climate finance. In addition, planned investments will have to be reallocated from high-carbon technologies to a range of low-carbon alternatives (World Bank, Ecofys, and Vivid Economics 2017). Additional resources for resilience building must accompany those for mitigation. The United Nations Environment Programme (UNEP) estimates that the cost of adapting to climate change in developing countries could range from $140 to $300 billion per year by 2030, and from $280 to $500 billion per year by 2050 (UNEP 2016, xii).

Private and public finance both play indispensable roles. While the private sector will have to cover the bulk of the cost of transitioning to a low-carbon, climate-resilient economy, *public* climate finance is still essential and indispensable.

In fact, international public climate finance with a degree of concessionality (in this paper synonymous with climate finance) is likely to play a pivotal role in the next few years in enabling developing countries to avoid carbon-intensive development trajectories and support climate-resilient pathways. However,

[16] *Sink,* oceans, forests, vegetation, or soils that can reabsorb CO_2, thereby removing it from the atmosphere.

[17] Paris Agreement (https://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf), p. 4.

[18] This paper is not informed implicitly or explicitly by a position on historical responsibilities for climate change, nor does it discuss responsibility regarding sources of climate finance. Instead, it focuses on maximizing the contribution of available and future public finance with a degree of concessionality to combating climate change and its impacts.

considering the size of the challenge—for mitigation as well as resilience building—total demand for concessionality in climate finance will likely far outstrip its supply (UNFCCC 2016).[19, 20]

1.2 Better and Faster Development through Climate Finance

It is widely recognized that no clear line exists between development finance and climate finance because the two are becoming increasingly interwoven. This paper defines "climate finance" as the international public finance that has the explicit objective of supporting mitigation and/or resilience-building activities and has a concessional component. Development finance has the explicit historical objective of promoting development, economic growth, and poverty reduction.

As the international community considers poverty eradication an urgent global priority, mitigation and resilience building should be deemed critical contributors to this objective. If it makes sense for the international community to support sustainable development and poverty reduction in developing countries, it also makes sense to help countries protect themselves against climate change—a threat to sustainable development and poverty reduction (Hallegatte et al. 2016). By helping people emerge from poverty and thereby better able to invest in their own futures, programs and projects aimed at poverty reduction enhance global stability and create conditions for broader economic prosperity. In this sense, supporting climate finance makes development aid more efficient, allowing donors to achieve more with less.

Climate action faces obstacles that are very similar to the obstacles to development and poverty reduction. Many market and government failures that impair development also explain why local policy makers fail to adequately invest in climate action. For instance, imperfect capital markets and asymmetry in information (on risks) can explain why developing countries do not select green technology even when they have a lower lifecycle cost.

Because climate policies cannot be separated from economic and development policies, climate finance cannot be separated from development finance. In fact, climate finance particularly aims to both *change* and *accelerate* development.

Climate finance aims to *change* development because climate policies and projects cannot be considered an "end-of-pipe" addition to development policies and projects. And achieving the objectives of the Paris Agreement require not so much increasing the volume of investments but rather redirecting investments from certain technologies and options toward greener, low-carbon, resilient ones. This redirection is better achieved if climate is mainstreamed into development plans and policies. Concessionality in climate finance, if used in conjunction with development policies and finance, can change development pathways by rewarding and complementing domestic policy action, and favoring policies and technologies that are consistent with climate objectives.

Equally important is the fact that climate finance also aims to *accelerate* development and can do so by contributing to closing financing gaps. Accelerating development is important because recent evidence suggests that development—as framed in the Sustainable Development Goals (SDGs)—is a powerful way of reducing future climate change impacts, especially those on poverty (Hallegatte et al. 2016). People living in extreme poverty are usually also extremely vulnerable to climate change and disaster risks. As

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[19] The report indicates annual concessional climate finance flows of $12.1 billion from developed to developing countries, including multilateral and bilateral sources (annual average over 2013–14).

[20] The required or even optimal volume of climate finance to achieve the objectives of the Paris Agreement will depend on national domestic policies, and estimating these needs is beyond the scope of this report.

the impacts of climate change will increase over time, there is a race between growing climate impacts and development that makes people more resilient to these impacts.

Therefore, climate policies that slow down development and poverty reduction would be counterproductive, even from a narrow climate perspective. The challenge in climate finance is thus to pursue strategies and actions today that will shift the economy toward climate-resilient pathways while at the same time helping improve livelihoods, social and economic wellbeing, and responsible environmental management. Concessional resources can be key to managing this trade-off and ensuring that better development is not slower development.

1.3 Concessionality in a Nutshell

1.3.1 Measuring concessionality

Finance with a concessional component is sometimes thought of as finance provided on more favorable terms than commercial finance available in a market.[21] For the purposes of this framework, climate finance can involve some degree of concessionality *without necessarily being "concessional,"* as it may be defined relative to the regular pricing of "non-concessional" windows of a Development Finance Institution (DFI). The favorable terms usually include a below-market interest rate, an extended grace period (in which only interest or service charges are due), and/or a longer repayment (maturity) period than is available on market terms. Financing subsidies can also appear in the form of risk-sharing instruments and results-based financing (RBF).[22]

The *degree of concessionality* of public finance is commonly measured by its *grant element*, defined as "the difference between the loan's nominal value (face value) and the sum of the expected discounted future debt service payments to be made by the borrower (present value), expressed as a percentage of the loan's face value." [23] This definition covers the grant elements of grants, loans, and results-based payments (if provided through public funds), as well as the grant elements of risk-sharing instruments. Whenever the interest rate charged on a loan is lower than the discount rate, the present value of the debt is smaller than its face value, with the difference reflecting the (positive) grant element of the loan.

The *volume and degree* of concessionality determine the overall subsidy delivered through a financial instrument. For a given subsidy need, the volume and degree of concessionality should be designed to structure incentives in a way that maximizes the probability of the program or project being successful.

1.3.2 Instruments for delivering concessionality

Different climate finance instruments introduce concessionality in different ways, and this affects how they are used. For instance, blending grants with commercial rate financing can ultimately yield the same

[21] The paper will use "concessionality in climate finance" or "(climate) finance with a concessional component" interchangeably.

[22] Concessionality is not inherent in RBF. However, in the case of climate finance, providing RBF on concessional terms helps enable policy reforms and investments. RBF is therefore typically provided on concessional terms for mitigation and resilience purposes (more details are given in Box 2-5).

[23] $Grant\ Element = \frac{Face\ value - NPV}{Face\ value} = \frac{Face\ value - \sum_{t=0}^{N}\frac{C_t}{(1+r)^t}}{Face\ value}$, where NPV = Net Present Value and $\sum_{t=0}^{N}\frac{C_t}{(1+r)^t}$ is the sum over time of cash flows in any period t (C_t), discounted at a rate r. In other words, the grant element is the percentage by which the discounted future debt-service payments to be made by the borrower (= the net present value of the expected stream of repayments) falls short of repayments that might have been generated at a given interest rate. Cash flow is also affected by other elements of the loan structure, among others, maturity and grace period (see http://ida.worldbank.org/financing/grant-element-calculations).

grant element as providing a below-market rate loan, but in the former case most of the financing comes from a commercial source.

In addition to below-market rate financing, the following instruments can be considered:

- *Instruments that share risk or lower the perceived/real risk of an investment.* These instruments lower the cost of commercial finance, and thereby shift the cost/benefit balance between public and commercial options. In these circumstances, governments can take on more risk—for instance, by adjusting the agreement, providing additional guarantees, or providing government grants or loans to reduce the extent to which the private party needs to raise finance—thus securing the bankability of the project. Another option is to assign some part of the project risk to a third party (through a credit enhancement, discussed below, or risk transfer instrument).
- *Blended finance instruments.* In developing countries, investors are not always ready to undertake low-carbon and climate-resilient investments because of their lack of market knowledge or capacity, among others. Blended finance instruments are designed to support first-of-its-kind projects that are likely to create a demonstration effect in high-priority problems such as climate change. However, financing is also needed for investments that are not "just at the threshold of commercial viability." The latter represents a continuous spectrum, and blending various instruments allows for smoothly varying the concessionality according to the distance (of the new technology in question) from that threshold. Lastly, the use of blended finance instruments may persuade commercial banks and private investors to finance climate projects and help develop markets.
- *Credit-enhancement instruments.* These include guarantees, insurance policies, and hedging mechanisms under which, for a fee, the provider agrees to compensate the concessionaire (or its lenders) in case of default and/or loss due to some specified circumstance. Risk mitigation or credit-enhancement instruments provide three types of coverage: (i) *full coverage*, that is, they cover the whole of a project's senior debt against all risks; (ii) *partial coverage*, that is, they cover only a certain proportion of a project's debt for all risks; and (ii) *special partial coverage*, which provides full or partial coverage of losses associated with specific risks.

Any instrument with a concessional component has an opportunity cost—requiring that priorities be chosen strategically and concessionality be accorded parsimoniously. Projects that can attract *commercial* finance (while remaining affordable to users and consistent with social objectives) should not receive public resources. This approach releases public resources (particularly those with higher degrees of concessionality) to be redeployed to needs that cannot be met by commercial finance. If perceived and/or real risks remain high and raise the cost of commercial capital beyond what is covered by project or corporate revenue generation, the potential for lowering the financing cost by deploying concessional and public resources through risk-sharing instruments should be explored.

1.4 The Need for Concessionality in Climate Finance

In deciding on finance terms for support to clients, the World Bank has tended to consider capital access based on two national-level proxies: credit and income. Finance with a concessional component has historically aimed to provide basic services for underserved groups. In principle, the more limited a country's access to capital, the more eligible a country is for concessionality, thereby ensuring its ability to invest adequately in projects that serve its national interests. Thus, concessionality generally targets countries, markets, and sectors where the spending level that is feasible is lower than optimal due to domestic budget constraints.

This paper suggests that the use of concessionality in supporting climate action look beyond the question of capital access to consider non-capital barriers as well, including interests, capacity constraints, real or perceived risks, and transaction costs. Domestic climate action tends to be underprovided, because climate change action is a public good with both international and intergenerational implications, and because climate action involves transition costs and knowledge externalities. This framework thus adds consideration of climate-related externalities to the decision calculus regarding the terms for offering concessionality in climate finance.

1.4.1 Mitigation

Mitigation projects are central to achieving deep decarbonization—at the sectoral and national level—yet the benefits of investing in mitigation are generally thought to be global and non-excludable. Fortunately, as the emission of GHGs is often associated with activities that also have *local* environmental and health impacts (Rogelj et al. 2014), governments have at least some incentive to invest in mitigation. In fact, mitigation options in developing countries often have co-benefits that would by themselves be expected to justify their implementation (Fay et al. 2015; World Bank 2012). These co-benefits arise from multiple factors, among others, *pure efficiency gains* and *reduced negative health impacts from air pollution.* Two examples of the former are giving poor people access to gridded electricity, allowing them to switch from more expensive energy sources (such as generators or batteries), and reducing urban congestion, which decreases emissions and makes these economic hubs more competitive and productive.

The following factors justify the use of concessionality for mitigation:

- **Misaligned national and global incentives to reduce GHG emissions.** This explains the lack of incentives for governments to invest adequately in mitigation; more specifically, the fact that national and global incentives to invest in mitigation do not necessarily overlap accounts for much of the underinvestment. As decarbonization is considered a GPG, concessionality should support mitigation projects.
- **Developing countries lack the resources to implement the mitigation projects required to achieve deep decarbonization.** Even though many climate policies bring significant domestic co-benefits, they often do incur significant short-term costs—among others, those associated with the critical investments required for deep decarbonization and the social costs linked to any economic transition (e.g., retraining of workers in declining industries).
- **In countries with limited access to capital markets, finance with a concessional component helps leverage private sector finance.** Given developing countries' lack of public funds and access to capital, crowding in private sector finance helps reduce the funding gap that hampers mitigation efforts.
- ***Temporary* interventions financed on concessional terms ease policy transitions and create new markets for low-carbon technologies**, which are at the heart of deep decarbonization. Without concessional support, nascent technologies will not break through fast enough or not at all, and certainly not on the scale needed to avoid a higher than 2°C global temperature rise.

1.4.2 Resilience building

The benefits of investing in resilience are often *localized and private,* but still involve *significant externalities.* The free rider problem often associated with mitigation is attenuated in most resilience-building activities because actors usually receive most of the associated benefits or, at least, sufficient benefits to warrant the investment (Keohane 2015). However, resilience building can also involve large externalities, because the impacts on one firm or infrastructure system can propagate in the economic

system through supply chains (Hallegatte and Rentschler 2015). Since increased resilience of one firm or infrastructure system contributes to raising the resilience of other firms and systems, individual firms and infrastructure operators tend to underinvest in resilience. Further, if the level of investments in resilience is inadequate from a global perspective, a global negative externality could result to the extent that it leads to conflicts, institutional failures, and large-scale displacement and migrations that spill across borders.

The following factors justify the use of concessionality for resilience building:

- The **lack of capital access and large transaction costs** that certain countries face in the implementation of resilience-building policies that deliver net local economic benefits.
- The fact that **donor countries may want the projects they finance to have some characteristics that differ from what recipient countries would do with domestic resources.** Traditionally, donor countries have been willing to focus their resources on specific issues or risks or have tried to ensure that the projects they support meet certain characteristics (e.g., regarding the beneficiary's profile). Similarly, there is some subjectivity in the level of risk that a population should or will accept, or the level of resilience that an investment should have. Different countries may have different views on these issues. For instance, a donor financing transport infrastructure may require higher resilience of the infrastructure than what the recipient government would otherwise see as immediately technically, economically, and politically necessary if funded with only domestic resources.[24]
- The **learning generated by resilience-building efforts.** When a resilience initiative involves new approaches, tools, or solutions, it entails a *risk* for the implementing country, and *benefits* for all others—a key characteristic of GPGs. Building resilience poses a huge challenge, due to the lack of (historical) data, uncertainties regarding future climate conditions, and the need for new strategies and technologies; it thus requires capacity and financial resources.
- Moreover, **international *transfer* of knowledge about factors accounting for success/failure in climate action could reduce the cost of resilience building globally**. However, it also creates perverse incentives, as being able to learn from the mistakes of others creates an incentive to delay action and stick to proven solutions rather than experiment with potentially more attractive, new approaches. Moreover, knowledge transfer does not happen automatically and is facilitated by financial support.
- **Negative global spillovers from low resilience.** Climate change impacts are unlikely to remain within country borders—quite the opposite, they often spill over internationally. Examples include health-related impacts, with the possible spread of communicable diseases on a global scale, and food security impacts caused by lower agricultural yields (resulting from extreme drought) in one region leading to higher food prices worldwide. Other, more uncertain but potentially very large sources of spillovers are:
  - *Migration:* If some places become unable to provide food security and jobs to the population, significant internal displacement and migrations could result, with large potential effects in terms of regional or global stability;
  - *Conflict:* Some evidence suggests that climate change may increase local and subnational conflicts, again with impacts that could extend throughout a region and globally;
  - *Costs* in the wake of a humanitarian crisis.

