HP 4 THEMATIC SERIES

HOW MINISTRIES OF FINANCE CAN ASSESS THE FISCAL CHALLENGES AND OPPORTUNITIES FROM GREEN AND RESILIENT TRANSITIONS

Available analytical tools and emerging good practice

JUNE 2025

A report of the Coalition of Finance Ministers for Climate Action Helsinki Principle 4 initiative: Economic Analysis for Green and Resilient Transitions

About this report

This publication is a product of the Helsinki Principle 4 (HP4) workstream under the Coalition of Finance Ministers for Climate Action. The overall aim of HP4 is to mainstream climate action into economic and fiscal policy. The report forms part of an effort to improve macroeconomic analysis and modeling tools for Ministries of Finance (MoFs) to drive climate action, including the capacity to assess the economic impacts of physical climate risk, climate mitigation, and adaptation measures. This effort recognizes that many MoFs urgently need improved access to tools to be able to address the most pressing climate policy questions they now face, tailored to and appropriate for their context, and operating on timescales that meet the needs of decision-makers.

Within this broad recognition concerning climate policy questions, feedback from MoFs points to the requirement to estimate the fiscal implications of climate change, climate mitigation, and adaptation measures as a core concern. This report focuses on how each climate-related issue can affect public finances, how those effects can be estimated using existing data, tools, and approaches, and where gaps remain.

The report aims to make it easier for Ministers, senior officials, and analysts within MoFs to get started and make progress in mainstreaming climate-related issues into core fiscal processes. It is also designed to assist external agencies and researchers in identifying where their efforts to fill gaps and advance understanding will be of most use to MoF audiences. It takes a pragmatic approach, recognizing that MoFs have many pressures on their resources, so they need to be able to build from existing analysis and tools wherever possible.

As well as the many reports and other sources referenced throughout the report, its contents have been informed by discussions at the 1st Forum on the Macroeconomics of Green and Resilient Transitions held in Washington, D.C. in April 2024, and a global survey of Ministries of Finance carried out under this workstream. It has also benefited from the many contributions to the Compendium of Practice compiled under this workstream—and those contributions referenced in Table A in particular.

The primary audience for this report is analytical staff seeking to factor climate change and related issues into core MoF processes, and the senior officials overseeing their work. It takes broad climate-related topics and identifies the questions MoFs are asking and the existing data, tools, and approaches that can be used to answer them, adding examples of good practice. This enables MoFs to select sources and tools that are most relevant to their circumstances—for example, to build capability more quickly or to focus their resources on targeted improvements to existing tools to meet their own specific needs.

This report is complemented by a range of other reports that are published alongside or are under development. As well as the Compendium of Practice mentioned above, these include a survey of the world's Ministries of Finance, an overview of analytical tools available to MoFs, and other thematic reports in areas related to the pressing climate policy needs of MoFs. A summary of the overall program objectives will also be captured in a separate report to be published later in 2025.

This report was led by Andy King, Visiting Senior Fellow at the Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Science

About this report

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Disclaimer

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About this report

Table A. Contributions to the Compendium of Practice used in this report

Institution	Authors	Title
European Union – European Commission	Quentin Dupriez	Determining investment needs to decarbonization and adaptation: the challenge and opportunity for Ministries of Finance in the EU
Switzerland – Federal Department of Finance	Benjamin Lerch, Thomas Brändle, Martin Baur	Modeling the fiscal impacts of the net zero target within fiscal sustainability analysis
Italy – Ministry of Economy and Finance		The Italian Ministry of Economy and Finance climate-related modeling tools: how to build a flexible suite of models serving different purposes
Australia – Department of the Treasury	Freya Carlton, Rebecca Cassells, Rebecca Colquhoun, Sebastian Porter	Estimating the impact of selected physical climate risks on the Australian economy
Sierra Leone – Ministry of Finance		Sierra Leone's first climate-economy model: challenges posed, opportunities arising
IMF Fiscal Affairs Department	Carolina Renteria, Tjeerd Tim	Fiscal risks of climate change: Quantitative Climate Change Risk Assessment Fiscal Tool (Q-CRAFT)
IMF Fiscal Affairs Department	Emanuele Massetti	The critical role of Ministries of Finance in investment in adaptation and the analytical principles and tools available
World Bank	Camilla Knudsen, Ammara Shariq, Stéphane Hallegatte	A bottom-up approach to estimating climate–development investment needs
World Bank		World Bank Group climate aware macroeconomic models available for use by Ministries of Finance
World Bank/IMF		The Climate Policy Assessment Tool (CPAT)
Inter-American Development Bank (IDB)/French Development Agency (AFD)/University College London	Adrien Vogt-Schilb, Steve Pye	How fossil-fuel-reliant Ministries of Finance can assess the fiscal risks of global climate action
Inter-American Development Bank (IDB)/French Development Agency (AFD)/University of Costa Rica	Jairo Quiros-Tortos, Adrien Vogt-Schilb, Marcela Jaramillo	Managing the fiscal impacts of electric vehicles, public transportation, and cycling
Council on Economic Policies	Patrick Lenain	It takes two to tango: the role of Ministries of Finance in pricing and non-pricing policies for a low-carbon economy
Imperial College London	Patrick Bolton, Alissa M. Kleinnijenhuis	Climate finance at scale to implement NDCs: decarbonizing the power sector
Danish Research Institute for Economic Analysis and Modelling (DREAM)	Peter Stephensen, Jens Sand Kirk	The GreenREFORM Model
ETH Zürich	Lint Barrage	New approaches to quantifying the fiscal impacts of physical climate change
French Economic Observatory (OFCE) – Sciences Po	Aurélien Saussay, Frédéric Reynès, Anissa Saumtally	The ThreeME model
France Stratégie	Grégory Claeys	Key messages from the report 'The economic implications of climate action'

