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EARLY INSIGHTS ON LONG-TERM CLIMATE STRATEGIES

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EXECUTIVE SUMMARY

Highlights

- Parties to the Paris Agreement are invited to communicate "long-term low greenhouse gas emission development strategies" (long-term strategies) by 2020.
- Six countries—Benin, Canada, France, Germany, Mexico, and the United States—have already communicated their initial long-term strategies to the UNFCCC.
- This working paper surveys the long-term strategies from these six countries. We find that countries highlight similar mitigation priorities but address finance flows and adaptation in different ways.
- The survey of these strategies also gives rise to key findings and questions for policymakers and the international community to grapple with as more countries embark on the process of developing a long-term strategy.

CONTENTS

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Parties to the Paris Agreement are invited to communicate "long-term low greenhouse gas emission development strategies" (long-term strategies) by 2020. These strategies are central to achieving the long-term goal of limiting warming to 1.5–2°C and will help reveal what is needed to bring national climate action in line with global ambition. Six countries—Benin, Canada, France, Germany, Mexico, and the United States—have already submitted their initial long-term strategies to the UNFCCC.

This working paper surveys the long-term strategies from these six countries, offers preliminary insights on how countries are approaching this exercise, and identifies key considerations both for countries that will develop these strategies and for the international community. Given the limited number and country representation of long-term strategies available to date, these insights and considerations must be considered preliminary. Our understanding will no doubt expand as a more diverse set of countries undertake to develop long-term strategies going forward.

Key findings

Countries develop new strategies or build on existing ones. Canada, Germany, and the United States developed new long-term strategies specifically in response to the invitation in Article 4.19 of the Paris Agreement. Benin, France, and Mexico opted to submit existing/updated strategies that were either originally mandated by national laws or developed in response to prior Conference of Parties decisions.

Countries lay out clear long-term mitigation objectives. The six countries reviewed in this paper had considered a national long-term vision for emissions reductions prior to developing a long-term strategy, which may have allowed them to move forward more quickly with this process. Apart from Benin, the countries reviewed here use model-based scenarios to inform their long-term strategies and explore technology pathways, trade-offs, and uncertainties, as well as the role of different medium-term targets and policies for longer-term emissions trends.

Countries highlight similar mitigation actions, such as transitioning to clean energy, improving energy efficiency and demand-side management, reducing non–carbon dioxide (CO_2) emissions, carbon pricing, changing behavior and moving toward sustainable consumption patterns, and protecting and enhancing natural carbon sinks.

Countries envision strong links between climate and development. These links are underscored strongly in the long-term strategy narratives. However, it is not clear to which extent development considerations shaped the pathways considered in the strategies, versus to which extent the pathways were developed primarily around climate goals, with the link to development priorities established after the fact to frame the strategies. Moreover, the extent to which, or the way in which, this link will be ensured during implementation is generally not made explicit.

Most countries provide a detailed description of the consideration of the long-term temperature goal and cite various studies to demonstrate that their vision for emission reductions is within an acceptable range of limiting warming to less than 2°C.

Adaptation is addressed to varying degrees. Canada, France, Germany, and the United States refer to separate adaptation planning documents, while Benin and Mexico have fully incorporated adaptation, creating a single long-term vision for low-carbon and climate-resilient development. In all cases, however, countries appear to recognize the inherent synergies and linkages between long-term adaptation and mitigation pathways.

Key considerations

From these findings, we identify a series of questions that will need to be considered by policymakers as they embark on developing a long-term strategy, as well as by the international community as it addresses the role of long-term strategies in the broader implementation of the Paris Agreement and the need to provide adequate support to countries as they develop their strategies.

The following questions are key considerations for policymakers who will be developing long-term strategies:

- What scope will best support the goals of the Paris Agreement as well as national development objectives?
- How can countries ensure that long-term strategies inform near- and medium-term decisions?
- What considerations should inform the establishment of a long-term target or vision for emissions reductions?

- Which central economic, policy, and technology questions and trade-offs should the long-term strategy explore? How might the long-term strategy make best use of scenarios, as well as existing literature, to explore these questions and trade-offs?
- How can stakeholders be engaged in long-term strategy development in a manner that is both meaningful and feasible?
- How can the long-term strategy best send the right market signals to investors?

The following are key considerations for the international community (negotiators, funders, civil society) more generally:

- What special needs and considerations might be applicable for long-term strategy development in countries with relatively limited capacities and resources?
- How can countries align the review and update of long-term strategies with the review cycles stipulated by the Paris Agreement?
- How can long-term strategies inform near- and medium-term decision making, including enhancing nationally determined contributions?
- How can the international community foster peer learning and cooperation on long-term strategies among countries?

1. INTRODUCTION

Under Article 4.19 of the Paris Agreement, parties are invited to communicate "long-term low greenhouse gas emission development strategies" (referred to here as "long-term strategies"). Countries have flexibility to formulate their strategies in the manner they see fit, within the context of their national circumstances and respective capabilities. These strategies offer countries an opportunity to develop transformative pathways considering the Paris Agreement's long-term temperature goal[1] and objective of reaching global net-zero greenhouse gas (GHG) emissions in the second half of this century.

The decision text that accompanies the Paris Agreement invites parties to communicate "midcentury," long-term strategies to the United Nations Framework Convention on Climate Change (UNFCCC) by 2020. Six countries—Benin, Canada, France, Germany, Mexico, and the United States[2]—did so toward the end of 2016.[3] Canada, France, Germany, Mexico, and the United States have put forward midcentury long-term strategies (i.e., up to 2050), while Benin's strategy covers a shorter time frame, from 2016 to 2025. These six strategies range in scope and length but are united by a common objective of creating a national long-term vision and framework for low-emissions development.

This paper surveys the contents of the long-term strategies from these six countries with a view to identifying emerging insights stemming from the strategies to date and identifying key considerations both for the international community and for countries that develop long-term strategies in the future. Of the six strategies surveyed, five are from G20 countries. This necessarily limits the scope of the insights gleaned and considerations identified; both can be expected to evolve as more countries—especially, developing countries—undertake long-term strategies.

The objectives of this paper are to capture succinctly the major elements of these initial strategies, examine the various approaches adopted, and identify key questions and considerations—both for the international community and for policymakers who develop long-term strategies in the future—stemming from these processes.

2. METHODOLOGY

This section describes the methodology for surveying the long-term strategies. First, we establish an initial set of survey elements based on all the relevant provisions of the Paris Agreement (Section 2.1). Then, we expand on these elements based on common themes that have emerged across several strategies (Section 2.2).

2.1. Develop survey elements based on the provisions of the Paris Agreement

The Paris Agreement provides guideposts for developing long-term strategies. Related excerpts are presented in Box 1.

Based on the provisions of the Paris Agreement presented in Box 1, the elements that we consider when surveying countries' long-term strategies are as follows:

- Mitigation (Articles 2.1a, 4.1)
- Development (Article 2.1)

Box 1 | Provisions of the Paris Agreement Related to Long-Term Strategies

Article 2.1
"This Agreement, in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by:

- Holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change;
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development, in a manner that does not threaten food production; and
- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."

Article 2.2
"This Agreement will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

Article 4.1
"In order to achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties, and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century, on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty."

Article 4.19
"All Parties should strive to formulate and communicate long-term low greenhouse gas emission development strategies, mindful of Article 2 taking into account their common but differentiated responsibilities and respective capabilities, in the light of different national circumstances."

The decision text of the Paris Agreement also provides further information related to long-term strategies:

Decision 1/CP.21, paragraph 5
"Invites Parties to communicate, by 2020, to the secretariat mid-century, long-term low greenhouse gas emission development strategies in accordance with Article 4, paragraph 19, of the Agreement, and requests the secretariat to publish on the UNFCCC website Parties' low greenhouse gas emission development strategies as communicated."

- Consideration of the long-term temperature goal (Articles 2.1a, 4.1)
- Adaptation (Article 2.1b)
- Finance flows (Article 2.1c)
- Equity and the principle of common but differentiated responsibilities and respective capabilities (CBDRRC), in light of different national circumstances[4] (Articles 2.2, 4.19)

These elements are based on our interpretation of the language in the Paris Agreement and should not be construed as mandatory topics that need to be included in long-term strategies. As noted in the introduction, countries have flexibility to formulate their strategies in the manner they see fit.

2.2. Identify additional common elements

Following a review of the six long-term strategies, several additional common elements appear in countries' strategies. These include a long-term vision for society, the objectives of the strategy, plans to review and revise the strategy, and the stakeholder consultation process.

2.3. Survey elements

The complete list of survey elements—based on the provisions of the Paris Agreement identified in Section 2.1 and the additional elements identified in Section 2.2—is as follows: a long-term vision for society; the objectives of the strategy; mitigation; development; consideration of the long-term temperature goal; adaptation; finance flows;

equity and CBDRRC, in light of national circumstances; the stakeholder consultation process; and plans to review and revise the strategy.