[24] When there is a big difference in the preferred specifications, donor countries may decide to use concessional resources only to fund the additional costs associated with the higher level of resilience they seek from recipients.

1.5 Appropriate Roles for Development Finance Institutions in Climate Finance

The necessary resources for creating a sustained transition toward a Paris-compatible climate pathway will eventually have to be raised primarily through domestic policies. Notwithstanding national responsibilities, DFIs have a critical *enabling* role to play. Climate finance cannot directly take over the role of carbon pricing in internalizing negative global externalities or replace appropriate incentives regarding risk management and mainstreaming adaptation considerations. However, climate finance used prudently by DFIs can help create the conditions for policy to become more palatable (for instance, by bringing down the cost of technologies or data collection and processing), or by preventing the lock-in of climate-incompatible development pathways while the policy ecosystem is emerging.

DFIs have special responsibilities in addressing a challenge like climate change that is global and regional, as well as intergenerational in nature. Countries vary in their ability to plan for the long term; countries facing the most immediate and pressing development needs may require more assistance to be able to take on the required long-term investments. Without concessional resources, mitigation projects in these countries would suffer generally, but those with higher marginal upfront costs even more so. This is true even when countries have strong domestic incentives to implement those projects. By providing countries in these situations with concessional resources to overcome transition-related obstacles, DFIs can reduce the overall cost of the transition toward resilient and low-carbon development pathways.

Maximizing the impact of DFI finance on climate change requires that the DFI play its role in concert with policy makers, the private sector, and peer institutions, as discussed in the remainder of this chapter.

1.5.1 Maximizing finance for development through policy changes

The WBG has recently adopted a "maximizing finance for development" (MFD) approach, which the framework in this paper reflects through the lens of climate change action. The MFD approach asks the institution to "help countries maximize their development resources by drawing on private financing and sustainable private sector solutions to provide value for money and meet the highest environmental, social, and fiscal responsibility standards, and reserve scarce public financing for those areas where private sector engagement is not optimal or available." The MFD approach aims to help identify where *commercial* financing can provide the largest transformational development impact for a given public expenditure—weighing up the benefits and costs of different financing options, on a case-by-case basis.

The objective of MFD is to encourage private sector participation, while leveraging and reserving scarce public dollars for critical public investments. It does so by seeking to first mobilize commercial finance, made possible by policy reforms where necessary—to address market failures and other constraints to private sector investment at the country and sector level. Where risks remain high, priority is given to applying guarantees (using the WBG's own capital) and risk-sharing instruments. Official development aid (ODA) and public resources are in principle only applied where market solutions based on sector reform and risk mitigation are not possible or excessively costly.

The main objective of pursuing *private* financing first is to create more fiscal space for further *transformational* investments, that is, identifying where priority investments could (and should) "pay for themselves" and allowing them to do so. If financing on *commercial* terms is available for a given climate investment, the project in question does not qualify for concessionality in climate finance or other public forms of financing. Public resources mobilized domestically (taxes) and DFI borrowing should only fund high-return investments that would otherwise fall outside the envelope of available resources or face other obstacles to implementation.

Seeking private capital to finance climate investments does not necessarily imply private ownership and operation of the assets resulting from those investments. The commercial entity raising finance could be a state-owned enterprise that is commercially run (and, hence, able to borrow without a government credit guarantee) or a private company operating under a range of contractual arrangements.

Enabling countries to reap these co-benefits may require technical assistance. For example, experience has shown that countries need substantial technical assistance in the development and implementation of carbon pricing policies, which is a new area of policy making for most countries, or to ensure that natural and climate risks are included in their land-use plans and policies.

1.5.2 Promoting innovation and new technologies

DFIs have a special role to play in the development of frontier technologies. As technologies move out of research and development into pre-commercial deployment phases, private actors and many developing countries lack the resources or incentives to invest in their development in the near term. Instead, countries may wait until low-carbon and climate-resilient technologies have become cheaper, creating a free riding challenge, even though the scale of market opportunity or domestic context would be well suited for demonstration of a promising technology. (And there are risks inherent in being the first actor to implement a technology in a country, even if this technology has been demonstrated elsewhere; these risks may delay the implementation of mature technologies in developing countries.)

To overcome the free rider problem, DFIs can support essential low-carbon and climate-resilient technologies in key markets where the context is appropriate, and the benefits may be enjoyed both domestically and globally.

In a context of deep uncertainty and strong pressure, development banks can help governments handle the challenge of making choices related to technologies and approaches. An important challenge related to *"picking winners,"* in the sense of selecting technologies or technical options to be supported/promoted, is that governments are under pressure from industry groups and constituencies that seek to influence policy outcomes in a way that may be neither economically efficient nor support the policy objective of a managed low-carbon, climate-resilient transition. DFIs can provide analytics and finance to identify projects most conducive to the policy objective, enabling governments to make better-informed choices. DFIs can also help governments with the financing of start-up costs and knowledge transfer associated with building institutions to facilitate low-carbon and climate-resilient pathways.

Central to the problem of technology deployment is the *risk of failure*, which is amplified by the large contingent losses that characterize the demonstration project stage of innovation chains. In the case of low-carbon technologies, these contingent losses tend to be particularly high because of the importance of front-loaded sunk costs stemming from the capital-intensity of many low-carbon technologies. This risk of failure essentially explains why the private sector cannot undertake these projects alone. The problem is aggravated in developing countries by the limited financial capacity of the public sector to bear significant losses. This problem of risk is even more acute when the benefits are long-term and involve international spillovers, as is commonly the case with climate investments. DFIs can offer finance instruments to hedge these risks and soften the impact of failure, given their stronger credit ratings, political distance, and stability.

1.5.3 Tackling the most difficult issues

While it makes sense to capture the cheapest opportunities to reduce emissions[25]—the "low-hanging fruits"—achieving the mitigation objectives of the Paris Agreement will also require early investments in

[25] This idea lies at the basis of the "marginal abatement cost curves" (MACCs) approach (McKinsey and Company 2009).

relatively expensive emission-reduction options. Moreover, there are two major reasons why starting with the cheapest measures is suboptimal:

- **First, through learning and technical change, investing in expensive technologies would lower their cost over the long term** (Wigley, Richels, and Edmonds 1996; Goulder and Mathai 2000; Bramoullé and Olson 2005; Kverndokk and Rosendahl 2007; del Río González 2008; Acemoglu et al. 2012; Creti et al. 2017). Indeed, it may well make sense to invest in offshore windmills, even if they are more expensive than onshore windmills or solar panels, in the hope that these investments will reduce the cost of offshore wind, making it a competitive renewable energy option in the future.
- **Second, in most sectors, an abrupt transformation would be more expensive than a smooth shift toward zero net emissions, making it preferable to invest early and smooth the transition** (Vogt-Schilb, Meunier, and Hallegatte 2018). In sectors that are particularly expensive and difficult to decarbonize, such as transportation, it is indeed preferable to start early to make the transformation as progressive as possible, minimizing the long-term costs. Even if technologies used in urban transportation are not expected to improve rapidly over time, policy makers may want to start early, given that transforming transportation systems gradually is cheaper than doing so quickly later.

These ideas will result in a recommendation *not to delay action* in the sectors that are the most expensive and difficult to decarbonize, especially as far as long-lived infrastructure systems are concerned. For example, it will not be possible to transform cities in just a couple of decades—at least not at an acceptable cost. Thus, actions on urban planning and urban transport systems are especially urgent.

Since investing in more expensive options and measures is more challenging for governments—in part because these options are less likely to attract private finance—support from DFIs in these sectors will be particularly important. It means that the need for support with concessional resources may be vital in the sectors that are more expensive and difficult to decarbonize but require immediate action, such as urban planning and development, public transit, and other transportation infrastructure.

1.5.4 Economies of scale and tipping points

Low-carbon, climate-resilient transitions require strong and predictable market signals, and for investments and technologies to reach specific tipping points. Investments by *public* investors can provide a signal to *private* market participants that a specific type of project is now or will soon be viable. The initial public investment can then crowd in additional private investment in stand-alone but similar projects. By triggering such co-financing of the overall transition, the public investment functions like a multiplier. It is important to coordinate the interventions of public lenders to achieve the so-called minimum efficient scale[26] (Box 1-1, page 11) or sufficient scale to send strong market signals.

A frugal public lender would seek to trigger tipping points in low-carbon market creation by collaborating with other financial institutions and complementing domestic policies, to reduce uncertainties around the market from the perspective of potential private investors.

Private investment can be triggered by *changed market expectations,* which DFIs can alter through careful use of concessionality at the project level and across a portfolio. To maximize this type of leverage, public lenders have a keen interest to let their projects send the strongest possible market signal. Maximizing leverage therefore also requires that public lenders communicate the big picture beyond the individual projects, conveying the overall storyline that the low-carbon, climate-resilient transition is under way.

[26] *Minimum efficient scale,* the smallest amount of production a company can achieve while still taking full advantage of economies of scale regarding supplies and costs (= the lowest production point at which long-run total average costs are minimized).

Communicating this wider storyline requires not only connecting the dots across an individual institution's own investment portfolio, but also connecting them to the efforts of other lenders. In most countries, more than one public lender actively supports these transitions. Each institution may support only a set of projects that, in isolation, may fail to persuade private investors that the time has come to enter the market. On the other hand, if the public lenders manage to send out a *coordinated* signal to the market, the collective effort to persuade private investors to invest in nascent technologies is much more likely to succeed.

National banks and DFIs should strive to coordinate their investment efforts so that their respective investments are, at least loosely, part of an *overall* programmatic approach that can be communicated as a cogent storyline. *Such coordination should be facilitated by alignment with well-defined national targets expressed in NDCs and corresponding policy frameworks that can become a defining reference point for DFIs and donors.* Signaling by DFIs and partners around their uses of concessionality toward a market's creation can make further use of public resources more effective.[27]

DFIs also have the capability to sustain investments long enough to reach tipping points. The deployment and demonstration stage is just one barrier in a longer series; it is followed by the challenge of creating a new, nascent market. It does not make sense to help a technology overcome an initial barrier only to let it subsequently fail as a niche market. For DFIs, this means that successful transitions to low-carbon, climate-resilient solutions require extended engagement; that is, the willingness to commit capital with a degree of concessionality for a long time. A lender who seeks to crowd in private lenders into technologies that are not yet viable—based on the creation of the *expectation* that the technology will become viable thanks to the lender's involvement—needs to convincingly signal *long*-term engagement. Likewise, a lender who seeks to persuade other DFIs into co-financing the same investment (to jointly reach the minimum efficient scale, as illustrated in Box 1-1) needs to itself commit to convince others to join.

[27] The value of market signaling to improve the efficiency in communication and coordination is observable in central banking A central bank can set interest rates through open market operations. Central banks almost always support these monetary policy operations with communications; central bankers use speeches to announce their targets and send out the strongest possible signal to communicate their commitment to reaching them. Once the market perceives this signal, market interest rates change immediately. Thus, the effective use of communications saves central banks public resources in achieving their interest rate objectives. Development banks could do the same to reach their objectives and save public money in the process.

BOX 1-1. THE ROLE OF DFIS IN ACHIEVING MINIMUM EFFICIENT SCALE

Consider a hypothetical cost function for supplying electricity with two different technologies, coal and wind power. The cost functions include both the private cost of production and the social costs. As a result, wind-generated electricity has a lower cost function than coal-fueled electricity in this example. However, coal power is the incumbent industry, with generating assets and empowered industry groups, and with Q_1 being supplied. The country does not yet have any wind capacity installed, so the output is Q_0. As both technologies are characterized by increasing returns to scale, their cost curves are sloped downward. However, there are barriers to the entry of the climate-preferred technology—it may not be able to enter the market, despite its *theoretical* cost advantage, merely because the size of the cost difference is eclipsed by the advantage of the increasing returns to scale enjoyed by the incumbent technology.

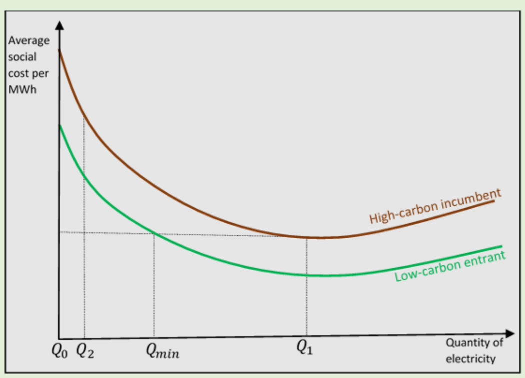
For wind power to achieve economies of scale where it could compete effectively, it would need to produce at Q_{min} (the point where average social costs per MWh of wind at volume Q_{min} equals coal energy volume Q_1). From that point on, small, iterative investments would also be competitive. However, reaching this "tipping point" is the challenge. Consider two outcomes:

- A single investor (or a coordinated group of investors) could make a "big push" investment to reach this point, after which smaller investors could be crowded in. The pioneering investor would incur losses in the process of creating the market for wind power in this abstract country. A transformational change will have also occurred: *If wind power energy reaches output Q_{min}, it will expand until displacing the incumbent coal energy at point Q_1.*
- Suppose the largest volume of wind electricity in which private investors are willing to invest is Q_2. In this case, wind energy fails to achieve sufficient economies of scale to become competitive and, as it continues generating losses for investors, the early investors will retreat.

In between these two extremes, a DFI can complement the private investors' funds and help shoulder the initial burden of technology deployment. *How should the public investor choose its intervention to have the necessary impact and use public resources as sparingly as possible?* To achieve the more efficient social outcome, the sum of public and private investment should not be less than Q_{min}. If the shortfall between $\mathrm{Q_{min}}$ and $\mathrm{Q_2}$ is not covered, continuous public support would be required to keep low-carbon energy producers in the market (causing "aid dependency").

For a low-carbon transition to happen, the efficient choice here is hence to either enter the market at sufficient size or to not enter at all. When going in, public resources need to be deployed at sufficient scale, so that, together with the private sector investment, the *entire financing gap* $(\mathrm{Q_2} - \mathrm{Q_{min}})$ is covered. Thus, achieving the minimum efficient scale and overcoming a barrier to implementation often requires an adequate volume and degree of concessionality (Figure 1-1).