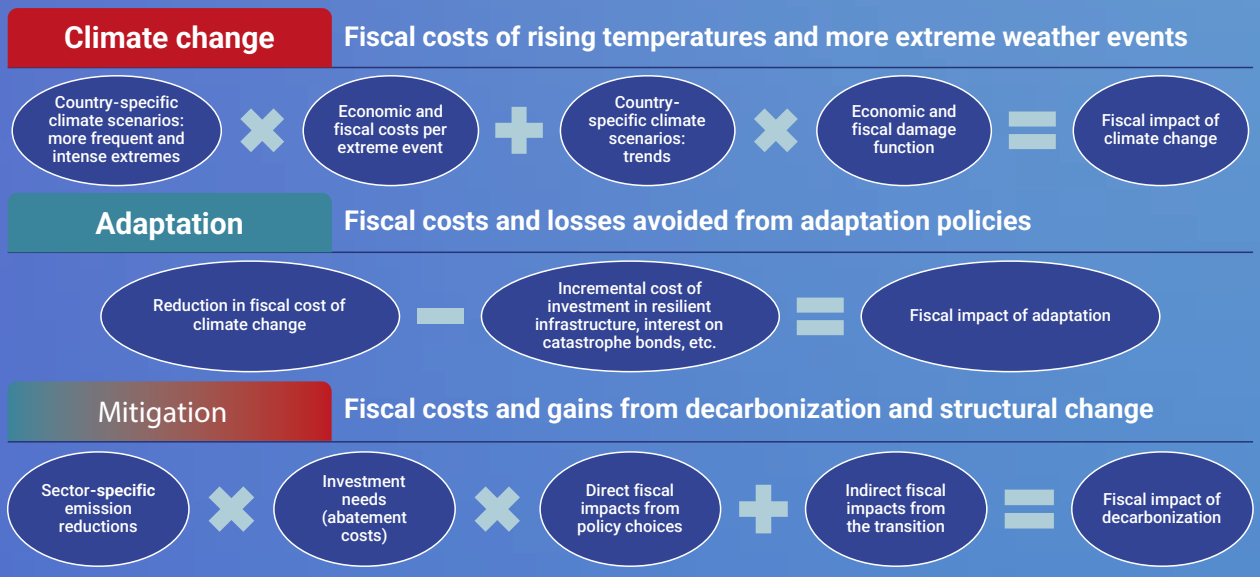
Contents

Summary for policymakers

Climate change and climate action can impact public finances and fiscal sustainability through three main channels, with implications that Ministries of Finance (MoFs) need to quantify (see also Figure S1):

- First, the **costs of extreme weather events** can inflict extensive physical damage, necessitating government-funded aid, disaster relief, and reconstruction; additionally, slow-onset events including rising sea levels, more frequent and intense heat waves, and desertification can hamper economic growth and productivity, ultimately reducing tax revenues.
- Second, **adaptation measures** can reduce the fiscal impacts of climate change, but governments also accrue costs to implement policies and invest in infrastructure to minimize exposure to and mitigate the effects of climate risks.
- Finally, **mitigation efforts** to transition away from fossil fuels and toward a net zero economy entail costs and opportunities. Their direct impacts include public investments, green subsidies, and carbon tax revenues; their indirect impacts include the fiscal consequences of the structural transformations required to reshape economies for sustainable development. There is potential for upfront investment costs to unlock powerful economic benefits, with the transition offering significant opportunities to expand revenue bases over time as new activities can come into the tax base.

Figure S1. Fiscal implications of climate-related issues: what do Ministries of Finance need to quantify?



MoFs have access to various policies and instruments to manage potential fiscal risks and support adaptation and mitigation efforts. These tools include macro-fiscal forecasting, budget-setting, expenditure control, fiscal risk identification and mitigation, and financial instruments such as green bonds or catastrophe bonds. However, effectively integrating climate change and climate action into fiscal policy first requires addressing the critical policy questions MoFs face – which in turn requires the use of different tools, models and case studies.

Summary for policymakers

Tools, models, and data to address fiscal planning questions

We categorize a set of analytical tools, models, and case studies of varying complexity that MoFs can use to address key fiscal planning questions into three groups, based on the policy questions they help answer:

1. **Analytical tools that help build scenarios and assess the impacts of climate change** on the fiscal position by providing estimates of national costs, productivity losses, and macroeconomic effects of physical and transitional risks. Approaches range from bottom-up sector models to integrated assessment models (IAMs), and hybrid frameworks that combine sector-level insights with macro-fiscal analysis, enabling governments to evaluate fiscal risks under various climate scenarios, such as those provided by the new Q-CRAFT tool of the International Monetary Fund (IMF).
2. **Analytical tools that can help estimate the benefits and costs of investing in adaptation**. Multiple initiatives enable estimates or approximations of the costs of adaptation interventions. Open-source models like Climate Change Explorer and climAdapt, and platforms like the Oasis Loss Modelling Framework, can be used to estimate financing needs. Key reports such as the World Bank's *Country Climate and Development Reports* and the IMF *Fiscal Monitor* provide valuable insights into adaptation investment requirements. The thematic report on physical risk and adaptation accompanying this report explores these questions and models in greater depth.
3. **Analytical tools that aid understanding of the fiscal implications of achieving mitigation targets and implementing climate policies such as carbon pricing**. Macrostructural models adapted for climate analysis can estimate the broader fiscal effects of decarbonization goals. Sector-specific tools like OSeMOSYS and TIMES provide insights into investment needs and fiscal consequences of energy transition. Models like the IMF's CPAT tool or CGE (computable general equilibrium) modeling approaches help estimate the effects of different policy interventions on emissions, GDP, and revenues, letting policymakers weigh-up multiple policy options.