3. SUMMARY OF ELEMENTS INCLUDED IN COUNTRIES' STRATEGIES AND EMERGING INSIGHTS

This section explores the various elements of the six countries' long-term strategies, based on the survey elements outlined in Section 2.3. Unless otherwise noted, the information in this section is sourced directly from countries' strategies. This section is organized as follows:

- Section 3.1 presents an overview of the six strategies, which includes a long-term vision for society and the objectives of the strategies.
- Section 3.2 highlights the mitigation components of the strategies, which covers the quantitative vision for emission reductions, mitigation scenarios, strategic areas of focus, and aligning short-, medium-, and long-term mitigation planning.
- Section 3.3 presents the development components of the strategies.
- Section 3.4 shows the linkages of countries' strategies with Article 2, which includes the consideration of the long-term temperature goals, adaptation, finance flows, and equity and CBDRRC, in light of national circumstances.
- Section 3.5 presents additional considerations, such as the stakeholder consultation processes and plans to review and revise the strategy.

Emerging insights on each theme are presented in boxes at the end of the subsections.

3.1. Overview

3.1.1. Long-term vision

At the beginning of their strategies, countries outline a long-term vision that will guide their decisions and frame policy priorities. Canada, France, Germany, Mexico, and the United States have put forward midcentury long-term visions (i.e., up to 2050), while Benin's strategy covers a shorter time frame, from 2016 to 2025.

Here are the related excerpts:

[Translated] "Benin, by 2025, is a country whose development is resilient to climate change with a low carbon intensity."

—Benin's Low Carbon and Climate Resilient Development Strategy, December 2016

"Canada is committed to creating a cleaner, more innovative economy that reduces emissions and protects the environment, while creating well-paying jobs and promoting robust economic growth."

—Canada's Midcentury Long-Term Low-Greenhouse Gas Development Strategy, November 2016

"Germany's Climate Action Plan 2050 is guided by the principle of achieving extensive greenhouse gas neutrality by the middle of the century."

—Germany's Climate Action Plan 2050, November 2016

"The French national low-carbon strategy orchestrates the implementation of the transition towards a low-carbon economy."

—France's National Low-Carbon Strategy, December 2016

"[Mexico's] long-term vision is fourfold:
(1) Mexico experiences sustainable development and low-emissions growth through an efficient management of natural resources and the use of clean energy resources.
(2) Mexico is a thriving, competitive, socially inclusive, and globally responsible country.
(3) The Mexican population has rewarding and well-paid jobs, and especially the most vulnerable population has advancement opportunities.
(4) Mexico has a climate resilient society and ecosystems, sustainable cities, and a green economy."

—Mexico's Climate Change Midcentury Strategy, November 2016

"The mid-century strategy demonstrates how the United States can meet the growing demands on its energy system and lands while achieving a low-emissions pathway, maintaining a thriving economy, and ensuring a just transition for Americans whose livelihoods are connected to fossil fuel production and use."

—United States Midcentury Strategy for Deep Decarbonization, November 2016

3.1.2. Objectives

The six strategies surveyed in this paper are guided by similar objectives, which are to

- inform near-and long-term planning and investments, taking climate objectives into consideration;
- present a vision, principles, goals, and main lines of action for low-emissions development;
- guide near-term policies and actions at the national, subnational, and sectoral levels; and
- identify key GHG abatement opportunities and areas where emission reductions may be more difficult to achieve (i.e., when considerable innovation, creative policies, and additional financing is needed to reduce GHG emissions).

Countries emphasize that these strategies present options and opportunities to advance on a low-carbon development pathway.

While countries are guided by similar objectives, each strategy has a distinct character. For example, Canada and the United States highlight the important role of innovation, which is a running theme through both strategies. Benin and Mexico give equal prominence to adaptation and mitigation, while the other four countries focus primarily on mitigation. Germany ties its strategy closely to the Sustainable Development Goals and Agenda 2030. France outlines a carbon budget approach and sets sector-specific targets for both the medium term (2028) and long term (2050).

3.1.3. Some familiar strategies, some new strategies

Of the six countries surveyed in this paper, three communicated new long-term strategies to the UNFCCC toward the end of 2016—Canada, Germany, and the United States. The other three countries—Benin, France, and Mexico—communicated either identical or updated versions of strategies that had been previously adopted at the national level.

Benin's Low Carbon and Climate Resilient Development Strategy, which was submitted to the UNFCCC in December 2016, is identical to the national strategy that was adopted in September 2016 (*Benin Times* 2016). The original strategy began its formulation in September 2013 in response to the Conference of Parties (COP) decisions 1/CP.16 and 2/CP.17, when developing countries were encouraged to develop low-emissions development strategies (Houanho 2016).

The French National Low-Carbon Strategy (Stratégie Nationale Bas-Carbone), which was submitted to the UNFCCC in December 2016, is identical to the national strategy that was adopted in November 2015 (INERIS 2015). The original strategy was developed to meet Article 173 of the country's Energy Transition and Green Growth Act, which stipulates that the government "must draw up and publish a report which explains how the carbon budgets and low-carbon strategy will be reconciled with the objectives stipulated in Article L. 100-4 of the Energy Code,[5] as well as France's European and international commitments." This law also defines other objectives for the energy sector, such as securing the energy supply and reducing pollution.

Mexico's Climate Change Midcentury Strategy builds on the National Climate Change Strategy: 10-20-40 Vision, which was adopted in June 2013 (Government of Mexico 2013). The original strategy was developed to meet Article 60 of the country's General Law on Climate Change, which states that the strategy will "constitute the document that governs national policy in the medium- and long-term to combat the effects of climate change and to transition to a competitive, sustainable low carbon emissions economy." The same topics are covered in both strategy documents, through Mexico's midcentury strategy includes an additional section on long-term mitigation scenarios.

Notably, those countries that developed entirely new strategies—Canada, Germany, and the United States—had previously considered quantitative mitigation visions for 2050 (see Table 1).

Emerging Insights

Some countries have developed new long-term strategies specifically in response to the invitation in Article 4.19 of the Paris Agreement. Others have opted to submit existing strategies, or updated versions of existing strategies, that were either originally mandated by national laws or developed in response to prior COP decisions.

Building on existing strategies—particularly those that stem from robust analytical and engagement processes at the domestic level—can offer numerous benefits, such as optimizing resources and ensuring the buy-in of key institutions. At the same time, existing strategies can be subject to certain constraints, depending on how they were initially designed. For example, strategies undertaken prior to the Paris Agreement may not consider the long-term, global goals embedded therein. Likewise, most preexisting strategies tackle a shorter time frame than midcentury. Therefore, if expanding on an existing strategy, it will be important not to lose sight of the following:

- **The opportunities afforded by long-term planning** (if, for example, the existing strategy covers a shorter time frame). Although Article 4.19 of the Paris Agreement does not stipulate a time frame for these long-term strategies, paragraph 5 of decision 1/CP.21 provides additional clarification, inviting parties to communicate midcentury long-term strategies. Developing a strategy out to 2050 provides a means to align short-, medium-, and long-term planning, thus minimizing the risks of carbon lock-in, stranded assets, and investments that are incompatible with a low-carbon and climate-resilient future.
- **Pursuing efforts to limit the temperature increase to 1.5°C above preindustrial levels** (if, for example, the existing strategy only considers the global temperature goal of limiting warming to 2°C). The Paris Agreement was adopted in December 2015, when, for the first time, parties agreed to pursue efforts to limit the global average temperature rise to 1.5°C by 2100. Long-term strategies developed prior to December 2015 are unlikely to have considered the more ambitious temperature goal. Submitting an updated strategy to the UNFCCC offers countries an opportunity to rethink their long-term visions and develop transformative pathways in light of a 1.5°C goal.
- **The opportunities to integrate other nationally relevant factors into long-term planning.** For example, including adaptation elements could help policymakers assess the impacts on resilience associated with long-term low-GHG development. Discussing finance in more detail in these strategies offers countries an opportunity to put in place the right policies to channel finance and reprioritize spending toward climate-related activities over the long term. While there are undoubtedly trade-offs between breadth (number of topics addressed) and depth (comprehensiveness of select topics), considering additional elements in these strategies allows countries to explore synergies and integrate additional factors in long-term planning.

Table 1 | **Countries' Long-Term Mitigation Goals**

COUNTRY	QUANTITATIVE VISION FOR EMISSIONS REDUCTIONS[a]	QUANTITATIVE VISION FOR EMISSIONS REDUCTIONS CONSIDERED PRIOR TO THE SUBMISSION OF THE LONG-TERM STRATEGY?	QUANTITATIVE SECTORAL TARGETS INCLUDED IN THE LONG-TERM STRATEGY?	USE OF INTERNATIONALLY TRANSFERRED MITIGATION OUTCOMES TO MEET LONG-TERM VISION?	USE OF MARKET-BASED INSTRUMENTS TO MEET LONG-TERM VISION?
Benin	The mitigation plans outlined in Benin's long-term strategy will deliver emission reductions at least equivalent to the commitments made in the country's INDC, or the avoidance of at least 12 $MtCO_2e$ and sequestration of 163 $MtCO_2e$ by 2030.	Yes, in the INDC (September 2015; Government of Benin 2015).	No	Yes, Benin discusses introducing a carbon tax (the taxation amount is not specified in the strategy).	Not mentioned in the strategy.
Canada	Canada examines an emissions abatement pathway consistent with net GHG emissions falling by 80% in 2050, relative to 2005 levels.	Yes, Canada joined the "Group of Eight" nations (G8) in calling for global emissions reductions of 50% by 2050, including reductions of 80% or more by developed countries (July 2009; G8 Leader Declaration 2009).[b]	No	Yes, "Canada's First Ministers and Indigenous Leaders . . . committed to developing a concrete plan to achieve Canada's international greenhouse gas reduction commitments through a pan-Canadian framework for clean growth and climate change. . . . They committed to deliver mitigation actions by adopting a broad range of domestic measures, including carbon pricing mechanisms, adapted to each jurisdiction's specific circumstances."	Yes, "Canada will consider internationally transferred mitigation outcomes as a short-to-medium term complement to reducing emissions at home. Likewise, Canada intends to take into account internationally transferred mitigation outcomes arising from cross-border subnational emission trading as part of its international contribution to addressing climate change."
France	France includes a target to reduce GHG emissions by 75% by 2050, relative to 1990 levels.	Yes, in the French energy policy law (July 2005), known as the POPE Framework Law 2005-781-Orientation Program for Energy Policy Law (Ministry of Ecology, Sustainable Development, and Energy 2013).	Yes, the strategy presents indicative sectoral targets for 2028 and 2050 for all sectors of the economy.	Yes, France plans to "progressively increase the share of carbon in domestic taxes on energy consumption without increasing overall taxation." The strategy also mentions a carbon price of €22/tCO_2 in 2016, increasing to €56/tCO_2 in 2020 and €100/tCO_2 in 2030 (in 2015€).	Yes, France discusses the EU Emissions Trading Scheme (ETS) in the context of its carbon budget approach and the GHG emissions covered by the ETS.