FIGURE 1-1. DFI SUPPORT AND MINIMUM EFFICIENT SCALE



Note: MWh = Megawatt hour; Q_{min} = minimum efficient scale of low carbon-intensity power generation. $\mathrm{Q_0}$ = volume of green electricity in initial equilibrium condition; Q_1 = volume of electricity in initial equilibrium condition without concessionality; Q_2 = maximum volume of wind that electricity private parties are willing to invest in without concessionality, such that (Q_1-Q_2) is coal-generated power. Consequently, $Q_2 - Q_{min}$ represents the financing gap. The cost functions include both the private cost of production and the social costs. The green curve represents the total costs of the wind-generated electricity producer (low-carbon entrant), while the brown curve represents the total costs of the coal-fueled electricity producer (high-carbon incumbent).

2. Framework for Maximizing the Impact of Concessionality for Climate Action

Both donors and recipients seek to maximize the impact of scarce concessionality**.** Despite the intentions, merits, and justifications for using concessionality for climate action described in the previous chapter, it is a resource in short supply. Furthermore, the above discussion has indicated that barriers to implementation have led to underinvestment in both mitigation and resilience-building, while development pathways need to be transformed to make them consistent with the Paris Agreement.

To this end, this chapter presents a basic framework that seeks to maximize the impact of climate finance consistent with the principles of "maximizing finance for development." On the one hand, the framework examines how to prioritize among climate-focused programs and projects for either mitigation or resilience building, irrespective of the concessional nature of the finance needed to make those investments feasible. On the other hand, the framework helps to determine the appropriate level of concessionality (if any) that is warranted for a given project. The framework can be applied separately to investment options for mitigation and resilience-building, but not across the two types of activities.

2.1 Parallel Analyses: Priority and Degree

The framework seeks to serve as a heuristic tool for making judgments about these complex questions. Two parallel levels of analysis are considered in the framework related to access to climate finance:

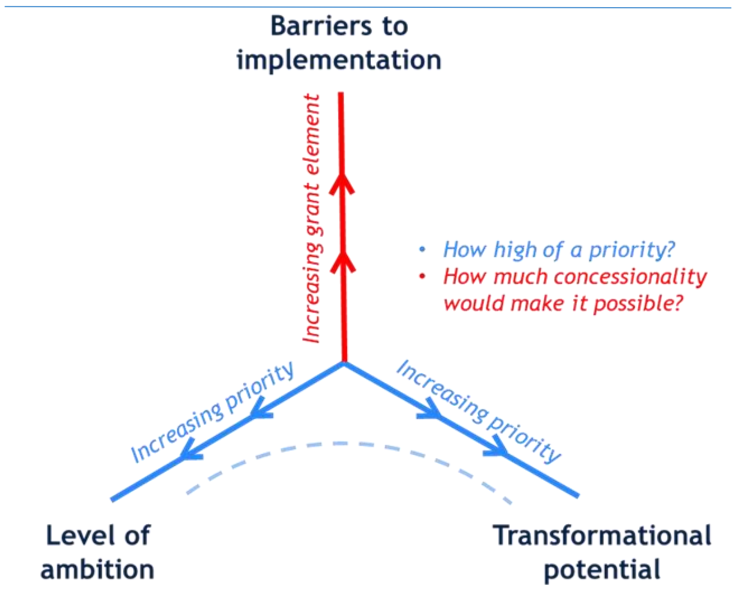
- **Priority:** How to determine the priority of a program or project, in the context of scarce concessional resources?
- **Degree:** How to quantify the degree of concessionality, or grant element (if any), that a program or project should receive?

These questions are linked, but their answers are largely independent: a program or project may be considered high-priority, regardless of whether it deserves a high degree of concessionality or none at all (in the latter instance, the project may be advanced with commercial capital, financial restructuring, or via upstream policy engagement). A high-priority program or project that has relatively small barriers may be supported, but not with a large grant element (if any at all). Conversely, a project requiring a large grant element would only be taken forward if it were considered high-priority. In other terms, a program or project should not be pursued with climate finance if it is low-priority, regardless of the magnitude of the barriers to implementation and the appropriate degree of concessionality. Figure 2-1 illustrates the basic elements of the framework, which are further elaborated below.

The answer to the priority and degree questions will be based on the program's or project's characteristics, and especially on the carefully assessed barriers to implementation it faces. As such, an essential piece of information that any climate project looking for concessional resources should provide is the identification (and, if possible, quantification) of the barriers to implementation, and of the mechanisms through which concessional resources would help overcome these barriers. Access to concessional resources cannot be justified for a project that faces no specific barrier to implementation (or barriers that can be overcome without cheaper financing).

Barriers to implementation include externalities, market or government failures, and lack of resources or capacity. While market and government failures[28] are often closely related, this is not always the case. Yet for practical reasons, *this paper uses market failures to imply a range of challenges, from externalities to government failures.* Market failures seriously hinder the low-carbon, climate-resilient transformation, and are highlighted in Box 2-1 (page 16) and Box 2-2 (page 17) for mitigation and resilience building, respectively.

FIGURE 2-1. THE THREE DIMENSIONS TO CONSIDER



Note: The three dimensions shown—barriers to implementation, level of ambition, and transformational potential—answer two parallel questions (grant element and priority). The **grant element** (or degree of concessionality) needed for a supported program/project *increases with the magnitude of the barriers to implementation*. The **priority** of a program/project *increases as the level of ambition and the transformational potential increase*. The level of priority is approximately the same along any dotted contour (or "indifference curve"), implying that ambition and transformation are partial substitutes. The implication is that (i) if either ambition or transformation is zero, the program or project would not be prioritized; and (ii) priority increases most substantially when *both* ambition and transformation increase.

2.2 Degree of Concessionality Required to Overcome Barriers

Despite the localized benefits from mitigation and adaptation discussed in chapter 1, many countries struggle to undertake these kinds of actions because of *lack of capital and/or obstacles linked to weak institutions or complicated political economy issues.* The objective of concessional resources is to overcome these obstacles so that the climate objectives—like those of the Paris Agreement and the NDCs—can be achieved.

[28] *Government failure,* an imperfection in government performance (as opposed to a market failure). It occurs when a government performs inadequately (e.g., when government intervention causes a more inefficient allocation of goods and resources than would occur without that intervention), including when it fails to intervene or does not intervene sufficiently.

A particularly important barrier is the carbon lock-in, which refers to the self-perpetuating inertia created by large, fossil fuel-based energy systems that inhibits public and private efforts to introduce alternative energy technologies. This inertia is caused by persistent market and policy failures that can hamper the diffusion of carbon-saving technologies, despite their apparent environmental and economic advantages. In fact, the more resources are invested in long-lived, high-carbon assets, the stronger the institutions supporting those assets will become and the greater the resistance to a low-carbon transition will be.

To overcome the carbon lock-in problem, mitigation policies such as carbon pricing are necessary but often insufficient—they must be complemented by policies that address the interacting market failures in low-carbon technology deployment (for instance, Daron et al. 2016; Aghion et al. 2014). These complementary measures include regulatory policies and public investments that require varying degrees of concessionality to be *financially viable*. And for these investments to be *effective*, they must be made at the minimum efficient scale required to compete with the incumbent technology or practice.

For the transition to low-carbon development to happen efficiently, states and DFIs, therefore, must act simultaneously on several fronts. Moreover, maximizing the contribution of concessionality in climate finance to climate action will require coordination among development institutions, to maximize synergies in the use of concessionality toward the same policy objectives. Even net-benefit options that will be beneficial for everybody in the long run can be unattractive to individual investors in the short term. The benefits of renewable power and energy-efficient cars will eventually pay for the cost of developing and deploying the technology, but no investor will make the first move without support.

To maximize the impact of climate finance, the degree of concessionality allocated to a program or project should be equal to what is needed to overcome the identified *barriers to implementation* and make the program or project viable.

Climate finance should not support programs or projects that could be implemented without it. (Some would refer to this criterion as "additionality"; again, this term is voluntarily avoided here as it has a long history and specific interpretation in climate negotiation and finance.)

It is useful to note that climate finance, as applied here, would not include results-based grants that reward projects or programs based on the value of the GPG benefits it generates (thereby internalizing the global externality). Rather, in this framework, the grant element provided by climate finance to a mitigation project does not depend on the volume of tons of carbon emissions avoided by the project, but on the resources required to make the project viable. The scale of the project and its impact on emissions are considered in the prioritization question only, not in the determination of the degree of concessionality.

Programs or projects where clients have an incentive to act (because of the direct benefits to be derived) may still face political, financial, and practical barriers to their implementation; insofar as the engagements are priorities for DFI involvement, they could receive concessionality commensurate with those barriers. An innovative project—for instance, the first geothermal power plant in a country—can be economically and financially viable on paper yet is unlikely to be financed by private investors alone because of the high perceived risk associated with first-of-its-kind projects in a country. And a zero-carbon transport infrastructure may generate more benefits than costs for a country but remain out of reach because the country is highly constrained in its ability to borrow and access global capital markets.

The need to identify a barrier to implementation does *not* exclude an activity that is in a country's own interest (or is least-cost). Rather, it means that political, financial, or practical obstacles to its implementation must exist, are identified by the program or project document, and can be lifted or

attenuated using concessionality support. For instance, countries with high poverty, low capacity, or limited access to capital markets will use concessionality to relax their financial constraints and implement projects that are in their own interest but could nevertheless not be implemented without this support.

A typical case would be where the cost of a project to enhance resilience or reduce emissions is higher than a lower-resilience or higher-emission project and is therefore difficult to finance. A concessional element can help make a bridge more resilient or replace a fossil fuel power plant with renewable generation. But non-economic barriers and other market failures can be as important: a more resilient option to build a dike or create a social protection scheme can be extremely difficult to implement because of lack of knowledge and data, or because it creates political economy issues that require compensation programs for those negatively affected.

In assessing programs and projects, teams need to *identify, characterize, and if possible quantify significant barriers to the implementation that the concessional element will help tackl*e; highest-concessionality funds would be reserved for prioritized engagements with the highest barriers. A condition for support would thus be that the barriers to implementation are clearly identified by the program or project, and that the concessionality is sufficiently high to overcome the barriers, but not higher.[29]

Determining the appropriate degree of concessionality can be challenging, and further methodological development in various sectors will be required to do just that. While it is relatively straightforward to estimate the grant element necessary to make a higher-cost, cleaner technology competitive with a more polluting one, it can be difficult to assess how much is needed to overcome obstacles linked to lack of capacity or political economy obstacles. Chapter 3 introduces a qualitative scale to illustrate how an institution might assess the scale of the barriers to implementation, which can be used to inform decisions on the degree of concessionality.

[29] Of course, higher marginal costs alone can still be a reason *not* to support a given project. The point is that this aspect needs to be weighed against the significance of the investment in question for the overall transition to a low-carbon, climate-resilient economy; despite its higher marginal costs, the investment could still be justified if deemed sufficiently transformational.

Box 2-1. Types of Market Failures Relevant to Mitigation

Negative externalities

Failure to mitigate GHG emissions at the national level creates a global negative externality because of the damage that emissions inflict on others. Unregulated markets in goods or services with significant externalities generate prices that do not reflect their full social cost or benefit, thus accounting for much of the inefficiency in resource allocation and technology choices. Quite aptly, therefore, GHG emissions have been called the world's worst market failure.

The *costs* of mitigation—defined as "activities and policies to reduce or avoid GHG emissions"—tend to be concentrated (borne by some well-defined group) and short-term, while its *benefits* are diffuse (spilling across national borders) and in the future (intergenerational). Investments in mitigation thus provide a GPG because the costs borne by some generate benefits shared by all. This leads to the *free rider* problem—actors lack private (or nationally excludable) incentives to invest in mitigation, resulting in underinvestment in *global* levels of mitigation, relative to what is socially optimal.

Furthermore, global climate externalities have negative effects on equity because climate shocks undermine poverty alleviation efforts, in the short and long term. In the generation of GHGs, as long as the social costs of fossil fuels are not internalized through carbon pricing, consumers of fossil fuels receive an implicit subsidy per unit of fuel they consume. Since fuels are a "normal good" (their consumption increases with income), this implicit subsidy mostly benefits the higher-income groups. As to the impact of GHG emissions, the least developed and most fragile countries also are the most vulnerable, and further disadvantaged by their low adaptive capacity. In fact, climate change could result in more than 100 million additional people living in poverty by 2030 (Hallegatte et al. 2016).

This type of market failure can be addressed with several *price*-based policy instruments—such as carbon taxation and carbon market mechanisms—as well as climate finance with a concessional component. A country's decision on whether to use any of the above or other instruments to cover the costs of mitigation (including command-and-control regulations such as renewable energy mandates) depends on several factors, among others, the quality of information; the degree of heterogeneity of the targeted firms; and the institutional capacity to implement those policies (Hepburn 2006); as well as the availability of concessionality.

Divergent domestic and global co-benefits

Many actions on climate change bring benefits beyond market rewards to participants, such as aggregate energy security, cleaner air, and protection of ecosystems. Nevertheless, approaches to mitigation based on *domestic* co-benefits will result in levels of mitigation that may be optimal from a national perspective, but not necessarily optimal given the *global* interest in climate stabilization.

R&D and deployment related to carbon pricing/markets

Ideas, examples, and investigations are "goods" in the public domain that can be disseminated and give guidance to other actors facing the same (technological) challenges. More specifically, any new insights regarding the most effective way of implementing carbon pricing and creating carbon markets that can be derived from R&D and deployment of low-carbon technologies enhance climate action and therefore represent GPGs.

Imperfections in risk and capital markets

Imperfections in capital markets refer to all limitations that reduce the range of financial contracts that agents can sign and/or that prevent financial contracts from being signed. As a result, individuals and firms cannot borrow or lend as much as they wish, on given market terms, independent of the amount desired, because of the lack of adequate information, enforcement clauses, collateral clauses, etc. These imperfections can make it particularly difficult for promising low-carbon technologies to be funded—at various stages of the innovation chain—because of the relatively high risk inherent in emerging technologies.

Technology-related network externalities

This type of externalities arises whenever demand for a specific good (for instance, an electric car) or service (for instance, wind energy) depends on other individuals' demand for them. How useful a good or service is to an individual depends on the number of people who consume the same (or compatible) good or use the same (or compatible) service. *Negative* network externalities exist if the benefits are a decreasing function of the number of other users (for instance, a road confers negative network externalities because the higher the number of drivers, the more traffic congestion). Conversely, cell phones confer *positive* network externalities since the higher the number of users, the more useful a cell phone is to an individual user.

Network externalities entail a set of coordination issues, deriving from the interdependence of demands of different individuals. In the context of mitigation, network externalities are particularly relevant to the creation of new markets based on low-carbon technologies—among others, for the energy and transport sector. In fact, network externalities, in which the adoption of a technology by one agent reduces the cost of adoption by others, are one of the main factors behind the tipping points in the transition to low-carbon technologies.

Inadequate information

Decision making can be severely hampered by a lack of information. In the context of mitigation action, the lack of data on how exactly the climate is changing, the precise impact in different countries over time, the most effective methods to slow down global warming, etc. make it difficult for policy makers to develop effective, science-based strategies and related policies. Moreover, manufacturers often lack detailed information about the needs of consumers, while consumers often lack information about the benefits of using specific new technologies. What is more, in times of rapid (technological) change, it is hard to be fully aware of everything that is happening and the possibilities it offers.