Regarding data, multiple needs and sources exist. Country-specific data, usually hosted by governments, can provide detailed information to feed tools. Higher-level global or regional data is also available and hosted by different organizations. For example, MoFs can build climate change scenarios based on the climate and emission data pathways produced by the Intergovernmental Panel on Climate Change (IPCC). On the cost of climate-related disasters and slow-onset effects, the EM-DAT International Disaster Database or the IMF's 'Fiscal Costs of Contingent Liabilities' dataset, among others, can be helpful starting points. Sector-specific information is also available to feed sectoral effects on the public finances. For instance, the International Energy Agency's *World Energy Outlook 2024* provides a comprehensive starting point with multiple scenarios.

The fiscal issues relevant across the spectrum of MoFs vary widely, given the significant variation in contexts and capabilities: from low- to middle- to high-income countries, from fossil fuel exporters to importers, from high-emission to low-emission economies, and from MoFs with established climate analysis units and back catalogues of assessments to those taking their first steps in assessing the fiscal implications of climate issues. Our focus is on assessing the fiscal impact of trends and policy choices that are covered in greater depth in other parts of the Helsinki Principle 4 workstream, and the scope is summarized in Figure S2. We do not address here important enabling factors such as the quality of public financial management processes.

Summary for policymakers

Figure S2. High-level summary of the questions, data, tools, approaches, and examples in the report

Assessing the fiscal implications of…

Climate change

Questions

- Likely vs. reasonable worst-case future climate scenarios?
- Fiscal implications of those scenarios along economic and other channels?

Data, tools, and approaches

- World Bank Climate Knowledge Portal
- World Bank Climate Risk Country Profiles
- EM-DAT database (for overview only)
- Climate hazard maps – e.g. GIRI for infrastructure sectors
- Damage functions
- IMF Q-CRAFT model

Existing reports and examples

- IMF tech. assistance (Georgia, Armenia, Jamaica)
- US Congressional Budget Office climate reports
- Rwanda fiscal risk statements
- EU Peseta IV research project

Adaptation

Questions

- Given analysis of climate change risks, which future losses can be avoided through adaptation–and at what cost?

Data, tools, and approaches

- Climate Change Explorer
- climAdapt
- CPI estimates of climate finance needs
- UNEP's model and NDC-based adaptation investment needs
- GIZ handbook on modeling resilience

Existing reports and examples

- IMF October 2020 Fiscal Monitor
- World Bank Country Climate and Development Reports
- Climate Prosperity Plans (with V20)

Mitigation

Questions

- Future climate scenarios?
- Fiscal impacts along economic and other channels?

Data, tools, and approaches

- World Bank Climate Knowledge Portal
- Climate Action Tracker
- IEA World Energy Outlook
- Way et al. (2022) technology cost curves
- MF/WB 'CPAT' policy analysis tool
- OECD Fossil Fuel Support, Effective Carbon Rates

Existing reports and examples

- Pisani-Ferry report for French PM
- UK OBR Fiscal Risks Report 2021
- Ireland IFAC and Dept of Finance analysis
- Swiss Fiscal Sustainability Report
- IMF working paper: Fiscal Implications of Global Decarbonization

Summary for policymakers

Conclusions

- **The fiscal implications of climate change and climate action—adaptation and mitigation—are becoming increasingly important for MoFs worldwide.** Climate-related issues cannot be left to line ministries alone to address: MoFs need to take an active role and can benefit from understanding how climate change physical risk impacts public finances.
- **To improve this understanding, MoFs need to assess the economic and fiscal consequences of the increased frequency and intensity of extreme weather events, including the vulnerability of public finances to such events, and of slow-onset phenomena.** These phenomena include rising temperatures that may reduce labor productivity, declining precipitation that could reduce agricultural yields, or sea level rise that might displace communities. The key drivers of these physical risks, including global emissions and climate trajectories, are inherently uncertain, emphasizing the importance of exploring multiple scenarios rather than relying on a single forecast for future planning.
- **Climate-related developments are increasingly influencing the economic and fiscal variables that feed into core MoF fiscal processes** like forecasting and budgeting, regardless of the action MoFs take, as climate-related disasters generate fiscal costs and climate-focused policies take effect. MoFs cannot ignore this.
- **Understanding overall investment needs for adaptation and mitigation is critical for effective fiscal planning.** To support climate action effectively, MoFs can benefit from understanding the scale of whole-economy investment required in mitigation and adaptation and how that can be delivered publicly or incentivized privately, for example via public investment, subsidies, regulations, or tax incentives. This understanding can enable MoFs to integrate climate action into their broader priorities, develop more informed budget plans, and identify potential funding sources.
- **MoFs can improve their fiscal planning processes by assessing the direct and indirect impacts of climate policy choices.** This includes understanding what structural transformation of economies means for growth and innovation and for prospects for existing and future tax bases. It also means assessing the specific impact of policies on debt and revenues. Climate policies in particular can have significant distributional effects on society, which may need to be mitigated through complementary measures such as targeted cash transfers.
- **MoFs are taking steps to mainstream climate-related issues into these processes and their broader fiscal sustainability analysis** by improving data, tools, and approaches to assess the fiscal implications of climate change and climate action. MoFs can learn from each other and from international organizations—there are now many analyses, reports, and experiences to draw upon and new tools being made available.
- **This means there is already sufficient information available for all MoFs to get started on analyzing the fiscal implications of climate-related physical damage, investment in adaptation, and climate action to reduce emissions.** It can often be better to get started and then refine than to defer analysis while waiting for better data, tools or approaches. (Note that World Bank economists recently concluded that the costs of delaying climate action exceed those of not achieving a fully coordinated approach by acting sooner.)
- **However, significant information gaps still need to be addressed.** MoFs require detailed assessments of the overall investments needed across sectors in their countries to decarbonize, achieve low-carbon growth, and evaluate the need for and benefits of adaptation. These estimates are crucial for understanding the fiscal impacts of different policy options and for designing strategies to drive and support necessary investments across the public and private sectors.