Table 1 | **Countries' Long-Term Mitigation Goals (continued)**

COUNTRY	QUANTITATIVE VISION FOR EMISSIONS REDUCTIONS[a]	QUANTITATIVE VISION FOR EMISSIONS REDUCTIONS CONSIDERED PRIOR TO THE SUBMISSION OF THE LONG-TERM STRATEGY?	QUANTITATIVE SECTORAL TARGETS INCLUDED IN THE LONG-TERM STRATEGY?	USE OF INTERNATIONALLY TRANSFERRED MITIGATION OUTCOMES TO MEET LONG-TERM VISION?	USE OF MARKET-BASED INSTRUMENTS TO MEET LONG-TERM VISION?
Germany	Germany includes a target to reduce GHG emissions by 80% to 95% by 2050, relative to 1990 levels. In addition, the strategy is guided by the principle of "extensive greenhouse gas neutrality in Germany by the middle of the century."	Yes, in the G8 announcement (July 2009)[c] and the German Energy Concept policy document (September 2010; BMWi and BMUB 2010).	Yes, the strategy presents quantitative sectoral targets for 2030 for all sectors of the economy, excluding land use and forestry.[d]	Yes, Germany will further develop the country's tax system, strengthen economic incentives to encourage polluters to reduce emissions, and remove environmentally harmful subsidies.	Yes, Germany advocates strengthening the ETS.
Mexico	Mexico aims to reduce GHG emissions by 50% by 2050, relative to 2000 levels.	Yes, in the Mexican General Law on Climate Change (April 2012; INECC 2012).	No	Yes, Mexico will develop "climate-specific fiscal policies and economic instruments [that] will promote a low-emission economic development and will increase our global competitiveness." Mexico also discusses its existing carbon tax.	No, Mexico did not simulate international emissions trading in its modeled mitigation scenarios.
United States	The United States envisions economy-wide net GHG emissions reductions of 80% or more below 2005 levels by 2050.	Yes, in the G8 announcement (July 2009)[e] and in the INDC (March 2015; Government of the United States 2015).	No	Yes, "carbon pricing will enable cost-effective emission reductions through market forces that encourage the development and deployment of the most cost-effective low carbon solutions across the economy. . . . An effective carbon price that starts at $20 per metric ton in 2017 and increases steadily over time would be sufficient to put energy CO_2 emissions on a pathway largely consistent with the MCS midcentury strategy vision."	Not mentioned in the strategy.

Notes:

a. Countries do not state whether their long-term quantitative visions for emissions reductions are conditional or unconditional.

b. The 2009 G8 Leader Declaration was seen as a vision toward collective ambition but does not constitute a specific commitment for any individual country.

c. The 2009 G8 Leader Declaration was seen as a vision toward collective ambition but does not constitute a specific commitment for any individual country.

d. According to Germany's long-term strategy, "accounting for emissions from land use and forestry is subject to considerable methodological difficulties," and "therefore, the German government does not include this sector directly in the national climate targets."

e. The 2009 G8 Leader Declaration was seen as a vision toward collective ambition but does not constitute a specific commitment for any individual country.

3.2. Mitigation

Mitigation is addressed on several fronts in the six countries' strategies. Typically, countries have included a long-term quantitative vision for emission reductions, mitigation scenarios, strategic areas of focus, and assertions of the need to align short-, medium-, and long-term mitigation planning.

3.2.1. Quantitative vision for emission reductions

Canada, France, Germany, Mexico, and the United States include an economy-wide, quantitative vision for emissions reductions in 2050. Benin's strategy, which covers a shorter time frame up to 2025, does not include a quantitative emission reduction goal. However, the country does state that the implementation of the mitigation plans outlined in its long-term strategy will deliver emission reductions at least equivalent to the commitments made in the country's intended nationally determined contribution (INDC). Table 1 presents an overview of countries' long-term mitigation goals.

3.2.2. Modeling and scenario development

Modeling and scenario development are central elements of most strategies and help reveal what and when specific mitigation actions are needed to achieve long-term goals.

Apart from Benin, the countries reviewed in this paper have used model-based scenarios to support the development of their long-term strategies. These countries have approached this exercise in different ways.

Canada and the United States use several scenarios to **examine trade-offs, explore different technological uncertainties, and identify common trends**. Canada draws on six scenarios to identify the type and scale of transformation needed for energy-related GHG emissions. Canada states that comparing results across models, or across modeled scenarios, provides overarching high-level messages and key takeaways. The United States models seven pathways to identify "findings that are robust across scenarios, which provide a strong basis for immediate action." The United States included several scenarios due to the "uncertainties surrounding the evolution of technologies, economic conditions, and social dynamics over the coming decades."

Mexico and France use scenarios to **explore the impact of medium-term goals and polices on a long-term pathway**. Mexico uses its scenarios to explore its unconditional and conditional nationally determined contribution (NDC) goals in the context of a longer-term emissions trajectory. France includes scenarios to illustrate the magnitude of the efforts to be made, as well as the expected transformations and cobenefits.

Germany uses scenarios to show that the GHG emissions reduction target is technically and economically feasible, based largely on known technologies (but doesn't provide additional modeling details in its strategy).

Table 2 details the types of scenarios that have been developed or referenced, and Table 3 summarizes the modeling tools used. The countries reviewed underscore that scenarios are included for illustrative purposes only and do not necessarily represent optimal pathways. Most countries highlight a range of different possible scenarios, reflecting uncertainties and showing that more than one pathway can be taken to reach their long-term visions.

3.2.3. Strategic areas of focus

All strategies outline the strategic areas of focus to transition toward a low-GHG economy. Common mitigation themes appearing across several strategies include transitioning to clean energy, improving energy efficiency and demand-side management, reducing non-CO_2 emissions, changing behavior and moving toward sustainable consumption patterns, carbon pricing, and protecting and enhancing natural carbon sinks. Table 4 presents the strategic areas of focus identified in each strategy.

3.2.4. Aligning short- and medium-term planning with the long-term vision

The long-term strategies recognize the need to align short-term planning with the long-term vision. Canada states that midcentury objectives will be ultimately realized though concrete, short-term action, drawing links to its Pan-Canadian Framework on Clean Growth and Climate Change[6] (its plan up to 2030). France includes key actions that need to be implemented over the next 10 years to meet its long-term goal. Similarly, as noted above, Germany sets quantitative sector targets and milestones for 2030, with associated activities, and also notes that programs and measures will be laid out by 2018 to achieve these targets. Mexico states that it intends to use its strategy to align its short- and medium-term actions with its long-term objectives. The United States mentions that long-term strategies can help put near-term emissions reduction goals in a longer-term context. Benin's strategy

covers a shorter time frame (from 2016 to 2025), which supports the alignment of short- and medium-term planning but lacks an explicit link to the longer term.

Apart from Benin, the countries reviewed in this paper also relate short-term planning to the risks associated with investing in fossil fuel infrastructure, which "locks in" a high emissions pathway and makes the shift toward a low-carbon economy more costly and complex. Canada, Germany, Mexico, and the United States discuss the risks of carbon lock-in in the context of long-lived infrastructure, such as electricity-generating facilities, distributional infrastructure, and buildings. France also includes a section on the financial sector's exposure to stranded assets (fossil fuel reserves that have been accounted for on companies' balance sheets but that need to be kept in the ground to avoid exceeding the carbon budget). Due to these risks, France's strategy recommends that institutional investors consider climate change in the management of their portfolios and guide funding toward low-carbon investments.