Institutions, including financial institutions, play an important role in transmitting information and in determining the extent to which incentives exist to share and act on information.

Source: Stern 2015.

Box 2-2. Types of Market Failures Relevant to Resilience Building

The *2014 World Development Report Risk and Opportunities* reviews the reasons why risk management and resilience building—and therefore climate change adaptation—are unlikely to be optimal without appropriate policies and coordinated collective actions (Figure 2-2).

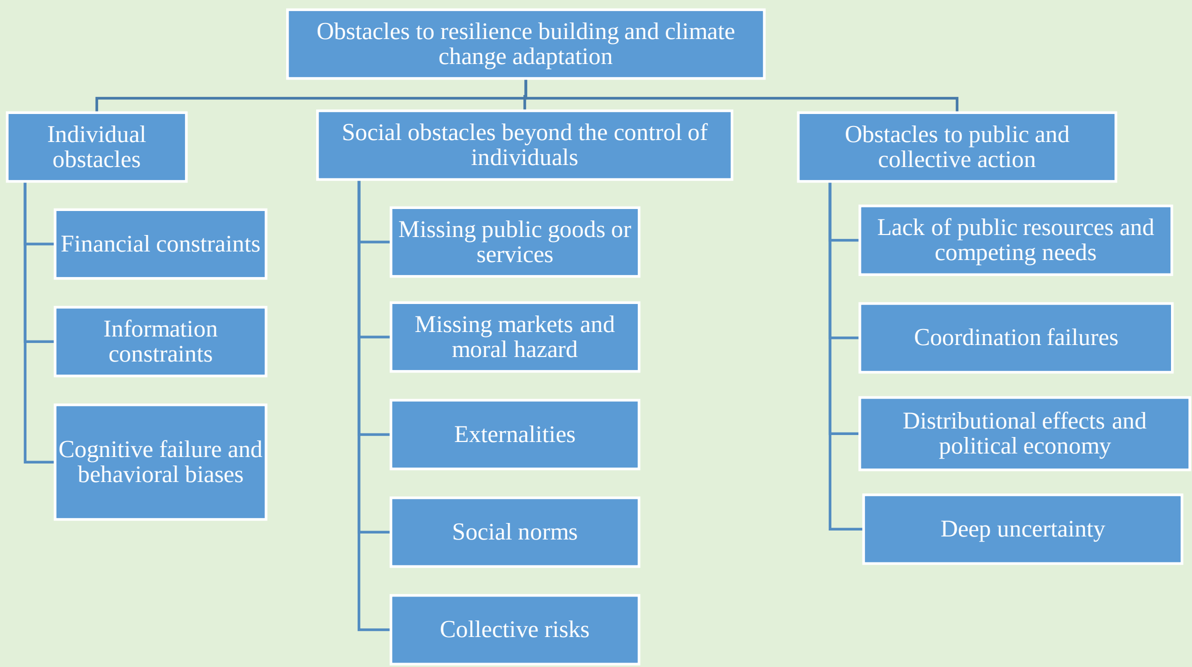
The reasons include obstacles to resilience that arise at the individual level: people face financial constraints due to imperfect capital markets, lack of information due to the transaction costs of accessing information, and cognitive failures and behavioral biases that mean that even when people are well-informed and able to act, they may still fail to do so.

Other reasons are linked to the interplay of risk management among individuals. Some risk management interventions have a public goods nature, such as infrastructure or data collection. Some risks are inherently collective, such as epidemics. And social norms are sometimes an obstacle to action.

Finally, collective action itself faces a large set of obstacles, ranging from coordination failure within governments, to political economy issues, to deep uncertainty with respect to future climate change.

These three sets of obstacles mean that smart policies are needed to ensure that individual and collective action for risk management, resilience, and adaptation to climate change are efficient and appropriate. They provide the main justification for public—domestic and international—action in these domains, and for the provision of finance with a concessional element, which can help relax these constraints and overcome these obstacles, and therefore improve global well-being.

Figure 2-2. Obstacles to Resilience Building and Climate Change Adaptation



Source: World Bank 2014, chapter 2.

2.3 Priority: Favor the Most Ambitious and Transformational Projects

2.3.1 The ambition needed to achieve the objectives of the Paris Agreement

Under the framework, teams would prioritize programs or projects that are ambitious enough to contribute significantly to achieving the objectives of the Paris Agreement. DFIs should support the achievement of the Paris objectives and, as such, prioritize projects that are consistent with these objectives. They should focus particularly on programs (covering countries, sectors, policies, and

technological solutions) and projects that could best put countries on pathways to deep decarbonization and/or system-level resilience to climate shocks.

Achieving the Paris Agreement temperature target requires large-scale transformation of economic activity, including a major change in the energy system (especially power generation), industrial processes, heating and transportation systems, urban forms, household behaviors and land use (including forests, grasslands, and agriculture). Stabilization at any given temperature requires reducing net emissions to zero (or balancing sources and sinks, in the COP21 Agreement language). The lower the desired temperature, the sooner net emissions need to be zero.

The ambition is particularly critical for the mitigation challenge, considering the efforts needed to contain climate change below 2°C. Doing so requires bringing net global emissions of carbon down to zero well before the end of the century. To do that *in a cost-effective way,* four parallel changes in the global economy are critical (IDDRI and SDSN 2014; IEA 2014; Krey et al. 2014; Williams et al. 2012; Clarke et al. 2014; IPCC 2014; Fay et al. 2015):

- *Decarbonizing electricity production* is necessary to stabilize climate change and requires the transformation of a capital-intensive system with long-lived assets to one that uses either renewable or other zero-carbon energies, or fossil fuels with carbon capture and storage (CCS);
- *Electrification* (to increase use of carbon-free electricity) is also necessary in residential, industrial, and transport sectors, or—at least as a transition—a switch to cleaner or zero-carbon fuels;
- *Efficiency* – Improved efficiency and reduced waste in all sectors (including agriculture, diets, and residential energy use) contributes to reduction emissions and facilitates (and reduces the cost of) the transition toward zero-net emissions;
- *Landscapes* – Preservation and improvement of natural carbon sinks, through "climate-friendly" landscapes and management of forests and other vegetation and soils, and changes in agricultural practices is particularly important in countries where most emissions are linked to land-use changes and would play a critical role if negative emissions are to be achieved in the second part of this century.[30]

By contrast, some programs or projects that reduce GHG emissions in a very efficient way can nonetheless be inconsistent with the Paris objectives, especially when they fail to contribute to the major *structural* changes needed. For instance, replacing existing coal power plants in a country by more efficient ones can reduce emissions at a very low cost when expressed in dollars of investment per avoided ton of GHG emissions. But considering the lifetime of a new coal power plant, such action could also lock the country into a high-emission trajectory that is not consistent with a cost-efficient pathway toward meeting the Paris objectives.

Long-term time horizons are critical to determine whether a project is consistent with the objectives of the Paris Agreement (Box 2-3). For countries with long-term plans—such as those involved in the 2050 Pathway Platform or the members of the "Towards Carbon Neutrality" coalition announced at the One

[30] Negative emissions can be achieved by removing GHGs from the atmosphere through afforestation, air capture, or the use of biofuels in power plants with carbon capture and sequestration. Negative emissions may allow achieving net negative emissions and thus a reduction in the concentration of GHGs in the atmosphere over time. They may also enable achieving net zero (or net negative) global emissions, with some residual positive emissions in a few sectors that are difficult to decarbonize or in some countries or regions.

Planet Summit—these long-term pathways can be used to assess how a project would contribute to the long-term objectives of the Paris Agreement.

Box 2-3. Long-Term Horizons and Optimal Climate Actions

In many countries, the best strategy for decarbonizing the electricity sector is not to *sequentially* switch from coal to gas, and then from gas to renewable power; instead, early investment in *renewable power* (sometimes known as leapfrogging) can smooth out costs over time and avoid wasteful overinvestment in gas power plants (Lecuyer and Vogt-Schilb 2014).

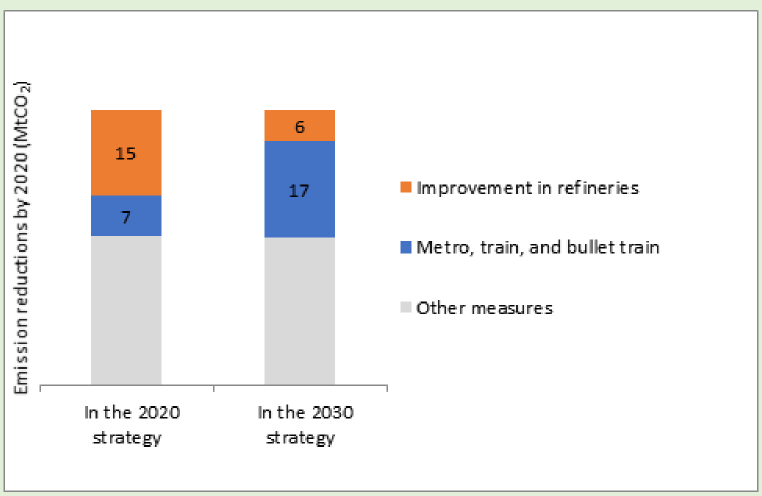
Another reason *not* to focus on the technological options with the *lower*, *short-term* technical cost is that many of the technologies used to reduce emissions (such as electric cars or RE) are still in the early stages of development and therefore relatively expensive. Since their cost will decrease as their deployment progresses—through learning-by-doing effects or economies of scale—it makes sense to use some of these options in the short term to bring their cost down (Azar and Sandén 2011; Bramoullé and Olson 2005; del Río González 2008; Gerlagh, Kverndokk, and Rosendahl 2009; Kalkuhl, Edenhofer, and Lessmann 2012; Rosendahl 2004).

Take the case of a low-carbon strategy analysis done for Brazil. The bar on the right-hand side of the figure below shows the efforts across various sectors in the period 2010–20, as part of the optimal strategy to reduce domestic emissions by 20 percent by 2030. To achieve that goal by *2030,* the optimal strategy includes significant investments in the transport sector before 2020. By contrast, the optimal strategy with a *2020* end goal (shown in the bar on the left-hand side) entails less ambitious actions for the transport sector, even assuming total reductions achieved are the same under both scenarios. The lack of investments in the transport sector under the 2020 horizon scenario is compensated by additional measures in other sectors, including improvements in refineries.

In this example, while the short-term (2020) and long-term (2030) strategies achieve the same amount of reductions by 2020, they do so in very different ways. **While the long-term strategy focuses on options that are more expensive and time-consuming to implement, it may ultimately contribute to deeper decarbonization.** Choosing the short-term strategy would thus be inefficient: the strategy that is optimal when considering the 2020 end goal would entail very high costs between 2020 and 2030 if the 2030 objective is to be achieved.

This problem is critical when one wants to assess whether a project is consistent with the objectives of the Paris Agreement: what may look appropriate when considering a 15- or 20-year time horizon may end up being ill-advised when the long-term goal of zero net emissions is considered. In general, it is preferable to consider a horizon going at least to 2050 to assess the desirability of mitigation projects.

Figure 2-3. Interplay of Time Frame and Optimal Policy Mix, Brazil



Source: Vogt-Schilb et al. 2014.
Note: $MtCO_2$ = millions of (metric) tons of carbon dioxide. The 2020 and 2030 bars represent an equal amount of emission reductions but based on a different policy mix. The bar on the left shows mitigation efforts under the scenario with a 2020 horizon, while the bar on the right shows mitigation efforts under the scenario with a 2030 horizon.

Although there is no strict quantified objective akin to the Paris temperature target for adaptation and resilience, the planning time frame remains salient. A resilience-building intervention can be inconsistent with the Paris Agreement, for instance, when it is not informed by mounting climate risks. Also, if an

engagement for one location or population makes another one less resilient, or if it provides only a marginal improvement (i.e., it is insufficient to substantively improve resilience and quality of life)—it would not be consistent with the intent of the Paris Agreement, and thus not ambitious under this framework.

In considering which potential engagements might be suitable for support with concessionality, teams must judge the extent to which the program or project is *ambitious* enough to contribute significantly to achieving the objectives of the Paris Agreement; the engagements judged to be most ambitious would be the highest priority for DFI engagement.

Determining how much an engagement should be prioritized is a separate question from the degree of concessionality. By contrast, engagements that barely contribute to reducing emissions or enhancing resilience and are unaligned with the Paris objectives should not be supported, irrespective of the concessionality needed to make them viable.

There will be some subjectivity in this criterion. The Paris Agreement provides a quantified mitigation objective only at the global scale (the 2°C and 1.5°C objectives, and the balance of carbon sources and sinks), not at the country level. There is no quantified objective for adaptation/resilience-building at the country level either, and some disagreement is likely to arise regarding what is "ambitious" under different national circumstances. While this chapter provided some guidelines to weigh the magnitude of the barriers to implementation, chapter 3 provides a qualitative scale that can be used to assess the level of ambition of a climate program or project.

2.3.2 Being transformational to make a difference

Under the framework, teams would prioritize programs or projects that are transformational by reducing in a meaningful manner the identified barriers to implementation faced by future climate-related programs/projects. A program or project is *transformational* if its implementation would make it easier to implement future programs or projects that will reduce emissions or boost resilience in a meaningful way.[31]

The transformational criterion looks beyond the direct scope of the project to consider its spillovers in terms of policy improvement, technological change, information/demonstration effects, and other positive externalities, and how it makes future climate projects easier to implement. Low-hanging fruits are important to capture, especially when they entail large development benefits. But a mitigation project that reduces emissions at a very *high* cost per ton of avoided emissions can still become a priority if it enables a reform of fossil fuel subsidies or demonstrates a new technology, as it would enable future investments that are less carbon-intensive.[32] In this context, it is particularly important to consider *long-term* policy horizons and their implications, not just short-term impacts. Thus, it is essential to consider the domestic policy environment when evaluating a project's transformational potential. In fact, an energy project that looks promising in two countries could end up radically transforming the energy sector in one country but barely making a ripple in the other country.

Transformation arises, among other things, from a type of market failure typical of many climate-related investments—the existence of *network externalities*. It is one of the factors that explain why low-carbon transitions are characterized by *tipping points,* rather than a smooth, gradual change. Theoretical

[31] In economic terms, such projects have positive spillovers or increasing returns.

[32] This is entirely consistent with the "follow the carbon" logic, which means that concessionality should be directed at the countries and sectors where it will have the largest, long-term impact on climate action.

conceptions of transformation are considered in Box 2-4, and then made more concrete for mitigation and resilience building further below.