1. Introduction

This report surveys analytical questions relevant to Ministries of Finance (MoFs) assessing the climate-related fiscal challenges and opportunities they need to manage and seize, as well as the available tools and examples of emerging best practice. It focuses on the fiscal costs and benefits in terms of public expenditure and revenues, including but not limited to the investment necessary to achieve resilience to climate change and the structural transition to a net zero economy. The equally important question of how to finance that investment—a critical cross-cutting issue for all forms of climate action—is addressed (in part) in several other reports across this workstream.[1]

A broad spectrum of fiscal implications

The fiscal implications of climate change are felt along three broad channels: the costs of climate change itself through physical damage; the costs and benefits of adaptation policies and investments to reduce exposure to physical damage; and the costs and benefits of mitigation efforts to transition all the key systems and sectors of the economy away from fossil fuels and to net zero emissions (including the value of avoided costs of future physical climate change impacts that come with adaptation and mitigation investments) (see Table 1.1 for an illustration). These fiscal implications span a broad spectrum from straightforward, direct fiscal costs (e.g., the damage to public infrastructure from more intense and more frequent extreme weather events), to indirect fiscal costs (e.g., lower productivity and output per capita due to climate change), to net fiscal gains (e.g., the returns

Table 1.1. Example climate-related events/issues and their fiscal implications for consideration by Ministries of Finance

Event/issue	Channel	Direct/indirect	Time horizon	Geography
Brazil: extreme flooding in Rio Grande do Sul in May 2024	Costs attributable to climate change and increased frequency and intensity of extreme weather events + investment in adaptation	Direct: support for affected region; cost of rebuilding Indirect: revenue loss through hit to regional GDP; partly offset by future costs avoided through climate-resilient rebuilding	Short to medium term (immediate costs of support, medium-term cost of resilient rebuilding, short- and medium-term impacts on economic growth)	Largely confined to one state within Brazil
Indonesia: proposed construction of a sea wall to protect Jakarta	Investment in adaptation + cost of climate change	Direct: cost of construction Indirect: benefits from flooding and subsidence avoided	Short, medium and longer term (multi-phase construction with long-run benefits and other indirect consequences)	Local: densely populated urban center within Indonesia
UK: decarbonizing residential buildings by transitioning from natural gas to electricity for heating	Investment in mitigation	Direct: subsidies (e.g., for heat pumps + retrofitting) Indirect: revenue effects via economic impact and, potentially, via regulation of new home building	Short, medium and longer term (varying over time as, for example, supply chains and unit costs evolve)	National, with spillover to other countries likely to be dominated by trade linkages in respect of the technologies deployed

[1] All to be published at www.greenandresilienteconomics.org during 2025, from June onwards.

on investment in green technology due to lower and less volatile energy prices, growth opportunities from supplying green industries, or the fiscal revenues that can be raised from taxing carbon more heavily). Fiscal implications vary in other ways, too: from direct to indirect impacts; accruing over the short, medium or long term; and being felt at the local, national, regional or global levels. And in many cases, investment costs come upfront while returns are felt later. This means climate change and the policy response to it ultimately will have implications for all the core responsibilities of MoFs: forecasting, budget-setting, policy analysis, scenario-based risk and debt sustainability assessments, and more.

With so many potential fiscal implications to consider, MoFs face a challenge in deciding where to allocate their scarce analytical resources. Prioritization can be a first step toward mainstreaming climate into fiscal analysis and outputs. Some MoFs might prefer to focus first on narrower questions with either large or immediate fiscal implications, such as investment in resilient infrastructure where climate risks are severe or the transition to renewable power generation that underpins wider decarbonization (these issues are the 'important' and the 'urgent' ones that demand early attention, but which may not necessarily overlap). Others will also be able to go further and consider broader aggregate fiscal implications of several channels operating together (which will ultimately be necessary for any MoF that seeks to incorporate climate-related issues throughout its core responsibilities such as macro-fiscal forecasting and budget-setting).

MoFs' desire for support on climate-related issues is wide-ranging, with particular emphasis on the need to develop analytical capabilities, access the latest developments in modeling, and access case studies–as borne out by a global survey carried out as part of the HP4 workstream (see Box 1.1). This report aims to offer guidance in all those areas, focusing on where to start for MoFs taking their first steps in climate-fiscal modeling, and how to move forward for those that have already started.

Box 1.1. Insights from the global survey of Ministries of Finance

A global survey was carried out to inform this workstream, with responses received from 59 MoFs, including 26 from advanced economies and 33 from emerging markets and developing economies. The survey results provide valuable insights into the current practices, needs and demands of MoFs when analyzing the fiscal implications of climate issues.