Table 2 | **Scenarios Included in Countries' Strategies**

COUNTRY	MITIGATION SCENARIOS
Benin	Benin does not establish mitigation scenarios its long-term strategy.
Canada	Canada draws on six scenarios: ■ A **High Ambition** (Deep Decarbonization Pathways Project) scenario, which achieves 89% GHG emission reductions below projections in 2050 (excluding agriculture) ■ A **Current Tech** scenario (from the Trottier Energy Futures Project), which achieves a 60% reduction in energy sector GHG emissions relative to 1990 levels ■ A **New Tech** scenario (from the Trottier Energy Futures Project), which also achieves a 60% reduction in energy sector GHG emissions relative to 1990 levels ■ Non-emitting Electricity scenarios: ☐ A **High Nuclear** scenario, which is heavily dependent on nuclear electricity production ☐ A **High Hydro** scenario, which relies on a mix of hydro and wind to produce the majority of electricity ■ A **High Demand Response** scenario, which achieves a net 80% GHG emission reduction by 2050 relative to 2005 levels ■ Unlike the other four countries that use scenarios in their long-term strategies, Canada does not include a benchmark scenario in its strategy.
France	France includes two scenarios in its strategy: ■ A **Trend-Based** (with Existing Measures) scenario, which is based on policies and measures implemented before January 1, 2014 ■ A **Reference** (with Additional Measures) scenario, which includes all measures included in the country's Green Growth and Energy Transition Law
Germany	Mitigation scenarios are not provided in the strategy.
Mexico	Mexico develops three scenarios to advance the understanding of its mitigation options: ■ A **Baseline** scenario, which estimates the emissions trajectory without imposing climate or energy policy constraints ■ An **NDC Policy** scenario, which achieves a 22% reduction of GHG emissions by 2030 (in line with Mexico's unconditional NDC target) and 50% by 2050, both relative to 2000 levels ■ An **NDC More Ambition** scenario, which achieves a 36% reduction of GHG emissions by 2030 (in line with Mexico's conditional NDC target) and 50% by 2050, both relative to 2000 levels
United States	The United States models seven scenarios due to the "uncertainties surrounding the evolution of technologies, economic conditions, and social dynamics over the coming decades." These include the following: ■ A **Benchmark** scenario as a starting point for the analysis ■ A **No CO_2 Removal Technology** scenario, which assumes that engineered CO_2 removal technologies like bioenergy with carbon capture and storage (BECCS) are unavailable ■ A **Limited Sink** scenario, which assumes not only limited availability of CO_2 removal technologies but also limited success in maintaining and enhancing the land sink ■ A **No CCUS** scenario, which achieves 80% reductions by 2050 without the use of carbon capture and storage (CCS) ■ A **Smart Growth** scenario, which portrays a different pathway to decarbonization in the transportation and buildings sectors ■ A **Limited Biomass** scenario, which explores an alternative to the midcentury strategy (MCS) benchmark scenario with lower bioenergy consumption and no deployment of BECCS ■ A **Beyond 80** scenario, which assumes stronger global action to reduce emissions and more rapid advances in low-carbon technologies

Table 3 | Modeling Tools Used

COUNTRY	MODEL[a]	MODEL TYPE[b]	MODEL SCOPE[c]	MODEL TIME FRAME	CO_2 EMISSIONS PATHWAY[d]	NON-CO_2 EMISSIONS PATHWAY[e]	SEQUESTRATION PATHWAY	GHG EXPORTS	COSTS OF ACTION?[f]
Benin	Modeling and scenario development are not included in strategy.								
Canada	Government CGE model and others	IAM/ computable CGE	Economy-wide/ sectoral	Up to 2050	Total energy and sectoral	By sector/ use	Not shown	No	No
France	NEMESIS and THREEME	Hybrid macroeconometric model and CGE	Economy-wide/ sectoral	Up to 2035	Total energy and sectoral	By sector/ gas	Not shown	No	No
Germany	Modeling and scenario development are not included in strategy.								
Mexico	EPPA	CGE	Sectoral	Up to 2050	Total energy and sectoral	CH_4, NOx, PFC, SF_6, HFC	Land-use net CO_2	No	No
United States	GCAM	IAM	Economy-wide	Up to 2050	Total energy and sectoral	CH_4, NOx and f-gases, by gas/use	Land-use net CO_2, forestland, land-use, CCS	No	No

Notes:

a. The United States used the Global Change Assessment Model (GCAM), developed and run by the Pacific Northwest National Laboratory; Canada used in-house modeling from the Government of Canada's computable general equilibrium (CGE) model and GCAM, while external analysis and results were represented from the Deep Decarbonization Pathways Project and from the Trottier Energy Futures Project (North American TIMES Energy Model [NATEM] and Canadian Energy System Simulator [CanESS] models); Mexico used the Massachusetts Institute of Technology Economic Projection and Policy Analysis (EPPA) model; and France used the New Econometric Model for Environmental Strategies Implementation for Sustainable Development (NEMESIS) and Multisector Macroeconomic Model for the Evaluation of Environmental and Energy policy (THREEME).

b. Integrated assessment models (IAMs) are policy-evaluation optimization tools that combine energy, climate, and economics modules. Computable general equilibrium (CGE) models are tools that use economic data and theory to simulate the reaction of an economy to changes in policy, technology, or other factors; pathway models start with an emissions target and/or other objectives, and scenarios are developed to show how these objectives can be achieved. France's THREEME model is a hybrid model that combines the top-down approach of general equilibrium macroeconomic models with elements of bottom-up energy models developed by engineers.

c. In this context, economy-wide models imply that all sources and sinks of greenhouse gas emissions are within the model scope.

d. The United States shows pathways for energy use from electricity, transportation, buildings, and industry; Canada shows pathways for energy-related GHG emissions for electricity supply, transportation, buildings, and industry.

e. Mexico also provides pathways for black carbon emissions.

f. None of the studies provides estimates of the overall costs of achieving the targets. The United States includes a pathway of energy sector carbon prices to 2040 and a range of investment costs for electricity-generating capacity; Mexico includes marginal abatement cost curves for mitigation opportunities.

Table 4 | **Strategic Areas of Focus Identified in the Strategies[a]**

	BENIN	CANADA[b]	FRANCE	GERMANY	MEXICO	UNITED STATES
Transition toward clean/renewable energy	X	X	X	X	X	X
Reduce energy consumption and improve energy efficiency and demand-side management	X	X	X	X	X	X
Move to lower or low-carbon fuels in sectors that are difficult to electrify		X	X			
Sector coupling[c]				X		
Enhance interjurisdictional electricity transmission		X				
Reduce non-CO_2 GHGs and/or short-lived climate pollutants		X	X		X	X
Change behavior and move toward a circular economy/ sustainable consumption patterns		X	X		X	
Develop sustainable cities		X			X	
Sequester CO_2 through forests and lands and protect/enhance carbon sinks	X	X	X	X[d]	X	X
Carbon pricing	X	X	X	X		
Collaborate with stakeholders to enable clean growth and reduce emissions		X	X	X		
Stimulate the bioeconomy (efficient use of wood and agricultural residues)			X			
Sustainable agriculture				X	X	
Develop CO_2 removal technologies that sequester and store carbon						X

Notes:

a. The table is based on the areas of focus explicitly highlighted in each strategy and may not fully reflect the range of issues considered by each country. Moreover, some countries have not always clearly delineated their strategic areas of focus in their long-term strategies.

b. Canada's midcentury strategy also touches on elements of stimulating the bioeconomy, sustainable agriculture, and CO_2 removal technologies (in the executive summary and chapters 6 and 7 of the strategy).

c. According to Germany's strategy, "sector coupling" is "thinking about different sectors and the interaction between them in an integrated way."

d. Although the German government does not include land use and forestry directly in its national climate targets (due to methodological difficulties), it states that this sector "is of long-term importance, particularly given the objective of greenhouse gas neutrality no later than the second half of the century as specified by the Paris Agreement."

Emerging Insights

Quantitative vision for emission reductions: Most of the countries reviewed in this paper had considered a national long-term vision for emission reductions prior to the development of their long-term strategy. Establishing a GHG emission reduction target can be a political process, and having previously considered a vision for emission reductions may have allowed these countries to move forward more quickly with developing a long-term strategy. Benin, which did not have a long-term (midcentury) emissions goal, was able to use the medium-term vision outlined in its climate strategy, which had been under development for several years.

Modeling and scenario development: Five of the six countries used modeling and scenario analysis to explore a diverse set of questions, from the feasibility of emissions pathways under various technological assumptions to the implications of more or less ambitious medium-term targets for long-term pathways to the impact of different possible socioeconomic pathways. While all of these questions are likely to be relevant to most countries, none of the countries examined explored all of them. Each country may need to weigh the range of possible questions against its own priorities when designing scenarios. Moreover, these five countries benefited from significant analytical and modeling capacity and data availability that are unlikely to be universally available. To facilitate the development of long-term strategies in countries that lack this capacity, it may be necessary to explore both capacity-building and alternative approaches; for example, the development of a qualitative vision for climate and development in 2050, which would be less reliant on modeling capacity.

Strategic areas of focus: The countries reviewed in this paper highlight similar mitigation actions, such as transitioning to clean energy, improving energy efficiency and demand-side management, reducing non-CO_2 emissions, changing behavior and moving toward sustainable consumption patterns, carbon pricing, and protecting and enhancing natural carbon sinks. It is notable that the strategies converged on these common areas of focus despite quite different mitigation goals and analytical approaches. These areas of focus align closely with those identified in the scientific literature (Rogelj et al. 2015) and may suggest a starting point for countries that have not previously established a 2050 mitigation goal and/or that lack modeling capacity.

Aligning short-, medium-, and long-term planning: The strategies acknowledge the need to align short- and medium-term planning with long-term goals. Several of the strategies address this implicitly; for example, by presenting pathways that achieve both medium-term NDCs and 2050 emissions goals (medium- and long-term) or (in the case of Benin) short-term actions that align with medium-term NDCs. The long-term strategies, however, are not intended to be implementation plans. In order to ensure that this alignment plays out in practice, countries will need to develop NDC implementation plans that align with long-term goals, because the same NDC target can be implemented in a variety of ways, some of which are more aligned with long-term decarbonization than others (Sachs et al. 2016). Countries will also need to ensure that these implementation plans are not siloed but instead drive short-term planning across sectors (including energy planning, transport planning, and land-use planning). In many cases, this will require reconsideration of current institutional arrangements.