Box 2-4. Conceptions of Climate Transformation

With **positive network externalities**, the adoption of a technology by one agent lowers the cost of adoption by others. For example, suppose the spread of electric cars is held up by the low density of recharging stations. Potential operators of recharging stations lack incentives to enter the market unless the demand for these cars is sufficiently high, but the demand for these cars will not be high enough unless there is a sufficiently dense network of recharging stations. Each of these factors is thus held back by the other. This situation can end up as a low-level equilibrium in which a technology transition never occurs, even if the technology itself is ripe for adoption. Suppose now that there is an exogenous rise in the number of *early adopters* of these cars; this will raise the incentive for potential operators to open recharging stations, which in turn will increase the incentives for potential consumers to purchase the new electric vehicles. The first increase in demand reduced the cost of adoption by the second generation of adopters. What connects these two groups is network externalities.

External economies of scale are a similar impediment to gradual, iterative low-carbon investments. These occur when the production cost/unit of a given product falls *in the output of another product*. For instance, assume that the unit cost of power generation based on offshore wind power falls when considering the production volume of certain types of steel that are required for offshore turbines but have little use in other markets. Steel producers would have insufficient incentives to develop and supply the needed steel type in the absence of strong demand from offshore wind park construction, and the wind parks would not be built unless their unit cost came down. Thus, if one of the limiting factors moves, it may abruptly unlock the growth potential of the other factor in a nonlinear way.

Low-carbon transitions are also held up by **internal economies of scale.** These occur when the production cost/unit of a given product falls *in its own output*. For example, the unit cost of solar energy has fallen significantly with the increase in its production. In wholesale markets, which take up the lowest marginal cost energy, this cost advantage can lead to *discontinuous* jumps in demand.

A related but separate source of discontinuous low-carbon transitions following public investments is the **need for complementary infrastructure.** For coal-fired power stations to be cost-competitive, countries must have adequately developed canal or railway systems to transport the fuel from the mines or ports to the power stations because transporting it by road would be expensive (given coal's weight). Many countries developed this transport infrastructure long ago—its cost was high and normally borne by the state and has long been paid for. The fact that the cost of these past investments in transport infrastructure has been paid off thus remains a major factor in the relatively low private cost of coal-fired power. By contrast, renewable energy (RE) sources *do not need* heavy fuel (and therefore cannot benefit from existing transport systems) but *do need* other enabling infrastructure. The intermittent supply from solar and wind power sources, for example, requires electricity storage systems, such as pumped hydroelectric dams, or fine-tuning grid loads across regions with different weather patterns by building long-distance, hyper voltage lines. RE sources therefore require the development of large new infrastructure systems, just like the development of coal power needed new infrastructure to be built in the past.

Thus, the need for investment in low-carbon electricity requires investments not just in RE projects themselves, but in the associated infrastructure as well. Yet, unlike in the past, many governments no longer see a role for themselves in the undertaking of such large public infrastructure investments nor do they believe they have the fiscal capacity to do so. Private finance is left to fill the gap, to some extent, but the investment gap is large, at least for the time being. In the meantime, public investments made in the past create continuous cost advantages that lock in the technology choices of the past. In the shadow of unmet infrastructure needs, RE technologies in a region can keep improving without translating into major gains in the RE market share. The growth potential of RE sources will only be able to jump in a discontinuous fashion after the infrastructure has been built.

Each of these barriers to low-carbon transitions can be a source of tipping points. They illustrate cases where low-carbon technologies are not adopted smoothly and gradually, but rather along a bumpy road with multiple equilibrium points. Each of the above examples requires some type of "big push" to overcome barriers to market entry. Without such an intervention, economies may be locked into emissions-intensive development, even if alternative, low-carbon technologies are available. More specifically, to overcome such tipping points, an intervention must be made at the *minimum efficient scale* (i.e., critical volume), bearing in mind that it does not need to be funded by concessionality in climate finance alone but may also involve domestic public spending and policies.

Mitigation projects are transformational when, once implemented, the cost of reducing emissions significantly drops for future projects. This is generally the case if the program or project fixes market

failures (e.g., removes disincentives created by distortive tax systems that promote fossil fuels), builds institutional capacity (e.g., creates a functioning regulator for energy markets), or generates information or innovative spillovers (e.g., demonstrates the viability of a technology in a country, or reduces the cost of a given technology through learning-by-doing or economies of scale). Box 2-1 (page 16) gives additional details on transformation through mitigation action.

While there is a continuum in terms of the level of transformation achieved through mitigation projects, extreme cases are easy to identify. At one end of the spectrum, changing investment regulations to reduce transaction costs for renewable energy (RE) projects would favor zero-carbon energy at the expense of fossil fuels. This intervention has a specific one-time cost, without further long-term costs but, once made, it affects the future emission pathway in the country in a durable way, even in the absence of any follow-up financing. This intervention is thus highly transformational in terms of mitigation. Another example is the financing of the *first* solar farm in a country, which can reduce risk perceptions about solar technologies and make the preference for zero-carbon energy permanent. This is also an opportunity for one-shot investments to have long-term effects on emissions.

At the other end of the spectrum, financing *one more* solar farm in a large country where this technology is already established—by compensating the cost differential with a lower-cost fossil fuel option—will reduce emissions compared with a non-intervention scenario but won't change the country's long-term emission pathway. To reduce emissions further, additional financing would be required. This intervention therefore reduces emissions without being transformational.

And some interventions lie between these two extremes. Implementing a feed-in tariff (FIT) for solar energy in a country is an investment with long-term financial implications and a variable cost: the larger the amount of avoided emissions, the higher the cost. However, it can at some point start yielding increasing returns to scale if a surge in the volume of solar energy leads to a decrease in the cost of solar energy per kWh. In this case, the FIT may only be necessary temporarily, until solar energy becomes competitive with fossil fuels, thereby making it a transformational investment.

Similarly, resilience projects are transformational if they make it significantly easier and cheaper to adapt to climate change and reduce climate and disaster risks in the future. As with mitigation, this happens when a program or project fixes market failures (e.g., removes incentives to build housing in flood plains), builds institutional capacity (e.g., creates a land-use plan that takes risks into account or improves building regulations), or generates information or innovative spillovers (e.g., develops a hazard map that can be used for all future investments). Box 2-2 (page 17) gives additional details on transformation through resilience-building action.

Again, while there is a continuum in terms of the level of transformation achieved through adaptation projects, extreme cases are easy to identify. At one end, improving capacity in local authorities so that they can create land-use plans based on zoning legislation that prevents people from investing in places with excessive natural disaster risk requires investments in data, land registries, and institutions. In fact, ensuring that land-use plans consider flood risks and provide free data on flood-prone areas not only reduces risks but also affects broader development patterns, without entailing a cost per new infrastructure/unit built.[33] Moreover, after those initial capacity investments, it reduces losses at a *negative* cost (because it avoids disaster losses) and does not require a continuous injection of concessional resources. Indeed, this intervention will influence all future investments, including private investments, thereby enhancing resilience rather than increasing vulnerability and future losses from natural disasters. It is thus highly transformational in that it mobilizes other sources of finance, affects the

[33] Assuming low-risk land is available on similar terms.

behavior of other economic actors, and reduces long-term risks, even in the absence of further investments funded with concessional resources.

By contrast, building one seawall to protect one neighborhood can be very cost-effective and desirable—leading to net benefits in the form of potential losses due to floods being avoided—but would not change risks in other places. It is therefore not considered a transformational project under this framework.

Another example of transformational action is the mobilization of private capital through the provision of appropriate incentives, an action strongly aligned with the MFD approach. Mobilizing private resources requires that the countries hosting these investments create the right policy environment. Supportive policy measures in this context include fuel taxation and other carbon-pricing schemes, the adoption of energy efficiency standards, and the introduction of incentive schemes (e.g., FITs for renewables). Countervailing policies such as fossil fuel subsidies promote carbon-intensive development, and therefore have high social opportunity costs. Thus, concessionality can support a *policy change,* for instance, financing the phase-in of domestic carbon pricing or international carbon market mechanisms through Results-Based Climate Finance (RBCF) (World Bank 2017), as explained in Box 2-5.

Box 2-5. Catalyzing Markets through Concessionality and Role of Results-Based Climate Finance

Results-Based Climate Finance (RBCF) is a concessional financing modality under which a donor or investor disburses funds to a recipient upon the achievement and independent verification of a pre-agreed set of results. It is well suited to catalyze the creation of domestic markets for mitigation outcomes, such as markets for clean electricity or greenhouse gas (GHG) emission reductions. By paying for mitigation outcomes, RBCF provides a price signal and incentivizes the private sector to engage. RBCF has a track record in supporting domestic policies to establish domestic markets and in building targeted implementation capacity and market infrastructure such as monitoring, reporting, and verification (MRV) systems.[b] RBCF can support the linking of domestic markets through crediting of domestic policies.[c] Finally, RBCF can be used to pilot new international market mechanisms through dedicated facilities such as the World Bank's Transformative Carbon Asset Facility (TCAF).[d]

RBCF can thus support the transition from finance to markets with a concessional component. This process takes time and will never be fully completed—there will always be activities requiring support through concessionality. The following elements can enhance efficiency in the interrelation of concessionality in climate finance and markets:[e] compatibility, optimal concessionality, and subsidiarity. *Compatibility* implies that climate finance and markets use the same methodological standards to determine mitigation outcomes. *Optimal concessionality* implies that (i) the role of concessionality in finance has been clearly defined as part of a broader support package; (ii) concessionality is limited and scaled with the barriers that cannot be addressed through policies and markets; and (iii) an exit strategy for concessionality has been defined. *Subsidiarity* implies that markets are always used before resorting to concessionality in climate finance and used to the highest extent possible.

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a. An international market can reduce the costs of meeting the 2030 NDC targets by more than 30 percent and mobilize resources amounting to one third of the required incremental investments (*State and Trends of Carbon Pricing 2016* and *State and Trends of Carbon Pricing 2017)*.

b. World Bank and Frankfurt School of Finance and Management. 2017. *Results-Based Climate Finance in Practice: Delivering Climate Finance for Low-Carbon Development*. 2017. Washington, DC: World Bank. (http://documents.worldbank.org/curated/en/410371494873772578/Results-based-climate-finance-in-practice-delivering-climate-finance-for-low-carbon-development)

c. ISSD (International Institute for Sustainable Development). 2016. *Supporting Energy Pricing Reform and Carbon Pricing Policies through Crediting* (https://cpf.wbcarbonfinance.org/sites/cpf_new/files/Supporting_Energy_Pricing-Reform_Carbon_Pricing_Through_Crediting_March_2016.pdf).

d. Additional information may be found at https://tcaf.worldbank.org/ .

e. These elements are explained in more detail in the *State and Trends of Carbon Pricing 2017* report.

When assessing transformational potential, it is important to consider *long-term* policy horizons and their implications, not just their short-term impact. There are tradeoffs in the assessment of transformation. Resources allocated to one approach can introduce barriers to alternate approaches that also have merits.

For instance, investing in a mature and low-cost technology such as hydropower could have a larger, *short-term* mitigation impact than support for penetration of a less mature domestic industry such as wind power. However, wind power may have a larger, be it uncertain, *long-term* payoff if the domestic industry starts experiencing positive and increasing returns. Failure to invest in the latter technology can result in the failure to identify potentially higher-return investments, thereby ultimately raising the cost of achieving decarbonization and resilience.

To effectively combat climate change, DFIs must balance the need to support climate action in the poorest countries with the need to focus on investments with the largest transformational potential. And as mentioned in chapter 1, these two imperatives do not necessarily coincide. When comparing options, it is important to consider how challenging it would be to shift high-emission to low-emission pathways in the respective countries, the size of the respective emission reductions, and whether the transitions could be achieved more easily by introducing specific policies or using other financing sources.

Resources with a concessional component can unlock opportunities for greater co-benefits that sustain domestic action. For instance, once a solar power has been demonstrated in a country using climate finance, domestic policy makers may continue to support it with domestic resources only because of local co-benefits for air pollution, even if the levelized cost of solar power remains higher than that of its alternatives. In some countries, significant carbon pricing is justified as a national policy because it helps reduce domestic public health problems and other local externalities (Parry, Veung, and Heine 2015),[34] and because the poverty alleviation policies that can be financed through environmental tax reforms lead to much better distributional outcomes than the underpricing of fossil fuels (Yusuf and Resosudarmo 2015; Ruggeri Laderchi 2014; Chiroleu-Assouline and Fodha 2014; Coady et al. 2016; Horowitz et al. 2017; Klenert et al. 2016). The amount of revenue that can be raised through carbon pricing may even be sufficient to close the infrastructure financing gap (Jakob et al. 2016), thereby making economies more productive and efficient (Abiad, Furceri, and Topalova 2015; IMF 2014). When such incentives for carbon pricing exist, the short-run costs of climate policies can be compensated by the short-term gains that may be derived.[35]

2.4 A Framework to Create the Right Incentives

Prioritizing programs or projects that face well-identified and significant barriers to implementation and have the greatest ambition and transformational potential (i.e., do the most to reduce barriers to implementation) creates the right incentives for governments and DFIs.

For governments, requiring that a program or project contribute meaningfully to removing barriers to implementation prevents moral hazard in the use of concessionality as well as the crowding out of domestic and commercial resources. Concessionality should only be provided to complement and crowd in domestic climate action and available domestic financial resources, *not* to substitute for it. For instance, concessional resources for climate can help make the construction of greener infrastructure possible even considering the constraints on domestic resources available for investments. The need to demonstrate that the project in question would be transformational implies that the government would have to realign

[34] Observational and modeling studies indicate that 3 million premature deaths are attributable to ambient air pollution and 4.3 million premature deaths to household pollution (WHO 2016). The global average marginal co-benefits of avoided mortality are estimated at \$50–380/tCO_2 (West et al. 2013).

[35] For example, the annual co-benefits of sector policies aimed at stimulating a shift to clean technologies in six regions (the United States, China, the EU, India, Mexico, and Brazil) are estimated at \$1.8–2.6 trillion in GDP growth (World Bank 2014). Bollen (2015) estimates that the economic value of co-benefits could be as high as 75 percent of total climate policy costs in the developing world. However, in many cases, decision makers and businesses fail to monetize, quantify, and even identify these co-benefits.

the unhelpful policies (e.g., a reform of fossil fuel subsidies or a policy change favoring poverty reduction), thereby reducing the moral hazard (i.e., a situation where a country has an incentive to neglect opportunities to address barriers to implementation, in expectation of receiving support to do so).

For DFIs, requiring that a program or project addresses well-identified (significant) barriers to implementation ensures that the poorest and most vulnerable are still considered for concessionality in climate finance and that the most difficult challenges are not ignored. If only the transformational criterion were applied, projects in high-capacity contexts where changes would be relatively easy to make might be favored, at the expense of more challenging countries and sectors; often the poorest countries. However, progress is also needed in countries and sectors where it is harder to trigger the low-carbon, climate-resilient transition.