As many as 89% of MoFs see climate as a core issue for their Ministry, with 32% saying that it lies within their own mandate, while 57% see it as the mandate of another body. Furthermore, Ministries of Finance are particularly concerned about the potential impacts of physical and transition risks on government finances. Seventy-one percent of respondents rate their level of concern about the impacts of physical climate risks on government spending at 4 or 5 (on a 5-point scale with 5 being 'extremely concerned'), while 51% rate their concern at this level for national transition risks, and 70% for global transition risks. Similarly, 51%, 49%, and 59% of MoFs, respectively, rate their concern about the impact of physical risks, national transition risks, and global transition risks on government revenue at 4 or 5.

Fiscal sustainability and affordability are cited as particularly important when considering climate policies—indeed, slightly more important, even, than impacts of economic growth and efficiency (89% rate fiscal sustainability at 4 or 5 on a 5-point scale with 5 being 'extremely concerned', while 83% do so for growth and economic efficiency).

Despite this, only a minority of MoFs surveyed have yet partly or fully integrated either climate risks or decarbonization into macroeconomic forecasts, budget projections, or tax and fiscal policy assessments. Of these, the area where most progress is being made is integrating physical risks into budgeting (fully or partially integrated by 35% of respondents). This perhaps reflects that those risks have been hitting ever more frequently and powerfully in recent years, making them more visible and less open to challenge than other types of climate impacts. Next on the list is integrating climate mitigation considerations into tax and fiscal policy and budget projections (both being fully or partially integrated by 29% of respondents).

Only 26% of MoFs have estimated domestic public adaptation costs, whereas around half have estimated overall domestic expenditure needs for decarbonization. The power and transportation sectors have been covered by approximately half of MoFs, whereas buildings, industry, and agriculture have been covered by around one-third.

The survey report is available at www.greenandresilienteconomics.org.

2. Demand-side: what analytical questions do Ministries of Finance need to answer?

The analytical questions that MoFs need to answer will, of course, be specific to their context, and they will evolve over time. **Using the three main channels as an overarching framework, some of the key questions that MoFs around the world are asking themselves include**:

- **What are the fiscal implications of climate change?**—where MoFs' primary need is to consider appropriate climate scenarios for their country and the potential fiscal costs associated with them
- **What are the fiscal implications of adaptation policies?**—where MoFs need to evaluate the extent to which it is fiscally beneficial to invest in resilience to reduce the costs of climate change
- **What are the fiscal implications of climate change mitigation?**—where MoFs need to understand emissions pathways and the potential policy mixes required to achieve those pathways, along with their fiscal, investment, and broader societal implications. The individual policies to achieve this sit on a fiscal spectrum from those that raise revenue to those requiring additional expenditure.

These questions have been validated by the survey, interviews, and other engagement for this workstream. They are explored below and summarized in Table 2.1, followed by some cross-cutting questions.

a. What are the fiscal implications of climate change?

Given the uncertainty around prospects for climate change and associated economic and fiscal costs, climate scenarios covering different likelihoods will be appropriate for different core MoF processes. For macro-fiscal forecasting and budget-setting, it is most appropriate to consider likely scenarios. For scenario-based risk analysis, reasonable worst-case scenarios are helpful. For each, the analytical steps to assess fiscal impacts start with climate scenarios then estimate fiscal implications along economic and other channels.

The first step is to ask, **what are the most likely scenarios for future economic and fiscal costs associated with climate change?** Climate change is already imposing economic and fiscal costs. These can be expected to rise in the future due to the increased likelihood and severity of extreme events that have the potential to generate fiscal and slow-onset costs, such as the damage to labor productivity at high temperatures, and the impact of climate-related depletion of physical, human, and natural capital. Answers to these questions will influence the macroeconomic and fiscal assumptions underpinning budget forecasts and expenditure plans. They should be conditioned on climate scenarios that reflect existing global and local prospects for emissions reduction, as well as the resilience of economies and infrastructure to extreme weather events and slow-onset pressures from a changing climate.

The importance of conditioning the macroeconomic forecasts that underpin budget-setting on appropriate climate assumptions is recognized in a report from the U.S. Council of Economic Advisors and U.S. Office of Management and Budget published during the Biden-Harris administration. It notes that, at present, the budget "does not explicitly account for the macroeconomic effects of climate change nor the transition to a clean energy economy" and that "Accounting for these factors could have important policy implications since the macroeconomic forecast informs the Administration's policy proposals and the budgets that Agencies submit to the Office of Management and Budget" (Council of Economic Advisers and Office of Management and Budget, 2024). Other countries—advanced and emerging economies, and low-income countries—are starting to address these issues, too.

The second step is to ask, **what are the reasonable worst-case economic and fiscal risks under more extreme future climate scenarios?** This would address the same analytical questions under more challenging conditioning assumptions about the extent of future climate change. For example, fiscal stress tests—as recommended in the IMF's fiscal risks toolkit[2]—should explore fiscal resilience to low-probability but potentially catastrophic, or so-called 'tail', risks.

Answers to these questions will inform fiscal risk analysis and associated decisions about the mitigation of those risks, for example by investing in greater resilience of infrastructure or the issuance of climate-contingent debt instruments such as catastrophe bonds.[3] Another potential framework for considering these risks is to view them as contingent liabilities of government, which facilitates analyzing the costs and benefits of adaptation changing the probability and potential losses associated with that contingent liability.

Rwanda's 2024/25 Fiscal Risk Statement provides an example of climate-focused fiscal risk analysis. It quantifies the impact of different long-term warming scenarios, discusses the impact of extreme flooding that occurred in the country in May 2023, and presents a risk matrix assessing specific climate-related fiscal risks to 10 major state-owned enterprises and public-private partnerships (Ministry of Finance and Economic Planning, Rwanda, 2024).