3.3. Development

The narratives that frame the long-term strategies refer significantly to development-related themes, including economic growth, job creation, investment, development planning, and sustainable development.

For Canada, France, Germany, and the United States, development is primarily related to economic growth, with a focus on gross domestic product (GDP), jobs, and new investments:

- They **assert that economic growth and climate action are mutually beneficial objectives**. For example, Canada states that a global clean-growth economy "offers considerable economic opportunities and co-benefits such as growing Canada's clean technology sector, using more efficient technology globally, mitigating other types of pollutants, improving health and air quality, and increasing productivity through more efficient life cycle production." France mentions that the energy transition and development of a low-carbon economy will "allow the country to support growth (and consequently GDP) over the next two decades and increase the number of jobs" (estimating on the order of 100,000 and 350,000 new jobs between 2015 and 2035, determined through a macroeconomic assessment using the THREEME model). Germany indicates that climate action is "crucial to successful economic, development, foreign, and security policies." The United States makes the case that rapid emissions reductions can be achieved while maintaining robust economic growth, showing evidence that the link between economic growth and CO_2 emissions has weakened significantly over recent decades.
- They **indicate their strategies' potential to catalyze sustainable economic transformation**.

For example, one pillar of France's strategy is to ensure that climate is considered in investment decisions (particularly related to infrastructure development), thereby "developing a new mode of growth that is more sustainable, contributes to better jobs and greater well-being." Germany's strategy introduces a "paradigm shift" to make clean energy shifts a standard mode of investment, thereby creating the "necessary conditions to keep Germany's economy competitive in a decarbonizing world."

Benin and Mexico **frame their strategies in terms of national development priorities**. For example, Benin's strategy was developed cognizant of the country's national development plan (ALAFIA 2025)—and, more specifically, with the aim of strengthening one of the eight themes of ALAFIA 2025 relating to sustainable development (which covers the three subthemes: environmental management and cities, the promotion of technology, and the promotion of the economy). Mexico aims to "address the climate issue as well as national priorities of sustainable and more inclusive development, thereby contributing to building the Mexico we envision."

Some countries also discuss development in the context of a **just transition**, ensuring that citizens whose livelihoods are tied to a high-carbon economy are not left behind in shift toward a low-emissions pathway. Canada, Germany, and the United States explicitly address the concept of a just transition[7] in the context of their unique, country-specific factors. The countries reviewed do not lay out concrete plans for achieving a just transition; rather, the concept is addressed more broadly, with countries highlighting its importance and/or providing a selection of examples. Canada discusses its plans and projects to reduce northern, remote, and indigenous communities' reliance on fossil fuel–generated energy. These projects will promote energy security as the country transitions to low-carbon energy sources. Germany states that its climate goals can only be achieved by reducing coal dependence and that through this transition the economic outlook and jobs in the affected regions must be considered. The concept is embedded in the long-term vision of the United States, with the approach aiming to provide a just transition for Americans whose livelihoods are connected to fossil fuel production and use. The United States also adds that additional support may be needed for low-income households and for Americans who are particularly reliant on a high-carbon economy. (Benin, Mexico, and France do not explicitly or implicitly address a just transition in their strategies.)

Emerging Insights

All six countries envision strong links between their long-term climate strategies and their development priorities, and this is reflected in the strategies' narratives. How these links will play out in practice, however, is not yet clear. It is not possible to establish from the strategies themselves the extent to which development considerations shaped the pathways considered in the strategies, versus the extent to which the pathways were developed primarily around climate goals, with the link to development priorities established after the fact to frame the strategies. Moreover, the extent to which, or the way in which, this link will be ensured during implementation is generally not made explicit. (In general, the strategies do not detail implementation plans.)

The six countries also highlight key drivers—in addition to reducing GHG emissions—for developing long-term strategies. Some of these drivers include ensuring economic competitiveness, promoting energy security, identifying areas of support for a just transition, and supporting economic, development, foreign, and security policies.

3.4. Linkages to Article 2

Although the Paris Agreement does not prescribe methodologies for designing long-term strategies, it does encourage parties to be "mindful" of Article 2—that is, in the context of sustainable development and efforts to eradicate poverty, parties should consider the long-term temperature goals, adaptation, finance flows, and CBDRRC in light of national circumstances.

This section explores the extent to which countries have incorporated these considerations in their strategies.

3.4.1. Consideration of the long-term temperature goal

The global long-term temperature goal is included in Article 2.1 of the Paris Agreement: "This Agreement . . . aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by . . . holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" (United Nations 2015).

Table 5 presents excerpts from the long-term strategies relating to the consideration of the long-term temperature goal.

According to a large body of literature, to have a likely (>50 percent) chance of limiting warming to 1.5°C, carbon dioxide emissions must reach net zero by 2045–50, and total greenhouse gas (GHG) emissions must reach net zero by 2060–80. For a likely (>66 percent) chance of limiting warming to 2°C, the same milestones must be met 15 to 20 years later (UNEP 2016). There are also limits to the cumulative emissions that may be released between now and the phase-out date; this is the remaining carbon budget. Global emissions are rapidly pushing the limits of this budget. Carbon Brief, which updates IPCC budgets based on emissions through 2016, finds that at current rates the budget for a 66 percent likelihood of 2°C will be exhausted in 19 years and for 1.5°C in a mere 4 years (Carbon Brief 2017).

These are global figures and trends; individual countries need not phase out emissions at the same time in order for the Paris temperature goals to be achieved. Indeed, the principles of equity and CBDRRC, enshrined in the UNFCCC and in the Paris Agreement, are widely understood to imply—among other things—that countries

Table 5 | **Consideration of the Long-Term Temperature Goal**

COUNTRY	AN EXCERPT FROM THE STRATEGY RELATING TO THE CONSIDERATION OF THE LONG-TERM TEMPERATURE GOAL OF THE PARIS AGREEMENT
Benin	Not mentioned in the strategy
Canada	"This [pathway] is consistent with the Paris Agreement's 2°C to 1.5°C temperature goal. . . . Building on analyses from the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, the United Nations Environment Programme (UNEP) states that GHG emission reductions in the order of 70 to 95% below 2010 levels would be required by 2050 to remain on a pathway consistent with a >50% likelihood of limiting average global temperature rise to 1.5°C. Achieving this temperature goal is only possible through actions on carbon dioxide and short-lived climate pollutants (SLCPs) together. For the purpose of the Mid-Century Strategy, Canada examines an emissions abatement pathway consistent with net emissions falling by 80% from 2005 levels" (Government of Canada 2016).
France	"According to the report published in November 2014 by the United Nations Environment Programme on the gap between requirements and capacities in terms of emissions reduction (the UNEP Emissions Gap Report), if the targets set by all countries for the coming decades allow us to attain a broadly similar level of emissions per capita all over the world by 2030 or 2050, we should be somewhere in the median range of the scenarios compatible with a 2°C global warming target" (Ministry of Ecology, Sustainable Development, and Energy 2016).
Germany	"Pursuing [the target] will make an appropriate contribution to implementing the commitment made in Paris, also with a view to the goal set out in the Paris Agreement of achieving global greenhouse gas neutrality in the second half of the century" (BMUB 2016).
Mexico	"This could be in line with a 2°C stabilization scenario of 450ppm, drawing from previous IPCC reviewed research" (SEMARNAT and INECC 2016).
United States	"Reaching net-zero global GHG emissions in 2080 would mean a roughly two-thirds chance of limiting warming to below 2°C in 2100. This MCS puts the United States on a trajectory to achieve net-zero emissions decades before that. If all other countries adopted the 2020–2050 rate of U.S. decarbonization starting in 2030, global net-zero GHG emissions could be achieved by 2070" (White House 2016).

will transform their economies at different rates. At a certain point, however, any unit of emissions that a given country is still emitting will need to be offset by negative emissions or removals; later or lower reductions in one country imply earlier or steeper reductions in another. A very large number of combinations of efforts by different countries could lead to the same global temperature outcome (see Box 2).

3.4.2. Adaptation

Although all countries describe the risks associated with climate inaction, the degree to which adaptation is addressed in countries' strategies varies.

Some countries, like Canada, France, Germany, and the United States, lightly touch on adaptation in their long-term strategies and refer to other national adaptation planning documents—France and Germany state their intent to develop synergies with the country's adaptation strategy wherever possible; the United States identifies some synergistic adaptation and mitigation measures, particularly in the agriculture and forestry sectors; and Canada mentions adaptation when referencing the Pan-Canadian Framework on Clean Growth and Climate Change.

Other countries, like Benin and Mexico, opt to fully include adaptation in their long-term strategies.

Benin's strategy is designed with the goal of building climate resilience and enhancing adaptive capacity while reducing emissions. The strategy highlights nine priority adaptation actions, which include developing early warning systems, building the capacity of local authorities, creating a diverse set of programs to protect the coastline and guard against climate-sensitive diseases, and establishing effective water management practices. These actions are identified based on an assessment of climate vulnerability, risks, and impacts.