Concessionality should support countries in achieving the transition to low-carbon, climate-resilient development pathways and *not* be used as a *substitute* for domestic policy action.

The intention of the framework is to create a high bar for making the case for which programs and projects should be a priority for receiving higher degrees of concessionality. Such a framework can stymie strategic behavior that might otherwise undermine the intentions of concessionality to promote low-carbon and climate-resilient pathways. The aim of the framework is to create such a structured assessment for prioritization among alternatives. One might argue that countries will not undertake any “tough” climate activities without the promise of concessionality—creating a moral hazard that slows progress to address climate change. This framework is meant to ensure that concessionality only goes to activities that are ambitious and transformational, and that the available concessionality is tailored to the identified barrier(s) to implementation. A rigorously applied framework should move the equilibrium toward more climate benefits, not less.

Concessionality is timebound, with the market taking over once concessionality has sufficiently brought costs down and improved the enabling environment. From a certain point onward, policies can be used to create (domestic) climate markets. Such climate markets pay for climate results; they can be phased in, for instance, through the application of RBCF. Initially, these climate markets will have highly discretionary features, reflecting the transition from a pure approach to concessionality. Over time, as technologies mature, the climate markets will converge to uniformity of price signals and international connectivity. As this process progresses, the role of concessionality should decline.

By separating the priority for DFI involvement and the degree of concessionality, the framework preserves scarce resources. A project that contributes meaningfully to the Paris Agreement objective and will lead to substantial subsequent private sector investment would certainly be a framework priority but would not necessarily receive substantial concessionality. Conversely, the transformational impact of the project may be achieved by near-commercial and less concessional investment if the project’s barrier(s) is(are) relatively low. This is consistent with the minimum concessionality of the blended finance principles as well.

The greater the degree of commitment and coordination, the smaller the total volume of public concessionality required to achieve the low-carbon transition and the creation of new markets. Despite the potential gains to be derived from the effective and frugal use of concessionality for supporting low-carbon transitions, uniting lenders around these elements is challenging. In the short run, lenders have an incentive *not* to take on the projects with the greatest risk of failure (and highest potential costs) because those projects require higher degrees of concessionality to succeed. Lenders would rather have an interest in financing the last stages of market accession for low-carbon technologies instead of supporting “infant” low-carbon technologies that are still forced to deal with significant market failures. Lenders may thus

have an incentive to let others take on the more challenging parts of the process to spur the transition to cleaner technologies. Clearly, this incentive to free ride on the efforts of others undermines the collective gains to be derived from collaboration in this area.

Strong leadership is needed; because of incentives *not* to cooperate and *not* to take on the deepest market failures, transformation will remain elusive without a disciplined role for highly concessional resources.

Making the largest number of transformational changes by breaking new paths for low-carbon, climate-resilient transitions requires investing where the market would otherwise fail, which is exactly where the expected returns from lending are smallest.

Achieving transformational changes toward achieving the Paris Agreement objectives will require that the biggest barriers—those with the longest outlook for investment—receive the highest degree of concessionality. Accordingly, operationalization of this framework would tailor the grant element to barriers that the private sector or a government cannot overcome without support. *Resources with the potential to overcome the hardest challenges should be reserved for this purpose.*

3. Approach and Implementation

This framework is applicable to different scales of analysis and decision making, from the project to the global scale. For a given program or project, it can help decide on the magnitude of the concessionality element for which that program/project may be eligible (i.e., project design). It can also be used to prioritize interventions within a country and to identify the programs or projects where concessional resources should be concentrated (i.e., program/project prioritization).

This chapter illustrates how the framework can be operationalized to guide decisions around targeting higher degrees of concessionality. It illustrates how the framework can be applied at the program/project level and the global level for both mitigation and resilience building. Implicit in these illustrations is that these issues are considered separately, while in reality, tradeoffs are likely even between prioritizing concessionality for mitigation vs. resilience building and vice versa.

3.1 Magnitude of the Barriers to Implementation

For both mitigation and resilience, the magnitude of the barriers to implementation can be measured qualitatively, based on the program or project characteristics, using four levels:

- *High*: The program or project is more expensive over its entire lifetime than alternative (higher-emission or lower-resilience) options (e.g., investment in a promising but frontier technological solution; renewable energy that is more expensive than the alternatives; costly investments to make infrastructure or buildings more resilient, etc.), or is opposed by interest groups that will be permanently affected (e.g., miners opposing the closure of coal mines).
- *Moderate*: Due to increased efficiency or reduced disaster-related losses, the program or project is less expensive over its entire lifetime than alternative (higher-emission or lower-resilience) options, but it has significantly higher upfront costs (e.g., most energy efficiency programs; stricter building codes for new buildings and infrastructure; many renewable energy generation projects), requires much higher institutional or technical capacity than what is present in the country, or creates significant transition costs or political opposition (e.g., those associated with fossil fuel subsidy reform and flood zoning that significantly affects land values).
- *Low*: The program or project is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher-emission or lower-resilience) options, but it is not a policy priority in the country (e.g., reforms in energy markets; renewable power that is competitive with fossil fuels; demonstrating the value of information on natural risks and climate change to the population and investors).
- *None*: The program or project is less expensive over its entire lifetime and has similar or lower upfront costs than alternative (higher-emission or lower-resilience) options and could be implemented even if concessional support is not available.

One option to operationalize this framework is to link these qualitative measures of the barriers to implementation to different degrees of concessionality.

3.2 Ambition of the Program or Project

Mitigation

An index can be similarly used to qualitatively measure how ambitious a program or project is with respect to the mitigation objectives of the Paris Agreement, taking any of the following four levels:

- *High:* The program or project is *necessary* to achieve the mitigation objectives of the Paris Agreement. Here, it can be demonstrated that a country or region cannot realistically achieve a development pathway compatible with the Paris Agreement if this (or a similar) program or project is not implemented (e.g., fossil fuel subsidy reform; energy reforms to increase investment in renewables; investment in the grid to allow for higher renewable share in the energy mix; ambitious energy efficiency program for buildings; carbon pricing; etc.).
- *Moderate:* The program or project may not be necessary, but does contribute significantly to the achievement of the Paris Agreement (e.g., a new public transit system to reduce emissions from transport), or is included in a long-term decarbonization pathways analysis (such as one produced in the context of the 2050 Pathway Platform or the "Towards Carbon Neutrality" coalition announced at the One Planet Summit).
- *Low:* The program or project reduces emissions, but only marginally, and does not significantly change the scale of the problem in a country (e.g., slightly more efficient automotive standards).
- *None:* The program or project is inconsistent with the Paris objectives, even if it reduces emissions, and risks creating a carbon lock-in in terms of emissions (e.g., new high-efficiency coal power plants).

Resilience

The Paris Agreement does not provide explicit objectives for resilience/adaptation. Still, a qualitative level of ambition for resilience-building and adaptation can nevertheless be attributed:

- *High*: The program or project is a component of a climate change adaptation, resilience, or risk-reduction plan or strategy (e.g., included in the NDC). It is *necessary* for increasing resilience and has an explicit objective in terms of resilience building or climate change adaptation that is included in a solid monitoring and evaluation (M&E) framework with dedicated quantified outcome indicators (e.g., reduced number of people living in the flood zone; or decreased damages in case of a hurricane). The program or project is explicitly designed to be *robust* (i.e., able to cope with many different environmental and economic conditions, including long-term climate change and its large associated uncertainties).
- *Moderate*: The program or project contributes significantly to adapting to climate change by increasing resilience or reducing risks. It has an explicit objective in terms of resilience building or climate change adaptation, which is included in a solid M&E framework with dedicated quantified indicators (e.g., reduced number of people living in the flood zone; or decreased damages in case of hurricane). However, the program or project may not consider the long-term repercussions of its implementation, focusing more on short-term needs.
- *Low*: The design of the program or project has been altered to account for natural risks or climate change, contributes to societal preparedness for specific changes, or avoids the creation of specific additional risks.
- *None*: The program or project does not have an explicit objective in terms of resilience building or climate change adaptation, and its design has not been altered to account for future climate change impacts (or has been based on a single climate scenario, without considering the associated uncertainties).

3.3 Transformational Potential

Finally, for both mitigation and resilience, an index qualitatively measuring the transformational potential of the program or project (i.e., its impacts on the barriers to implementation that future projects or programs will face) can take any of the following four levels:

- *High:* The program or project expects to durably improve government processes, economic incentives, or price signals; significantly improve access to finance for long-term, low-carbon or resilience projects; or reduce the cost of technologies (e.g., carbon pricing and fossil fuel subsidy reforms, large-scale feed-in tariff for renewable power in a large country, major change in land-use planning or building regulations, demonstration project with new technologies for resilience or emission reductions, changes in bank regulations to facilitate the financing of low-carbon or resilience projects, a policy to make social protection more reactive to climate shocks, etc.). If this program or project is implemented, future mitigation or resilience-building projects or programs will become viable with a degree of concessionality that is lower than today, and this difference is articulated in the project document.
- *Moderate:* The program or project expects to provide important foundations for future investments, programs, or projects that reduce emissions (e.g., investment in power transmission and smart grids) or increase resilience (e.g., creation of a household registry to provide post-disaster support to populations); build technical and institutional capacity that will facilitate future action (e.g., support to planning and implementation of NDCs, create capacity for risk assessment or climate change modeling, implement a law to make land-value capture available as a way of financing low-carbon or resilience projects); or improve the incentive structure (changes in tax structure, reduction in fossil fuel subsidies, valuing water to facilitate more efficient use and delivery, reform of insurance markets, etc.). If this program or project is implemented, future mitigation or resilience-building projects or programs will become viable with a degree of concessionality that is lower than today, and this difference is articulated in the project document.
- *Low:* The program or project helps build momentum, without affecting the basic incentives or costs in the country (e.g., a large-scale renewable power plant in a country where a similar plant already exists or a large flood management project).
- *None:* The program or project may reduce emissions or increase resilience but does not trigger any structural change or improvement in incentives or barriers to implementation for future projects (e.g., a small renewable power plant or a small drainage project). Such projects are not prioritized for climate finance.

3.4 Bringing It All Together

Taking these categorizations together, the framework can inform program or project decision making on climate finance with a concessional element through *parallel* processes that consider both the degree of concessionality and prioritization. Table 3-1 illustrates how the framework could be applied and the resulting implications for DFI support.

The examples illustrated in the table are in part supported by an analysis of selected CIF projects from the ongoing CIF Evaluation and Learning Initiative. The selected projects were coded based on the levels of ambition and transformation reflected through a retrospective application of the framework to project design documents. The aim of this analysis was to test the framework's ability to meaningfully rate and

prioritize projects (e.g., that separate ratings for levels of ambition and levels of transformation are feasible). Further, while this simple “backcasting” exercise did not attempt to gauge the barriers to implementation inherent in these CIF projects, due largely to a lack of data, the analysis found that the CIF portfolio generally rated high for project levels of ambition and transformational potential according to the framework presented in this paper.

TABLE 3-1. SPECIFIC EXAMPLES THAT ILLUSTRATE POTENTIAL APPLICATIONS OF THE FRAMEWORK

	Degree of Concessionality	**Prioritization**		
	Barriers to implementation	**Ambition** (Paris compatibility)	**Transformational potential** (durable removal of barriers)	***Implication for DFI support***
Mitigation				
Carbon pricing	*High* [Carbon pricing internalizes the cost of a global externality, raising political and technical obstacles and probably increasing energy costs.]	*High* [Aligning economic incentives with the Paris Agreement is considered a necessary step.]	*High* [Aligning economic incentives will make future emission reduction projects economically viable and much easier to implement.]	*Clear priority for highest concessionality funds*
First solar power plant in a low-income country	*Moderate* [Solar has higher upfront costs than other generation options but is cheaper than fossil alternatives when considering global externalities; furthermore, costs of borrowing are high.]	*Moderate* [Decarbonizing power is the first and most important step in a Paris-compatible path.]	*High* [As the first solar plant in the country, the project is expected to resolve administrative hurdles and give developers experience with the technology in that market, opening the way for private investors.]	*Among priority projects for higher concessionality funds*
Solar power plant in a large country with significant solar penetration already	*Low* [Solar has higher upfront costs than other generation options, but in many markets, it is increasingly competitive on a lifetime basis; however, at higher penetration, it creates issues with network stability, which requires additional complementary actions.]	*Moderate* [Decarbonizing power is the first and most important step in a Paris-compatible path.]	*None* [One more solar power plant reduces emissions but does not affect the incentives and barriers/costs for future projects.]	*If the investment cannot address the barrier (grid integration), project is not a priority*
Investment in transmission **(with an option to add electricity storage)**	*Low* without storage [Transmission may improve penetration of low-marginal-cost RE in absence of merit order dispatch, a policy failure.] *Moderate* with storage [Storage has high upfront costs but may offer system benefit and flexibility that is not compensated under existing policy frameworks.]	*High* [Stronger and more flexible grids enable decarbonization of power, which is needed to achieve Paris objectives, though ambition is only high insofar as transmission's objective is to facilitate variable RE integration.]	*Moderate* without storage [Future RE projects may be more viable because of the strengthened grid.] *High* with storage [Storage adds more flexibility to system operation than transmission alone and is seen as one key enabler of high variable RE penetration.]	*Transmission without storage are priority projects, but not for high concessionality funds, unless storage is incorporated with intention to facilitate RE objectives.*