To answer questions in this area, MoFs would need access to reliable climate scenarios that are conditioned on appropriate assumptions about future paths for global emissions and for local climate trends consistent with those emissions paths. From that foundation, they would need data and projections for the frequency, severity, and cost of extreme weather events (both to the economy as a whole and directly borne by the public sector). For analysis of slower-onset changes, they would need robust country-specific assessments of the relationship between climate trends (such as temperature and precipitation, both averages and extremes) and economic and fiscal outcomes—often termed 'damage functions', as discussed later in this report. In all cases, it is likely to be beneficial to explore several scenarios, given the fundamental uncertainty around future climate paths.

An accompanying thematic report on physical climate risks and adaptation[4] discusses the macroeconomic and budgetary impacts of the physical risks from climate change and adaptation policies in greater detail, providing advice on modeling tools and approaches appropriate for MoFs.[5]

b. What are the fiscal implications of adaptation policies?

Armed with a fuller understanding of the costs and risks from climate change described above, MoFs then need to assess the fiscal implications of adapting to climate change. This includes both the private and public investment necessary to reduce expected costs in an efficient and cost-effective manner, as well as the associated benefits from reducing the costs of future climate events. These issues are explored in depth in the HP4 Physical Risks and Adaptation Report, which notes that while analytical challenges faced by MoFs in respect to adaptation are very context-specific, the relevant questions can be grouped into three categories: (i) establishing the scale of adaptation needs, in order to (ii) inform the evaluation of adaptation interventions by weighing up the costs and benefits of action, so as to (iii) enable adaptation in the face of constrained financing conditions and uncertainty about what level of climate change to adapt to and by when.

One important feature of understanding the fiscal implications of adaptation needs is that MoFs need detailed assessments of different climate risks and different locations within their country to be able to assess where costs should be borne by the public sector. They also need estimates of the gains from investment in terms of

[2] General guidance is available at: www.imf.org/en/Topics/fiscal-policies/Fiscal-Risks/Fiscal-Risks-Toolkit/Fiscal-Risks-Toolkit-FST

[3] The issuance of catastrophe bonds involves much more complex analysis than simply determining the scale of climate-related risk a country faces, as discussed in Ahmed and Rambarran (2024) in relation to Jamaica's experience.

[4] Henceforth described as the 'HP4 Physical Risks and Adaptation Report' (CFCMA, 2025b).

[5] See also 'New approaches to quantifying the fiscal impacts of physical climate change', contribution from ETH Zürich to the HP4 Compendium of Practice. All Compendium contributions will be available at www.greenandresilienteconomics.org from June 2025 onwards.

reduced economic and fiscal costs of extreme events, plus benefits from unlocking economic potential and wider co-benefits, to assess the case for action and to deploy scarce funds efficiently (see Tanner et al., 2015 for a fuller discussion).

To answer questions in this area, MoFs can benefit from being able to identify and quantify risks (i.e., the results from analysis of the macro-fiscal impacts of climate change, along with bottom-up, location-specific analysis)—and to evaluate the impact of climate adaptation interventions in reducing those risks (for specific assets and locations, and at the aggregated macro-fiscal level). This requires establishing: first, a relationship between risk drivers—climate hazards, exposure, vulnerability—and their economic and fiscal impacts to understand the need for adaptation; and second, an understanding of the role that different adaptation interventions can play in addressing these risks, and their expected costs and benefits. As with assessments of physical risks themselves, there is likely to be value in assessing adaptation policies in several future climate scenarios to reveal those low-regrets policies that are robust to several different futures.

c. What are the fiscal implications of climate change mitigation?

In contrast to the risks from climate change and the returns from adaptation policies, which are global-, country- or local-level issues, mitigation efforts are intrinsically linked to international negotiations—notably the Paris Agreement—and the Nationally Determined Contributions and net zero targets that have followed.

Achieving net zero emissions requires a combination of moving away from existing emissions-intensive activities and adding new low-emissions activities. For some countries, decarbonization will be the primary concern: switching power generation and other energy use from fossil fuels to renewables and the clean electricity it generates. For others, the key objective will be achieving low-carbon growth by deploying clean technologies from Day One. Regardless of different starting points and emphasis on particular challenges, MoFs in general need to understand the fiscal implications of meeting climate mitigation targets: for instance, the cost of a specific subsidy policy or the revenues lost from fuel taxes by decarbonizing the transportation sector. Further examples of this are provided later in this report. Understanding the fiscal implications of the transition ranges from individual countries assessing their own situation to cross-country studies from international organizations, such as the comprehensive analysis of the fiscal implications of global decarbonization in a recent IMF working paper (Black et al., 2024).

At the highest level, the fiscal implications of decarbonizing economies depend on:

1. **The volume of emissions reductions required** relative to baseline trajectories—in aggregate and for individual sectors
2. **The average investment required and other costs incurred** at the whole-economy level to achieve those emissions reductions, as technologies and their costs evolve, thanks to innovation and learning-by-doing through deployment
3. **The fiscal implications—positive and negative—of the policy mix deployed** to incentivize the transition to net zero emissions, including the share of costs that fall to the public sector through subsidies and direct public investment, and the share borne by international transfers
4. **Any fiscal costs or gains from wider economic implications** of the transition to net zero (such as the costs of carbon removal technologies or the potential gains from improvements in energy efficiency and co-benefits from cleaner technologies).