Mexico's strategy is rooted in the vision of building a climate-resilient society while transitioning toward a low-emissions economy. The adaptation section of Mexico's long-term strategy is drawn from the country's National Climate Change Strategy: 10-20-40 Vision, released in 2013. It includes a vulnerability assessment, which leads to the identification of three main strategic areas of focus with associated lines of action. These areas include reducing vulnerability factors and building social resilience, ecosystems-based adaptation, and measures to protect strategic infrastructure and production systems. While the adaptation section is distinct from the mitigation section in the strategy, Mexico does present six cross-cutting elements[8] that set the foundation of climate policy in the country, for both adaptation and mitigation.

Box 2 | **Compatibility with Paris Agreement Temperature Goals**

A recent study examined over 600 scenarios that use different combinations of national and regional emissions reductions to limit warming to below 2°C—including some that limit warming to 1.5°C—and that meet certain equity criteria (Jones et al. 2016). The equity considerations are that developed countries as a group follow the same emissions decline rate post-Paris and always cut emissions faster than developing countries, and developed countries always begin emissions reductions at the same time as or sooner than developing countries. The study identified range and median values of 2050 emissions for the world's major economies, including Canada, the European Union, Mexico, and the United States.

Of the five strategies that contain 2050 targets, all are within the range the study identified as compatible with limiting warming to below 2°C. Most, however, are less ambitious than the mean reductions, which implies that other countries would have to set 2050 visions that are more ambitious than the mean identified in the same study. Relative to scenarios that limit warming to 1.5°C, only Germany's strategy (and potentially that of the United States, depending on what is meant by 80 percent "or more") falls within the compatible range. The other strategies set 2050 visions that are less ambitious than even the least ambitious end of the range required to limit warming to 1.5°C. This suggests that for this goal to be achieved, other countries that have not yet set visions for emissions reductions in 2050 would need to establish long-term targets that are more ambitious than the range of scenarios examined in the study. Moreover, countries may need to go even further than this study suggests now that the United States—the world's second-largest emitter—has ceased the implementation of contributions related to the Paris Agreement (see endnote 2).

Bearing in mind that only one study to date has explicitly examined the range of targets compatible with the Paris Agreement temperature goals and that future analysis may reach different conclusions, it is nonetheless worth considering how countries might be encouraged to consider, in particular, the 1.5°C goal in their initial strategies and when they revise their strategies in the future.

3.4.3. Finance flows

Countries tackle finance flows in different ways in their strategies.

Germany and France recommend that climate objectives be considered in all public and private sector investment decisions. Canada and the United States view their strategies as a means to provide market signals to investors that economies are headed to a low-emissions future. Mexico states that it needs "accessible, timely, and sufficient economic resources that allow for timely and decisive action on mitigation of and adaptation to climate change." Benin discusses the financing mechanisms that will need to be mobilized to implement the long-term strategy, which include the state budget, loans, grants and donations, and to a lesser extent, private sector investment.

France and Germany also mention eliminating environmentally harmful subsidies. Germany provides additional clarification, stating that that the subsidies will be removed "with due regard for the interests of consumers and other aspects of the national economy" or may be "diverted into future-oriented investments that will benefit society and the environment."

3.4.4. Equity and CBDRRC, in light of national circumstances

The six countries surveyed in this paper do not explicitly address the concept of CBDRRC. Canada does not mention it; Benin, France, Germany, Mexico, and the United States briefly touch on related concepts:

- Benin states that while it is a non–Annex I country with low-GHG emissions, the country remains committed to reducing GHG emissions.
- France states that it has one of the lowest rates of per capita emissions among the world's developed nations, mentioning that per capita emissions are higher in 90 percent of developed nations.
- Germany acknowledges its responsibility to reach the European climate goals and make a reasonable and fair contribution.
- Mexico highlights the topic of CBDRRC occasionally, through broad statements such as "an important ethical question arises regarding the fair burden sharing of the global mitigation effort. The Paris Agreement helped us break the impasse in the climate negotiations by providing a framework through the NDCs submissions where all countries act considering a fairness principle and their national circumstances," and "while Mexico is a developing country, we acknowledge the need to take action that can trigger the level of ambition needed to reach the 40 to 70% global reduction by 2050."
- The United States emphasizes that it plans to achieve countrywide net zero emissions decades earlier than what's needed globally.

Emerging Insights

Countries are not explicitly asked to incorporate the provisions of Article 2 into their long-term strategies; instead, they are requested to be "mindful" of Article 2. Moreover, the topics that a country chooses to include in its strategy will reflect its national circumstances, its priorities, and how it views the role of long-term strategies. Therefore, unsurprisingly, there is a marked difference in how the six countries have presented linkages to Article 2 in their strategies.

Most countries have provided a detailed description of the consideration of the long-term temperature goal, citing various studies to demonstrate that their vision for emission reductions is within an acceptable range of limiting warming to below 2°C. However, most have opted to only lightly touch on finance flows and CBDRRC.

Adaptation is addressed in varying degrees. Some countries refer to separate adaptation planning documents in their long-term strategies, while others have fully incorporated adaptation, creating a single long-term vision for low-carbon and climate-resilient development. In all cases, however, countries appear to recognize the inherent synergies and linkages between long-term adaptation and mitigation pathways.

The strategies allude to various dimensions of financial flows, including the need to consider climate implications in public and private investment decisions, the role of the strategies themselves in providing a market signal, the need to mobilize adequate finance to support implementation, and the benefit of eliminating environmentally harmful subsidies.

3.5. Additional considerations

3.5.1 Stakeholder consultation process

In developing their strategies, countries collaborated across government agencies and engaged with scientists, businesses, civil society, and the public. While all countries describe their stakeholder consultation processes, they do not explicitly address the impact that these consultations had on the development of their long-term strategies. The countries also provide little information on the balance and representation of various stakeholder groups.

Table 6 presents the stakeholder consultation process for each country.

3.5.2. Plans to review and revise the strategy

All countries plan to review their strategies at regular intervals. Table 7 presents the frequency of the reviews.

Table 6 | **Stakeholder Consultation Process**

COUNTRY	WORKSHOPS?	ONLINE PUBLIC CONSULTATION?	ELABORATION OF STAKEHOLDER CONSULTATION PROCESS
Benin	X		Benin held several workshops while developing its strategy. These included a methodological workshop in April 2015 (in which members of sectoral working groups were trained in the use of tools to assess vulnerability and mitigating potential) and four stakeholder consultation workshops from July 2015 to February 2016.
Canada	X	X	Canada's strategy was informed by a domestic consultation effort, which included an academic workshop, a web portal to solicit views from the public, and consultations with stakeholders, experts, and subnational governments (Government of Canada 2017). (Canada does not state how many inputs were received.)
France	X	X	France's National Low-Carbon Strategy was developed with representatives of civil society and included an online public consultation process (Government of France 2015).
Germany	X	X	Germany conducted an extensive stakeholder consultation process. The country received joint proposals for strategic climate measures from German states, municipalities, associations, and citizens between June 2015 and March 2016. These proposals were whittled down to a list of 97 that were presented to the federal environment minister for consideration. The German Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety (BMUB) also created a short promotional video about this stakeholder consultation process[a] and made recordings of the stakeholder meetings available on YouTube.[b]
Mexico	X		Mexico's Climate Change Midcentury Strategy builds on the country's National Climate Change Strategy: 10-20-40 Vision, which was developed with contributions from the federal government, states, civil society, and the academic community and released in 2013 (Government of Mexico 2013).
United States	X		The United States solicited input for its strategy at a series of stakeholder listening sessions with nongovernmental and private sector organizations in the summer of 2016.

Notes:
a. This promotional video is accessible at https://www.youtube.com/watch?v=WkNm5ZFzPhM&index=10&list=PL8RzGVmZSvAueWwtMuEsHZ8KPKqP1IXR2.
b. Recordings of Germany's stakeholder consultation meetings are available at https://www.youtube.com/playlist?list=PL8RzGVmZSvAueWwtMuEsHZ8KPKqP1IXR2.

Table 7 | **Frequency and Purpose of Reviews**

COUNTRY	FREQUENCY	PURPOSE OF THE REVIEW
Benin	"Periodic review."	To draw on the main lessons from the monitoring and evaluation reports and develop an implementation action plan.
Canada	"Canada's position is that the Mid-Century Strategies should be submitted in an iterative or cyclical process, where Parties provide regular updates as low-GHG technologies and national circumstances continue to evolve."	To allow the Canadian public, experts, and stakeholder communities to provide substance to this framework as Canada moves toward a common global objective of reducing greenhouse gas emissions.
France	Every 5 years (through the country does not mention explicitly aligning this process with the international review cycle since the strategy was established before the Paris Agreement was adopted).[a]	To review the success of the carbon budgets in place and possibly adjust future budgets and policy design.
Germany	Every 5 years, following the periodic review cycles under the provisions of the Paris Agreement.[b]	To review intermediate targets and milestones, transformation pathways, and the associated measures to ensure that they are consistent with the long-term goals that have been set. If necessary, they will be adapted in response to technical developments and societal, political and economic trends and changes, as well as the latest scientific findings.
Mexico	Mitigation component at least once every 10 years, adaptation component at least once every 6 years.	To evaluate any deviations from forecasts and update (while not lessening) scenarios, projections, objectives, and goals.
United States	Every 5 years, following the periodic review cycles under the provisions of the Paris Agreement.	To assess progress and increase ambition wherever possible.