Feed-in tariff for latest-gen solar power	*High* [Feed-in tariff can be costly for public finance and incite opposition from utilities. Targeting latest-gen technology can create learning spillovers for other markets, which are not compensated.]	*High* in high-capacity emerging economies [Developing more efficient solar power technology can reduce decarbonization costs.] *Moderate* in lower-income, lower-capacity countries [Decarbonizing power is the first and most important step in a Paris-compatible path, so favoring RE is important; however, proven technologies may be better suited for low-income countries.]	*Moderate* in high-capacity emerging economies [Large demand for latest-gen solar technology can drive cost down and reduce the need for the feed-in tariff over time; reform of the regulatory and utility-enabling environment can lead to durable market creation.] *Low* in a low-income country [Same as above, but market may have difficulty translating experience into durable market creation.]	*Focus of highly concessional resources should be on higher-capacity markets.* *More fundamental programs may be favorable in lower-capacity markets.*
Metro or Bus-Rapid-Transit (BRT) in large growing city, as part of an urban development plan	*High* [Low-Carbon mass transit has large upfront costs with difficult profit models, since benefits accrue through economic stimulus and inclusion, lower local and global emissions, and reduced congestion. Some consumers may prefer private transport options, creating political economy challenges]	*High* [Reducing emissions from urban transit is needed to achieve Paris objectives, and there is urgency since urban forms are influenced by available transit options.]	*High* [Low-carbon urban transport infrastructure can avoid lock-in of carbon-intensive transport options and sprawling urban development patterns.]	*Priority for higher concessionality climate funds. The coupled economic, social, and climate goals could also be achieved with other concessional resources.*
Reform of construction codes for more efficient homes / buildings	*Moderate* [Improving construction codes is difficult because it increases upfront cost. Developers may have little incentive to build more efficient homes because long-term gains accrue to the building owner/tenant—a market failure. Incentivizing enforcement of codes can also be costly.]	*High* [Buildings consume a large fraction of the total energy use, and it is impossible to achieve Paris objectives without progress in this sector; it is also urgent, since buildings have long lifetimes.]	*Moderate* [Developing enforcement capabilities and technical experience for better buildings, and consumer expectations for lower energy intensive buildings. More efficient buildings might also be more compatible with shifting heating to electricity, which is required to ultimately achieve zero net emissions.]	*Clear justification for higher concessionality funds, though upstream policy engagement may be sufficient without direct public expenditures.*
Residential energy efficiency improvements	*Moderate* [Wide-scale adoption of residential energy-efficiency equipment for lighting, refrigeration, and heating/cooling is difficult because utilities have little incentive to	*Moderate* [Energy-efficiency improvements in this country, while "low-hanging fruit," do not represent significant GHG emission reductions; other	*High* [Implementing the program across the country would be highly transformational, in that it addresses the barriers to residential energy efficiency on a wide scale by financing vouchers and credit to	*A suitable project for DFI support given its "high" transformational potential, but other highly transformational projects would be considered*

	decrease consumers' energy use and consumers lack resources to invest in more expensive technologies that will save them money in the long term.]	sectors here demonstrate greater need for achieving Paris objectives.]	consumers for energy-efficient appliances and strengthening the capacity of the energy utility to incentivize and design energy efficiency activities.]	*above this if their ambition is also "high."*
Resilience Building				
Law to implement evidence-based flood zoning in cities	*Moderate* [Flood zoning affects land value, negatively affecting some landowners who may have to be compensated. Analytics are needed for policy makers to zone for a changing climate. The long-term cost should be negative, however, thanks to avoided flood losses.]	*High* [Provided that the project is a priority component of a climate change adaptation, resilience, or risk-reduction plan, and the M&E system tracks success of the project, such as an indicator monitoring the number of municipalities with an urban plan accounting for floods, or the change in the number of new buildings built in flooding zones.]	*High* [Changes in land-use plans and permits will significantly affect future investments from the private sector in new buildings.]	*A high priority for a climate program, involving concessionality to overcome upfront costs.*
Improvement of an existing social protection system to make it adaptive (i.e., able to respond to natural disasters)	*Low* [Project may require important investments in capacity and systems that represent an obstacle to implementation. However, it also brings many co-benefits in terms of resilience to nonclimate-related shocks, so barriers are minimized.]	*Moderate* [The project will increase the resilience of the broader population over the short term, and the M&E framework includes evaluating the coverage of the new system as an indicator of its benefits.]	*High* [The project will influence future financial flows of social assistance in the country and use them for resilience building.]	*A priority but for resources with a lower degree of concessionality.*
New flood management infrastructure in a major city (considering long-term climate changes and uncertainties)	*Moderate* [Upfront costs are large while the benefits—avoided flood losses and created land value—accrue in the future.]	*High* [The project is a critical component of an urban resilience plan and explicitly takes into account long-term climate risks with due consideration of the uncertainties and includes relevant indicators in its M&E framework.]	*Low* [This project protects existing and future investments, but in and of itself is not really changing the incentives or capacities in terms of risk management.]	*A suitable project for DFI support given its long-term outlook with moderately concessional resources.*
Early warning system and hydromet strengthening	*Low* [Early warning systems are good investments and they can save lives and avoid losses at low cost; depending on the context, they may or may not have a significant	*Moderate* [The project systematically increases peoples' resilience and can easily provide indicators in its M&E framework to document its intended outcomes.]	*High* [The project can increase the resilience of future projects by generating the data needed to take risks into account, thereby reinforcing capacities regarding disaster risks.]	*Strong priority for DFI support, though a high degree of concessionality may be unnecessary to overcome the barriers.*

	upfront cost (depends on what already exists in the country).]			
A new railway, built outside of the flood plain, and strengthened to resist high winds and precipitation	*Moderate* [Assuming the strengthening of the railway increases the upfront costs.]	*Low* [Not a specific priority for the country to increase resilience of its population. The railway would not otherwise be designed around a changed climate.]	None [This project is made more resilient but does not change the conditions for future projects and investments.]	*Low priority, though concessionality could cover the marginal cost of making the railway resilient.*
Improvement to a country's institutional and financial framework for resilience investment planning	*Moderate* [Significant investments may be required in capacity to integrate strategic resilience planning across the national government.]	*High* [Contributes significantly to the adaptation/resilience agenda of the country, including its NDC, by mainstreaming climate resilience into national development planning; creating several ministerial strategic plans with resilience actions; and assisting with sectoral budget allocations for resilience issues.]	*High* [The project integrates climate risk management into regional planning, thus seeking to increase resilience of vulnerable populations on a large scale. In so doing, it introduces new approaches and technologies that will improve the efficiency of delivering resilience through innovation and scale-up from pilot districts.]	*Strong priority for support, but the degree of concessionality depends on existing capacity to integrate resilience across the various line ministries and implement the activities identified through the strategic plans.*

Note: DFI = development finance institution; M&E = monitoring and evaluation; RE = renewable energy.

At the global scale, the framework might be used to select countries where concessionality has the largest potential impacts on climate change, particularly in terms of GPGs, whereby guiding DFI priorities for higher degrees of concessionality can serve as a useful signal to donors and international funds.

For the case of mitigation, the three dimensions at this scale of analysis translate into:

- Whether there are large barriers to implementing low-carbon development pathways consistent with Paris goals;
- Whether a country has objectives consistent with the Paris Agreement; and
- Whether available actions that can be supported in the country through concessionality have a large potential to influence attainability of the low-carbon development pathway (transformational potential).

Importantly, prioritizing concessionality should not be driven mainly by the existing emissions gap and the countries with large emissions. It should rather be driven by the ambition of the countries' objectives and the potential of concessionality to create conditions that sustain emission reductions beyond a finite intervention (in other terms, the efficiency of concessional resources in a given country). As a result, countries with relatively small emissions may be prioritized if limited concessionality can have a very large impact on their emissions. This is the case in poor countries where infrastructure systems are still to be built and can be designed in a low-carbon manner and at a small additional cost. By the same logic, countries with large emissions may be prioritized if the concessionality addresses a key barrier that can cause a cascade of efforts to reduce emissions.

For the case of resilience building, the three dimensions similarly translate to:

- Whether the country is particularly vulnerable to climate change impacts and unable to implement a more resilient development approach (a measure of the barriers to climate-resilient development);
- Whether a country has resilience-building/adaptation objectives that meaningfully contribute to the Paris Agreement; and
- Whether certain actions can be taken that will have a large effect on resilience (that is, the transformational potential in the country).

Again, the prioritization should not only involve the most vulnerable countries but should also consider how efficient concessionality is in increasing resilience in various countries (an efficiency criterion).

Finally, the framework also translates into a few "rules of thumb," which serve as cross-check considerations to ensure it is operationalized in the manner intended (Box 3-1).

Box 3-1. "Rules of Thumb" to Consider When Implementing the Framework

Concessionality should support policy-enabling environments. Changes in national policies tend to be the most transformational actions. National policies can create the kind of environment that allows concessionality to have larger, catalytic effects on mitigation and resilience building. Moreover, such policies may help mobilize additional domestic and international capital to address climate change. When market or government failures result from domestic regulatory and institutional barriers, perverse and conflicting incentives should be addressed as a matter of urgency. Higher degrees of concessionality should be used to encourage and support policy and regulatory changes that remove institutional and market barriers to transformational programs or projects.

Concessionality should "maximize finance for development" (MFD). Commercial finance should be mobilized for climate projects whenever feasible and cost-effective. Where perceived or real risks deter commercial financing for low-carbon, climate-resilient projects, interventions should address policy, regulatory, and institutional reforms. If consumers have insufficient capacity to pay for externalities, the use of higher degrees of concessionality should be considered to reduce (perceived or actual) risks through credit enhancements and other risk-sharing instruments. If commercial finance remains elusive, directly applying a sufficient degree of concessionality to enable the investment in question should be considered. To avoid unwanted market distortions and maximize the impact of concessionality, the degree of concessionality should neither be greater nor smaller than what is necessary to enable the intended investment and address any barrier to implementation that has been identified.

The effectiveness of concessionality is improved by sending strong, consistent, and coordinated signals. Triggering systemic, low-carbon and climate-resilient transformations, and providing predictable incentives for crowding in commercial finance both require long-term, programmatic engagements. In using concessionality, DFIs should be prepared to stay the course to support a change in trajectory up to the *tipping point*, where the targeted barriers to implementation are overcome and commercial finance can take over. DFIs should signal that concessionality is timebound, delimited by a clear exit strategy, and meant to encourage and support policy changes that promote the adoption of nascent technologies and solutions. Sending clear signals may require coordination within and among DFIs to enable market transformation through scale, and to exploit comparative advantages in addressing complex, system-level changes.

GLOSSARY

Big push model*,* an economic concept that emphasizes that a firm's decision whether to industrialize or, in this context, innovate depends on its expectation of what other firms will do. It explains when industrialization/innovation happens, based on the assumptions of economies of scale and an oligopolistic market—a market situation in which each of a few producers affects but does not control the market structure.

Carbon capture and storage/sequestration (CCS), the process of capturing waste carbon dioxide from large point sources, such as fossil fuel power plants, transporting it to a storage site, and depositing it where it will not enter the atmosphere, normally an underground geological formation.

Carbon lock-in, the self-perpetuating inertia created by large fossil fuel–based energy systems that inhibits public and private efforts to introduce alternative energy technologies.

Carbon market, a market that is created from the trading of carbon emission allowances to encourage or help countries and companies limit their carbon dioxide emissions.

Carbon pricing*,* charging for the amount of GHGs released into the atmosphere—to cover the external costs of carbon emissions that the public pays for in other ways (such as damage to crops and health care costs from heat waves and droughts, or to property from flooding and sea level rise) and tie them to their sources through a price on carbon.

Carbon taxation, putting a price directly on carbon by defining a tax rate on GHG emissions or—more commonly—the carbon content of fossil fuels.

Command-and-control regulation, the direct regulation of an industry or activity by legislation that states what is permitted and what is illegal.

Credit enhancement, a method whereby a borrowing company attempts to improve its debt or credit worthiness by providing the lender with reassurance that it will honor the obligation through additional collateral, insurance, or a third-party guarantee; it lowers the risk of securities for investors.

Feed-in-tariff (FIT), a policy mechanism designed to accelerate investment in renewable electricity technologies by providing *long-term*, typically *fixed-price* payments to producers per unit of renewable electricity supplied to the grid (based on the cost of generation of each technology used).

Free rider problem, a problem that arises when people take advantage of being able to use a common resource, or collective good, without paying for it; it results in the underprovision of the good in question.

Global public goods, goods marked by benefits and/or costs that potentially extend to all countries, people, and generations—in other words, are *nonexcludable*. Some examples of global public goods are mitigation, financial stability, security, knowledge production, and global public health.

Government failure, an imperfection in government performance (as opposed to market failure). It occurs when a government performs inadequately (e.g., when government intervention causes a more inefficient allocation of goods and resources than would occur without that intervention), including when it fails to intervene or does not intervene sufficiently.

Grant element, the difference between the loan's nominal value (face value) and the sum of the discounted future debt-service payments to be made by the borrower (present value), expressed as a percentage of the loan's face value.

Low-carbon markets, markets for low-carbon technologies such as renewables. Besides markets for technologies ("climate inputs"), there are markets for "climate outputs or outcomes" (markets for

mitigation or resilience results). Such markets are created by regulation and include carbon markets, markets for renewable energy certificates or energy efficiency certificates, and green bonds.

Marginal abatement cost, the cost of one additional unit or ton of pollution that is abated, or not emitted.

Market failure, a situation in which the allocation of goods and services is not efficient, that is, another conceivable outcome is possible that results in an individual being better off without someone else being worse off, and society as a whole being better off.

Minimum efficient scale, the smallest amount of production a company can achieve while still taking full advantage of economies of scale in regard to supplies and costs (= the lowest production point at which long-run total average costs are minimized).

Moral hazard, (i) in the context of *insurance*, refers to the situation where someone takes more risks because someone else bears the cost of those risks (if the risk materializes)—the party isolated from risk behaves differently from how it would if it were fully exposed to the risk; (ii) in the context of *climate change,* the cost of future retrofits or crisis management supported by the international community.

Results-Based Climate Finance (RBCF), a financing modality or approach under which a donor or investor disburses funds to a recipient upon the achievement and independent verification of a pre-agreed set of results.

Results-Based Finance (RBF), an instrument that links financing to predetermined results, with payment made only upon verification that the agreed results have indeed been delivered.

Sink, oceans, forests, vegetation, or soils that can reabsorb carbon dioxide, thereby removing it from the atmosphere.

Social cost*,* the "private cost" (= the costs carried by the individuals involved) plus the cost of externalities; in the case of a business, the social cost equals the production expenses plus any indirect expenses or damages borne by others.

Sunk costs*,* costs that have already been incurred and cannot be recovered.

Tipping point, the point at which a series of small changes or incidents become significant enough to cause a larger, more important change; in the context of technologies, often related to network externalities.

BIBLIOGRAPHY

Abiad, A., Furceri, D., and P. Topalova. 2015. "The Macroeconomic Effects of Public Investment: Evidence from Advanced Economies." IMF Working Paper 2015/95.

Acemoglu, D., Aghion, P., Bursztyn, L., and D. Hemous. 2012. "The Environment and Directed Technical Change." *American Economic Review* 102 (1): 131–166. doi: 10.1257/aer.102.1.131.

Acemoglu, D., Akcigit, U., Hanley, D., and W. Kerr. 2016. "Transition to Clean Technology." *Journal of Political Economy* (124.1): 52–104.

Aghion, P., Hepburn, C., Teytelboym, A., and D. Zenghelis. 2014. "Path Dependence, Innovation and the Economics of Climate Change." The New Climate Economy Policy Paper.

Arze del Granado, F., Coady, D., and R. Gillingham. 2012. "The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries." *World Development* 40: 2234–2248. doi:10.1016/j.worlddev.2012.05.005.

Audoly, R., Vogt-Schilb, A., and C. Guivarch. 2014. "Pathways toward Zero-Carbon Electricity Required for Climate Stabilization." World Bank Policy Research Working Paper 7075.