The fiscal implications of achieving low-carbon growth from a low-emissions starting point fall under similar headings but require thinking through the investment needs of alternative pathways to development rather than removing emissions from existing activities. **In either context, this can be reduced to questions of**:

1. **How much investment (broadly defined) is required** at the whole-economy level for a given policy mix to decarbonize activities or to achieve growth without raising emissions while also achieving any gross removals that prove necessary (through natural or technological means)

2. **The fiscal implications of the policy levers that are used to incentivize that investment** (which sit on a spectrum from carbon taxes and the withdrawal of fossil fuel subsidies that yield fiscal gains, through regulatory measures with only indirect fiscal impacts, to subsidies and public investment with direct fiscal costs).

Answers to these questions will inform macro-fiscal forecasts, tax policy analysis, and budget-setting, enabling MoFs to integrate the fiscal and climate effects of their government's policy choices. (The modeling tools and approaches available to help inform choices about which policy mix to pursue are covered in a separate report within this workstream [CFMCA, 2025c], so are beyond the scope of this report.)

It is worth stressing that the four stages of assessing the fiscal implications of emissions reductions—and the whole economy's investment needs and policy mix to deliver emissions reductions—are not independent of one another. For example, the question of the appropriate volume of emissions reductions will depend on the investment costs, gains, and economic implications of decarbonization while sustaining economic growth.

Most pressingly, then, **to answer questions around the fiscal implications of climate mitigation efforts**, MoFs need country- and sector-specific estimates of the overall additional investment required to reduce emissions across systems and sectors under different policy mixes. Such estimates enable them to consider the fiscal impacts of ways to incentivize, or directly contribute to, required investment through mitigation policies. While there are several estimates of global or regional investment needs to achieve decarbonization or low-carbon growth,[6] there are fewer bottom-up estimates of investment needs by country and by sector. This level of disaggregation would be most helpful for MoFs seeking to answer fiscal questions and prioritize the use of fiscal resources.

Core to this question of the fiscal implications of incentivizing investment in the transition is the public–private split of that investment. MoFs need to judge the extent to which private investment could be incentivized through taxing emissions, removing fossil fuel subsidies, or subsidizing clean alternatives, or mandated through regulation. MoFs can also evaluate whether the public sector can invest on its own account. The appropriate balance will vary across countries and sectors, reflecting, for example, the maturity of the private sector, depth of financial markets and cost of capital, and uncertainties around technology costs.

MoFs will also need estimates of the fiscal impacts associated with using different policy tools and policy mixes to achieve decarbonization in different sectors and activities. This will include additional public investment, direct revenue increases or decreases through pricing of emissions and fuel use etc., along with other impacts such as costs for compensation of vulnerable groups, or fiscal effects from air pollution, congestion, and so on. Political reality means that it will not always be possible to use the most economically efficient and fiscally beneficial policy lever, namely, setting a carbon price and taxing emissions to incentivize private investment in clean alternatives. The IMF often recommends a combination of uniform carbon pricing with public spending in case of market failures and targeted measures for vulnerable groups. It recognizes that governments face "a trilemma between achieving climate goals, fiscal sustainability, and political feasibility," and that "no single policy measure on its own can fully deliver on climate goals," with a need for a practical mix of policies accounting for their economic efficiency, administrative practicality, and political feasibility, among other attributes (IMF, 2023).

MoFs, therefore, can benefit from understanding the fiscal trade-offs in choosing between different policy tools or mixes of them to ensure the political feasibility of climate action. Beyond carbon pricing, those tools include direct public investment, subsidies (from the government or via customers' bills), feebates, public lending and guarantees, and the use of regulations or outright bans. MoFs need to understand both the climate and the fiscal implications of these tools, including how they can be used in concert or in sequence to achieve the best outcomes for emissions and public finances (e.g., see Lenain, 2024).

[6] See the latest report from the Independent High-Level Expert Group on Climate Finance (Bhattacharya et al., 2024) and Black et al. (2023) for the IMF.

Finally, analysis of the indirect implications of the transition can be key inputs for MoFs. These include:

- **Revenues**–such as loss of existing fossil fuel royalties and export revenues, particularly for countries where these account for a large share of overall fiscal revenues, or loss of existing fuel tax bases, analysis of which can also inform decisions about replacement taxes and revenue sources.[7]
- **Expenditure**–such as compensation for affected groups or the recycling of carbon tax revenues that bolster popular support by ensuring a just transition.
- **The wider economy**–reflecting frictions in the transition, discussed in an accompanying report on macro-critical transition risks, costs where green solutions are less productive than existing fossil fuel technologies, and also the longer-term gains from investment in secure, clean energy systems and more productive, energy-efficient technologies; and **wider co-benefits**, for example, the reduced pressures on public spending on healthcare that flow from reductions in fossil fuel use.

Table 2.1. Summary of analytical questions that Ministries of Finance need to answer

Channel	Policy questions	Core MoF functions	Analytical needs (developed in collaboration with line ministries and other sources)
Climate change	Most likely future paths for physical climate risks? Reasonable worst-case scenarios for future extreme weather events? Productivity losses from warming climate? Climate risks that can be addressed through global mitigation efforts?	Macro-fiscal forecasts Fiscal risk assessments Long-term fiscal sustainability assessments	Reliable climate scenarios and climate hazard maps Data and projections for economic and fiscal costs of extreme climate events Country-specific estimates of climate-macro effects
Adaptation	Scale of adaptation needs? Evaluation of adaptation interventions? Enabling adaptation given constrained financing and climate uncertainty?	Policy analysis Budget-setting Investment appraisal Mitigation of fiscal risks	Detailed assessment of local-level risks, now and in the future Analysis of links between risk drivers (hazard, exposure, vulnerability) and outcomes Estimates of costs and benefits of interventions, including direct and indirect fiscal implications of policies
Mitigation: decarbonization and low-carbon growth	Setting appropriate decarbonization targets? Sector-level pathways to decarbonization/net zero or low-carbon growth? Sector-specific investment needs to meet targets? Policy tools/packages best suited to incentivizing the necessary investment and emissions reduction?	Policy analysis Budget-setting Macro-fiscal forecasts Fiscal risk assessment Long-term fiscal sustainability assessments Strategic planning	Emissions pathways, technology costs and investment needs Analysis of direct and indirect fiscal implications of policies used to incentivize transitions Analysis of the macro costs and benefits of policy choices and transitions

[7] For an example of this debate playing out in the UK, see the Resolution Foundation's report on options for reforming vehicle taxes, which calls for progressively replacing fuel duties with a per-mile road duty (Marshall and Corlett, 2023).