Notes:

a. The French review cycle could review alignment with the international review cycle, since France plans to publish an updated strategy by July 1, 2019.

b. The Paris Agreement establishes an ongoing, regular process to review and increase climate action by all countries. This process includes a global stocktake to review collective progress every 5 years (starting in 2023, with a facilitative dialogue in 2018) and the submission of updated nationally determined contributions from countries every 5 years (starting in 2020; Northrop 2015). The process of review and revision aims to strengthen ambition toward achieving the long-term goals.

Emerging Insights

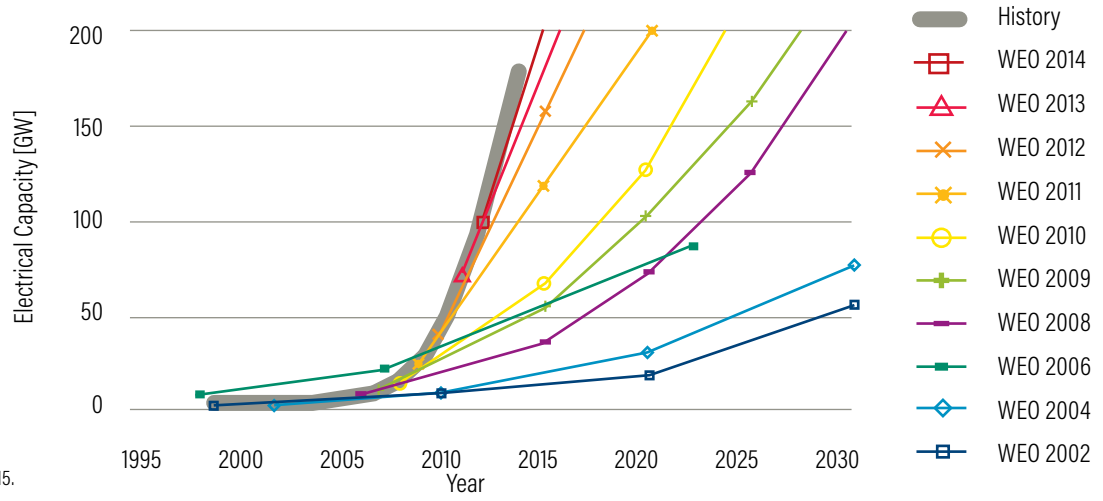
Stakeholder consultation processes: The six countries reviewed in this paper engaged with stakeholders while developing their long-term strategies. This is important since the goals of the Paris Agreement imply a profound transformation across key sectors of the economy, with implications for jobs, livelihood, health, and a range of other environment and development considerations. These transformations will only happen if they enjoy sufficient public engagement and support. Moreover, developing long-term strategies requires transformative ideas and solutions, which can be fostered in processes that bring together decision makers, researchers, and other stakeholders. The effectiveness of these processes, however, is beyond the scope of this study and merits further investigation.

Plans to review and revise long-term strategies: The six countries reviewed in this paper plan to review and revise their strategies at regular intervals. This is key to ensuring that strategies keep pace with research, development, and demonstration (RD&D); innovation; and the declining costs of emissions mitigation technologies. A prime example of the rapid pace of transformation is presented in Figure 1, which shows how the estimates of the growth of solar calculated by the International Energy Agency (IEA) have evolved over the past 15 years. This illustrates how much modeling assumptions can change in the space of a few years, based on new information on the pace and costs of new technologies. Note the difference in the forecasted growth of solar between the IEA World Energy Outlook (WEO) 2004 report and the 2014 report (10 years) and the 2009 report and the 2014 report (5 years).

Germany and the United States mention that they plan to update their strategies in line with the five-year cycle of review under the provisions of the Paris Agreement.[a] This will allow them to update their NDCs and long-term strategies in a single process, thus better aligning near-term policy, planning, and targets with long-term goals and helping minimize the risk of carbon lock-in.

Note:
a. This commitment was made under a previous U.S. administration.

Figure 1 | **The IEA's Evolving Estimates of the Growth of the World's Total Installed Solar Capacity**



Source: Metayer et al. 2015.

4. KEY CONSIDERATIONS FOR POLICYMAKERS AND THE INTERNATIONAL COMMUNITY

Six countries have communicated their initial long-term strategies to the UNFCCC well before the 2020 deadline mentioned in the Paris decision, which offers an opportunity to gather early insights on possible approaches to this exercise. The survey of countries' long-term strategies also gives rise to several key considerations for policymakers and the international community.

4.1 Considerations for policymakers developing long-term strategies

What scope will best support the goals of the Paris Agreement as well as national development objectives?

Long-term strategies to date have addressed a wide range of themes, including emissions pathways, sustainable development, and adaptation, among others. While countries will need to contend with trade-offs when developing their strategies (including trade-offs between what is comprehensive and what is manageable, as well as which issues are best addressed in the context of a long-term strategy and which are best addressed through other vehicles), due consideration of each element at the outset will help ensure strategic use of limited resources.

How can countries ensure that long-term strategies inform near- and medium-term decisions?

Given that countries have identified informing near-term planning, investments, policies, and actions as among the objectives of undertaking a long-term strategy, it makes sense to consider at the outset how this goal can best be achieved. The practice of some of the six countries surveyed here of integrating the strategy into ongoing national processes provides one option to consider. As policymakers develop and implement their long-term strategies, it will be useful to identify linkages to elements of existing planning documents and opportunities to centrally coordinate climate- and development-related activities. Considering the roles and relationships of key institutional stakeholders may also facilitate buy-in of key players involved in near-term decisions.

What considerations should inform the establishment of a long-term target or vision for emissions reductions?

All six strategies reference a quantitative "vision" for emissions reductions, and most also discuss the consistency of this vision for emission reductions in 2050 with the long-term temperature goals of the Paris Agreement. The strategies discuss the alignment of these visions with the long-term temperature goals, although literature to date calls into question the extent to which the strategies align with the aspiration to pursue efforts to limit warming to 1.5°C.

Interestingly, multiple countries explicitly avoid referring to this vision as a "target." For example, Canada "examines an emissions abatement pathway consistent with net GHG emissions falling by 80 percent in 2050, relative to 2005 levels." The United States "envisions economy-wide net GHG emissions reductions of 80 percent or more below 2005 levels by 2050." Governments may be reluctant to explore more ambitious scenarios if they are viewed as "NDCs for 2050"—that is, commitments to a specific pathway to which they expect to be held accountable. Indeed, one objective that countries have identified for developing a long-term strategy is to identify areas where mitigation may be difficult to achieve.

An alternative approach may offer countries an opportunity to openly discuss the level of transformation that is needed and to identify where innovation is most needed without feeling that they are locked in to a target that they don't know how to achieve yet.

Which central economic, policy, and technology questions and trade-offs should the long-term strategy explore? How might the long-term strategy make best use of scenarios, as well as existing literature, to explore these questions and trade-offs?

As outlined in Section 3.2.2, countries have designed scenarios to explore trade-offs between alternative development pathways, technological uncertainties, and the impact of different medium-term goals and policies on long-term pathways. Moreover, countries have also explored the macroeconomic impacts, including job creation, of development scenarios. As countries set out to plan their long-term strategies, clearly outlining and prioritizing the questions and trade-offs that will play the greatest role in long-term planning will help them lay out an analytical approach best suited to addressing those issues. Using existing studies can also help make efficient

use of limited resources and explore common themes and conclusions that emerge across several studies. For example, Canada reviewed four existing analyses on long-term decarbonization when developing its strategy.

Countries might also consider carving out a space in their long-term strategies to lay out open questions, such as those related to RD&D and future investment needs. This can help focus international collaboration to close the gap. The IPCC's special report on the impacts of global warming of 1.5°C and related global GHG emission pathways (to be released in 2018) may also prove to be a good opportunity for countries to further engage on this issue and seriously consider what additional effort would be required to reach the 1.5°C temperature goal versus the 2°C temperature goal.

How can stakeholders be engaged in long-term strategy development in a manner that is both meaningful and feasible?

Meaningful stakeholder engagement requires time and resources. This is especially true for long-term strategies, which present special challenges due to both their technical complexity and the breadth and depth of transformation they suggest. There is a risk that superficial stakeholder engagement—for example, a single workshop, with inadequate time and resources provided for stakeholders to understand and digest proposals—can lend undeserved legitimacy to a long-term strategy. Meaningful engagement is both iterative and transparent. This suggests that countries should plan their long-term strategies well in advance (more than a year) of when they intend to communicate them to the UNFCCC, in order to allow time to line up resources to support a robust process and to actually carry out the process.

How often should the long-term strategy be revisited and updated?

As noted in Section 3.5.2, there is benefit to conducting strategy reviews and updates at more frequent intervals and alongside national planning processes: First, countries can update their strategies at a frequency that better keeps pace with RD&D, innovation, the costs of fossil fuels, improving projection tools, and the declining costs of emissions mitigation technologies. Second, the regular review and update creates an opportunity to add additional themes of relevance (for example, land use) that weren't previously considered in the initial strategy.

How can the long-term strategy best send the right market signals to investors?

To achieve the long-term goals of the Paris Agreement, countries will need to undertake profound transformations of their energy systems and land, which in turn implies major changes to their economies. If developed and implemented effectively, long-term strategies can send early and predictable signals that will allow the market to better anticipate the transition. This can also help avoid new investments in fossil fuel–related infrastructure and support a just and equitable transition for workers whose livelihoods are tied to a high-carbon economy.