Azar, C., and B.A. Sandén. 2011. "The Elusive Quest for Technology-Neutral Policies." *Environmental Innovation and Societal Transitions* 1: 135–139. doi: 10.1016/j.eist.2011.03.003

Baer, P., Athanasiou, T., Kartha, S., and E. Kemp-Benedict. 2009. "Greenhouse Development Rights: A Proposal for a Fair Global Climate Treaty." *Ethics Place and Environment* 12 (3): 267–281.

BASIC experts. 2011. "Equitable access to sustainable development: Contribution to the body of scientific knowledge." Paper by BASIC expert group: Beijing, Brasilia, Cape Town, and Mumbai.

Bertram, C., Luderer, G., Pietzcker, R.C., Schmid, E., Kriegler, E., and O. Edenhoferet. 2015. "Complementing Carbon Prices with Technology Policies to Keep Climate Targets within Reach." *Nature Climate Change* 5 (3): 235–239.

Bollen, J. 2015. "The Value of Air Pollution Co-Benefits of Cimate Policies: Analysis with a Global Sector-Trade CGE Model Called WorldScan." *Technological Forecasting and Social Change* 90: 178–191.

Bosello, F., Carraro, C. and E. De Cian. 2010. "Climate Policy and the Optimal Balance between Mitigation, Adaptation and Unavoided Damage." *Climate Change Economics* 1 (02): 71–92.

BRACED (Building Resilience and Adaptation to Climate Extremes and Disasters). 2015. "The 3As: Tracking Resilience across BRACED." Paper.

Bramoullé, Y., and L.J. Olson. 2005. "Allocation of Pollution Abatement under Learning by Doing." *Journal of Public Economics* 89 (9–10): 1935–1960. doi:10.1016/j.jpubeco.2004.06.007.

Cao, L., and K. Caldeira. 2008. "Atmospheric CO_2 Stabilization and Ocean Acidification." *Geophysical Research Letters* 35, L19609. doi:10.1029/2008GL035072.

Chiroleu-Assouline, M., and M. Fodha. 2014. "From Regressive Pollution Taxes to Progressive Environmental Tax Reforms." *European Economic Review* 69: 126–142.

Clarke, L., Jiang, K., Akimoto, K., Babiker, M., Blanford, G., Fisher-Vanden, K., Hourcade, J.C., Krey, V., Kriegler, E., and A. Loeschel. 2014. "Assessing Transformation Pathways." In *Climate Change 2014: Mitigation of Climate Change, Working Group III Contribution to the IPCC 5th Assessment Report.* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.). Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA.

Coady, D., Parry, I., Sears, L., and B. Shang. 2016. "How Large Are Global Fossil Fuel Subsidies?" *World Development* 91, 11–27. doi:http://dx.doi.org/10.1016/j.worlddev.2016.10.004.

Creti, A., Kotelnikova, A., Meunier, G., and J.-P. Ponssard. 2017. "Defining the Abatement Cost in Presence of Learning-by-Doing: Application to the Fuel Cell Electric Vehicle." *Environmental and Resource Economics*. https://doi.org/10.1007/s10640-017-0183-y.

Davis, S. J., Caldeira, K., and H.D. Matthews. 2010. "Future CO_2 Emissions and Climate Change from Existing Energy Infrastructure." *Science* 329 (5997): 1330–1333.

Davis, S. J. and R.H. Socolow, 2014. "Commitment Accounting of CO_2 Emissions." *Environmental Research Letters* 9 (8), 084018.

del Río González, P. 2008. "Policy Implications of Potential Conflicts between Short-Term and Long-Term Efficiency in CO_2 Emissions Abatement." *Ecological Economics* 65: 292–303. doi: 0.1016/j.ecolecon.2007.06.013

Dennig, F., Budolfson, M.B., Fleurbaey, M., Siebert, A. and R. H. Socolow. 2015. "Inequality, Climate Impacts on the Future Poor, and Carbon Prices." *Proceedings of the National Academy of Sciences* 112 (52): 15827–15832.

Fay, Marianne; Hallegatte, Stephane; Vogt-Schilb, Adrien; Rozenberg, Julie; Narloch, Ulf; and Tom Kerr. 2015. *Decarbonizing Development: Three Steps to a Zero-Carbon Future. Climate Change and Development.* Washington, DC: World Bank. © World Bank.

Gerlagh, R., Kverndokk, S., and K. Rosendahl. 2009. "Optimal Timing of Climate Change Policy: Interaction Between Carbon Taxes and Innovation Externalities." *Environmental and Resource Economics* 43: 369–390.

Goulder, L.H. and K. Mathai. 2000. "Optimal CO_2 Abatement in the Presence of Induced Technological Change." *Journal of Environmental Economics and Management* 39 (1): 1–38.

Grübler, Arnulf, Nebojša Nakićenović, and David G. Victor. 1999. “Dynamics of Energy Technologies and Global Change.” *Energy Policy* 27 (5): 247–80. (May.) doi: 10.1016/S0301-4215(98)00067-6.

Hallegatte, S., and J. Rentschler. 2015. "Risk Management For Development – Assessing Obstacles and Prioritizing Action." *Risk Analysis* 35 (2): 193–210.

Hallegatte, Stephane; Bangalore, Mook; Bonzanigo, Laura; Fay, Marianne; Kane, Tamaro; Narloch, Ulf; Rozenberg, Julie; Treguer, David; and Adrien Vogt-Schilb. 2016. *Shock Waves: Managing the Impacts of Climate Change on Poverty.* Climate Change and Development. Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/22787. License: CC BY 3.0 IGO.

Hannam, P.M. 2016. *Contesting Authority: China and the New Landscape of Power Sector Governance in the Developing World.* Doctoral dissertation, Princeton University.

Hepburn, C. 2006. “Regulation by Prices, Quantities, or Both: A Review of Instrument Choice.” *Oxford Review of Economic Policy* 22 (2): 226–247.

Horowitz, J., Cronin, J., Hawkins, H., Konda, L., and A. Yuskavage. 2017. Methodology for Analyzing a Carbon Tax, U.S. Treasury Working Paper 115.

IDDRI (Institute for Sustainable Development and International Relations) and SDSN (Sustainable Development Solutions Network). 2014. *Pathways to Deep Decarbonization.* http://unsdsn.org/wp-content/uploads/2014/09/DDPP_Digit_updated.pdf

IEA (International Energy Agency). *World Energy Outlook 2014.* Paris, France. https://www.iea.org/publications/freepublications/publication/WEO2014.pdf.

IMF (International Monetary Fund). 2014. " How Much Carbon Pricing is in Countries’ Own Interests? The Critical Role of Co-Benefits." IMF Working Paper WP/14/174. https://www.imf.org/external/pubs/ft/wp/2014/wp14174.pdf

IPCC (Intergovernmental Panel on Climate Change). 2007. In Mitigation of Climate Change Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, B., Davidson, O.R., Bosch, P.R., Dave, R., and L.A. Meyer (eds.)].Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

———. 2013. “Summary for Policymakers. In *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change”* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex & P.M. Midgley (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, USA, p. 27.

———. 2014. "Summary for Policymakers." In *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. http://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policymakers.pdf

Jakob, M., Chen, C., Fuss, S., Marxen, A., Rao, N.D., and O. Edenhofer. 2016. "Carbon Pricing Revenues Could Close Infrastructure Access Gaps." *World Development* 84 (8): 254–265.

Kalkuhl, M., Edenhofer, O., and K. Lessmann. 2012. "Learning or Lock-In: Optimal Technology Policies to Support Mitigation." *Resource and Energy Economics* 34: 1–23. doi:10.1016/j.reseneeco.2011.08.001

Keohane, R.O. 2015. "The Global Politics of Climate Change: Challenge for Political Science." *PS: Political Science & Politics* 48 (01): 19–26.

Klenert, D., Schwerhoff, G., Edenhofer, O., and L. Mattauch. 2016. "Environmental Taxation, Inequality and Engel's Law: The Double Dividend of Redistribution." *Environmental and Resource Economics*: 1–20. doi:10.1007/s10640-016-0070-y.

Krey V., G. Luderer, G., Clarke, L., and E. Kriegler. 2014. "Getting from Here to There – Energy Technology Transformation Pathways in the EMF27 Scenarios." *Climatic Change* 123: 369–382.

Kverndokk, S., and K.E. Rosendahl. 2007. "Climate Policies and Learning by Doing: Impacts and Timing of Technology Subsidies." *Resource and Energy Economics* 29 (1): 58–82.

Lecuyer, O. and A. Vogt-Schilb. 2014. "Optimal Transition from Coal to Gas and Renewable Power under Capacity Constraints and Adjustment Costs." World Bank Policy Research Working Paper No. 6985.

McGuire, M. C. and H. Aaron. 1969. "Efficiency and Equity in the Optimal Supply of a Public Good." *The Review of Economics and Statistics*: 31–39.

McKinsey and Company. 2009. Pathways to a Low-Carbon Economy – Version 2 of the Global Greenhouse Gas Abatement Curve. McKinsey&Company.

Parry, I., Veung, C., and D. Heine. 2015. "How Much Carbon Pricing is in Countries' Own Interests? The Critical Role of Co-Benefits." *Climate Change Economics* 6.

Pigou, A. C. 1932. *The Economics of Welfare.* (4th edition). London, Macmillan and Co.

Rogelj, J., den Elzen, M., Höhne, N., Fransen, T., Fekete, H., Winkler, H., Schaeffer, R., Sha, F., Riahi, K., and M. Meinshausen. 2016. "Paris Agreement Climate Proposals Need a Boost to Keep Warming Well below 2° C." *Nature* 534.7609: 631–639.

Rogelj, J., Schaeffer, M., Meinshausen, M., Shindell, D. T., Hare, W., Klimont, Z., Velders, G., Amann, M., and H. J. Schellnhuber. 2014. "Disentangling the Effects of CO_2 and Short-Lived Climate Forcer Mitigation." *Proceedings of the National Academy of Sciences* 111 (46): 16325–16330.

Rogelj, J., Schaeffer, M., Friedlingstein, P., Gillett, N., van Vuuren, D., Riahi, K., Allen, M., and R. Knutti. 2016. "Differences between Carbon Budget Estimates Unravelled." *Nature Climate Change* 6 (3): 245–52.

Rosendahl, K.E. 2004. "Cost-Effective Environmental Policy: Implications of Induced Technological Change." *Journal of Environmental Economics and Management* 48, 1099–1121. doi:10.1016/j.jeem.2003.12.007.

Ruggeri Laderchi, C. 2014. "Transitional Policies to Assist the Poor While Phasing Out Inefficient Fossil Fuel Subsidies That Encourage Wasteful Consumption." World Bank Technical paper.

Samuelson, P. A. 1954. "The Pure Theory of Public Expenditure." *The Review of Economics and Statistics* 36 (4): 387–389.

Smit, B., and J. Wandel. 2006. "Adaptation, Adaptive Capacity and Vulnerability." *Global Environmental Change* 16 (3): 282–292.

Stern, N. H. 2007. *The Economics of Climate Change: The Stern Review*. Cambridge, UK: Cambridge University Press.

———. 2015. *Why Are We Waiting? The Logic, Urgency, and Promise of Tackling Climate Change*. MIT Press, Cambridge, MA.

Tavoni, M., Kriegler, E., Riahi, K., van Vuuren, D. P., Aboumahboub, T., Bowen, A., Calvin, K., Campiglio, E., Kober, T., Jewell, J., Luderer, G.,. Marangoni, G., McCollum, D., van Sluisveld, M., Zimmer, A., and B. van der Zwaan. 2015. "Post-2020 Climate Agreements in the Major Economies Assessed in the Light of Global Models." *Nature Climate Change* 5 (2): 119–126.

UNEP (United Nations Environment Programme). 2016. *The Adaptation Finance Gap Report 2016*. Nairobi, Kenya: UNEP. Summary and recommendations by the Standing Committee on Finance on the 2016 biennial assessment and overview of climate finance flows.

van de Walle, D. and K. Nead, eds. 1995. *Public Spending and the Poor: Theory and Evidence*. World Bank Publications. Washington, DC: World Bank.

Vogt-Schilb, A., Hallegatte, S., and C. de Gouvello. 2014. "Marginal Abatement Cost Curves and Quality of Emission Reductions: A Case Study on Brazil." *Climate Policy.*

Vogt-Schilb, A., Meunier, G., and S. Hallegatte. 2018. "When Starting with the Most Expensive Option Makes Sense: Optimal Timing, Cost and Sectoral Allocation of Abatement Investment." Journal of Environmental Economics and Management 88 (March): 210–33.

UNFCCC (United Nations Framework Convention on Climate Change). 2016. *Summary and Recommendations by the Standing Committee on Finance on the 2016 Biennial Assessment and Overview of Climate Finance Flows.*

Wei, T., Yang, S., Moore, J. C., Shi, P., Cui, X., Duan, Q., ... and Z. Yang. 2012. "Developed and Developing World Responsibilities for Historical Climate Change and CO_2 Mitigation." *Proceedings of the National Academy of Sciences* 109 (32): 12911–12915.

West, J.J., Smith, S.J., Silva, R.A., Naik, V., Zhang, Y., Adelman, Z., Fry, M., Anenberg, S., Horowitz. L.W., and J.-F. Lamarque. 2013. "Co-Benefits of Global Greenhouse Gas Mitigation for Future Air Quality and Human Health." *Nature Climate Change* 3 (10): 885–889.

WHO (World Health Organization). 2016. *Ambient Air Pollution: A Global Assessment of Exposure and Burden of Disease.* World Health Organization.

Wigley, T.M.L., Richels, R., and J.A. Edmonds. 1996. "Economic and Environmental Choices in the Stabilization of Atmospheric CO_2 Concentrations." *Nature Volume* 379: 240–243.

Williams, J. H., DeBenedictis, A., Ghanadan, R., Mahone, A., Moore, J., Morrow III, W.R., Price, S., and M.S. Torn. 2012. "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity." *Science* 335: 53–59.

World Bank. 2012 *Inclusive Green Growth – The Pathway to Sustainable Development.* Washington, DC: World Bank.

World Bank and Frankfurt School of Finance and Management. 2017. *Results-Based Climate Finance in Practice: Delivering Climate Finance for Low-Carbon Development*. Washington, DC: World Bank.

World Bank, Ecofys, and Vivid Economics. 2016. *State and Trends of Carbon Pricing* 2016. Washington, DC: World Bank.

———. 2017. *State and Trends of Carbon Pricing 2017.* Washington, DC: World Bank.

World Bank Group. 2017. *Maximizing Finance for Development: Leveraging the Private Sector for Growth and Sustainable Development.* Development Committee.

Yusuf, A.A., and B.P. Resosudarmo. 2015. "On the Distributional Impact of a Carbon Tax in Developing Countries: The Case of Indonesia." *Environmental Economics and Policy Studies* 17 (1): 131–156.