Countries have identified informing near-term investments as among their objectives in developing long-term strategies. To ensure that the strategies have this effect, those developing them might consider ensuring that the strategies reflect the necessary level of transformation, specify the changes that are needed in key sectors, and identify where additional innovation is most needed.

4.2. Considerations for the international community (negotiators, funders, civil society)

What special needs and considerations might be applicable for long-term strategy development in countries with relatively limited capacities and resources?

To date, most long-term strategies have relied significantly on sophisticated modeling and analytical capacity that are unlikely to be universally available. It is natural that large economies draw significantly on these capacities when developing their strategies, but small and least-developed countries in particular may wish to consider alternative approaches that address their priorities and are feasible in the context of their national circumstances. (These countries also generally face much more uncertainty in their future development and growth paths.) Such approaches might include qualitative scenario analysis, a central role for national development priorities, simplified quantitative methods, or other approaches.

Similarly, the international community will need to consider how to ensure that all countries can develop the needed capacity—particularly in-country, lasting capacity—they will need to develop, implement, and review their

strategy. Capacity considerations should take into account not only analytical needs but also stakeholder engagement needs. There is likely to be a trade-off between providing capacity in a timely manner (e.g., via international experts) to support the development of strategies by 2020 and the sustainability of that capacity (e.g., by strengthening domestic institutions and expertise).

How can stakeholders align the review and update of long-term strategies with the review cycles stipulated by the Paris Agreement?

The Paris Agreement establishes an ongoing, regular process to review and increase climate action and ambition by all countries. This process includes a global stocktake to review collective progress every five years (starting in 2023, with a facilitative dialogue in 2018) and the submission of updated NDCs from countries every five years (starting in 2020; Northrop 2015). Countries can benefit from conducting long-term strategy reviews alongside the international review cycle since they will be able to update their NDCs and strategies in a single process, thus better aligning long-term goals with near-term policy, planning, and targets. Of course, this review and revision will require ongoing access to resources and capacity, so both the international community and national governments will need to consider their respective roles in ensuring the availability of the same.

How can long-term strategies inform near- and medium- term decision making, including enhancing nationally determined contributions?

The strategies reviewed in this paper acknowledge the need to align short- and medium-term planning with long-term goals. Several of the strategies address this implicitly. For example, Mexico presents two pathways in its long-term strategy: The first sees the achievement of the unconditional NDC target in 2030 and the long-term emissions goal in 2050; the second sees the achievement of the more ambitious conditional target in 2030 and the long-term emissions goal in 2050. These pathways show that achieving the conditional target in 2030 creates a smoother trajectory toward longer-term decarbonization, which is likely to be true for many countries with unconditional and conditional goals. The international community could support countries in finding ways to meet their conditional targets in 2030, thus helping avoid the need for extremely steep, costly, and unprecedented rates of decarbonization in the post-2030 period.

How can the international community foster peer learning and cooperation on long-term strategies among countries?

Peer learning and cooperation can be an effective way to share knowledge and explore complementary strengths among countries. Canada, Mexico, and the United States worked together to align and coordinate the development of their long-term strategies while identifying further areas of collaboration. Benin stated that bilateral cooperation with France is key to the implementation of its long-term strategy. The United States closed its strategy, emphasizing that it is "ready to share its experiences and engage with other nations in developing ambitious, rigorous, and transparent mid-century strategies."

As more countries embark on the development of long-term strategies, the international community will need to consider how it can best support the exchange of knowledge and resources. Fortunately, this community is coming together to address these needs. The 2050 Pathways Platform, for example, brings together national and subnational governments, businesses, and technical experts to support the development of robust long-term strategies. World Resources Institute (WRI) is a technical partner of the platform. The Low Emission Development Strategies Global Partnership (LEDS GP) provides regional training on LEDS planning. WRI and the United Nations Development Programme, in cooperation with the UNFCCC, are developing a set of resources that all countries can use to create these long-term strategies, which will also contribute to the 2050 Pathways Platform Such initiatives build on long-standing efforts by partners in the Deep Decarbonization Pathways Platform to construct pathways consistent with limiting warming to 2 degrees C. To the extent that initiatives such as these can both accelerate the uptake of long-term strategy development and enhance the quality of such exercises, the Paris goals will be well served.

4.3. Looking ahead

The considerations presented here are drawn from an initial set of long-term strategies. Five of the six strategies reviewed in this paper were developed by G20 countries. The considerations above are therefore unlikely to reflect the full range of issues that countries will confront as they set out to undertake this exercise—and even those identified here will benefit from more in-depth analysis, including case studies, and more detailed guidance for countries.

The road toward integrating a long-term perspective into national policy and planning processes will be a long one, but achieving the goals of the Paris Agreement depends on getting started right away.

ABBREVIATIONS

BECCS	bioenergy with carbon capture and storage
BMUB	Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety
CBDRRC	common but differentiated responsibilities and respective capabilities
CCS	carbon capture and storage
CGE	computable general equilibrium
COP	Conference of Parties
CO_2	carbon dioxide
EPPA	Economic Projection and Policy Analysis
ETS	Emissions Trading Scheme
GCAM	Global Change Assessment Model
GDP	gross domestic product
GHG	greenhouse gas
IAM	integrated assessment model
IEA	International Energy Agency
INDC	intended nationally determined contribution
IPCC	Intergovernmental Panel on Climate Change
LEDS GP	Low Emission Development Strategies Global Partnership
M&E	monitoring and evaluation (M&E)
MCS	midcentury strategy
MRV	measurement, reporting, and verification
NDC	nationally determined contribution
NEMESIS	New Econometric Model for Environmental Strategies. Implementation for Sustainable Development
RD&D	research, development, and demonstration
THREEME	Multisector Macroeconomic Model for the Evaluation of Environmental and Energy Policy
UNFCCC	United Nations Framework Convention on Climate Change
WEO	World Energy Outlook
WRI	World Resources Institute

ENDNOTES

1 The global long-term temperature goal is included in Article 2.1 of the Paris Agreement: "This Agreement . . . aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by . . . holding the increase in the global average temperature to well below 2 °C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5 °C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change" (United Nations 2015).

2 On June 1, 2017, President Donald Trump announced that the United States would formally withdraw from the Paris Agreement, a legal process that will take nearly four years to complete, with an official exit on November 4, 2020 (Plumer 2017). In his speech, Trump stated that the United States "will cease all implementation of the non-binding Paris Accord . . . [which] . . . includes ending the implementation of the nationally determined contribution" (White House 2017). The speech did not address the long-term strategy of the United States.

3 As of May 31, 2017, these are the only long-term strategies that have been submitted to the UNFCCC.

4 One interpretation of this clause could be different phase-out time frames for developed and developing countries (Oberthür et al. 2015).

5 Art. L. 100-4 presents the objectives of France's national energy policy.

6 The Pan-Canadian Framework on Clean Growth and Climate Change is Canada's plan to meet its 2030 GHG emissions reduction target while growing the economy. It includes four pillars: pricing carbon pollution; complementary measures to further reduce emissions across the economy; measures to adapt to the impacts of climate change and build resilience; and actions to accelerate innovation, support clean technology, and create jobs (Government of Canada 2015). This plan was released in December 2016.

7 The International Trade Union Confederation's Just Transition Centre states that "a just transition brings together workers, communities, employers and government in social dialogue to drive the concrete plans, policies and investments needed for a fast and fair transformation. It focuses on jobs, livelihoods and ensuring that no one is left behind as we race to reduce emissions, protect the climate and advance social and economic justice" (ITUC 2017). The concept is also included in the Paris Agreement, as follows: "taking into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities."

8 These elements include interinstitutional collaboration; market-based instruments; innovation, research and development, and technology adoption; building a climate culture; social participation; measurement, reporting, and verification (MRV) and monitoring and evaluation (M&E); and international leadership.

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The Open Climate Network brings together independent research institutes and stakeholder groups to monitor countries' progress on climate change. We seek to accelerate the transition to a low-emission, climate-resilient future by providing consistent, credible information that enhances accountability both among and within countries. www.openclimatenetwork.org.

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Natural resources are at the foundation of economic opportunity and human well-being. But today, we are depleting Earth's resources at rates that are not sustainable, endangering economies and people's lives. People depend on clean water, fertile land, healthy forests, and a stable climate. Livable cities and clean energy are essential for a sustainable planet. We must address these urgent, global challenges this decade.

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We envision an equitable and prosperous planet driven by the wise management of natural resources. We aspire to create a world where the actions of government, business, and communities combine to eliminate poverty and sustain the natural environment for all people.

Our Approach

COUNT IT

We start with data. We conduct independent research and draw on the latest technology to develop new insights and recommendations. Our rigorous analysis identifies risks, unveils opportunities, and informs smart strategies. We focus our efforts on influential and emerging economies, where the future of sustainability will be determined.

CHANGE IT

We use our research to influence government policies, business strategies, and civil society action. We test projects with communities, companies, and government agencies to build a strong evidence base. Then, we work with partners to deliver change on the ground that alleviates poverty and strengthens society. We hold ourselves accountable to ensure our outcomes will be bold and enduring.

SCALE IT

We don't think small. Once tested, we work with partners to adopt and expand our efforts regionally and globally. We engage with decision makers to carry out our ideas and elevate our impact. We measure success through government and business actions that improve people's lives and sustain a healthy environment.

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