These assessments feed into and are framed by choices about fiscal frameworks and targets. For example, the IMF has explored issues around setting 'green' fiscal frameworks to promote climate action without undermining fiscal sustainability (Caselli et al., 2024). It also provides technical assistance on green public financial management.

d. Cross-cutting issues and interactions

MoFs are likely to face analytical questions that cut across the three channels set out above, and areas where decisions in one area will influence outcomes in another. For example:

- For many countries, creating an enabling environment (through sound public financial management, revenue administration, expenditure policy, and macro-fiscal frameworks) is crucial to supporting both development and progress on climate adaptation and mitigation.
- The greater the expected losses due to extreme weather events, the stronger the case for investment in adaptation and resilience.
- Attracting international public finance can reduce the costs of climate mitigation and adaptation policies that must be borne by domestic fiscal authorities.
- While some low-carbon technologies already improve resilience to climate-related physical risks, new infrastructure to deliver the green transition must also factor in the need for resilience and the risks from climate change—for example, hydro power plants can be adversely affected by both droughts and extreme flooding.[8]
- Many adaptation or mitigation policies have co-benefits for the whole economy (for instance, higher taxes on fuel also lead to reduced health mortality and accidents/congestion costs).
- For the handful of large economies and large emitters that can influence global emission paths with their domestic decisions, choices over the pace and extent of emissions reductions can influence the fiscal risks they face from climate change.

[8] Rwanda's MoF estimated that extreme flooding in the country in May 2023 would cost RWF 518.6 billion (US$415 million or 3% of GDP), with infrastructure-related costs to roads, bridges, and power constituting 75% of the total.

3. Emerging good practice: what tools and approaches can Ministries of Finance draw on?

With such a broad range of analytical questions to address, MoFs need to be able to access comprehensive, consistent, and trusted sources of information across many areas. These needs include accessible data, tools, and models, as well as analytical reports to inform their work. As MoFs are typically constrained in terms of analytical resources and time, it is important that they can feel confident that the information and tools they access are sufficiently robust for their purposes without having to invest significant time in understanding their every detail.

This section summarizes some of the more readily available and prominent data, tools, and approaches that MoFs can draw on. It is a partial rather than comprehensive treatment of what is available. The Compendium of Practice[9] and a forthcoming thematic report summarizing the tools available to MoFs provide more information on the broad suite of relevant macroeconomic tools (both modeling and non-modeling approaches) on which MoFs can draw. Some, but not all, of these can assess fiscal impacts. In general, this broader review finds that there is value in shifting away from static cost–benefit analysis appropriate for marginal projects with narrow and known risks, to risk–opportunity analysis and options theory. The latter informs decisions that can generate economies of scale in production and shape the future supply-side of the economy while avoiding locking into redundant infrastructure, skills, and ideas.

What is outlined below places particular emphasis on those tools that are most relevant for assessing potential fiscal impacts. Many of these tools are described in further detail in other outputs of the workstream, such as the Compendium of Practice and the HP4 Physical Risks and Adaptation Report.

In general, the tools and models presented in this section support responses to policy questions in three key areas:

- **Evaluating possible consequences of climate change physical risk**. Tools in this area bring valuable inputs such as estimates and scenarios of the overall national costs of climate change physical risks, revenue projections under different scenarios, and assessments of productivity and overall macroeconomic impacts. Available tools include bottom-up sector models that directly assess physical impacts and economic damages from climate change, and top-down approaches that place particular emphasis on loss and damage functions. Other approaches include integrated assessment models (IAMs), macroeconomic computable general equilibrium (CGE) models, econometric models and macro-fiscal models. With these tools MoFs can also build scenarios by projecting different climate outcomes in order to assess risk better. For instance, the IMF's new Q-CRAFT tool helps governments assess fiscal risks from climate change under different IPCC climate scenarios. More information on analytical tools to assess physical climate risks is provided in the HP4 Physical Risks and Adaptation Report.
- **Estimating benefits and costs of adaptation policies and evaluating adaptation interventions**. Adaptation investment costs can be contrasted with the potential impacts of climate change physical risks, as presented in the previous key area. Multiple initiatives enable users to estimate or approximate the costs of adaptation interventions. Open-source models such as the Climate Change Explorer and climAdapt, and platforms including the Oasis Loss Modelling Framework and Resilient Planet Data Hub, can be used to estimate financing needs. Key reports such as the World Bank's Country Climate and Development Reports and the IMF Fiscal Monitor provide insights into adaptation investment requirements.

[9] See www.greenandresilienteconomics.org for the full Compendium and a Summary Report (CFMCA, 2025a).

- **Understanding the fiscal implications of mitigation targets and climate policy**. Macroeconomic CGE models, adapted with climate components, or macro-structural models can be used to assess the fiscal impacts of overall climate goals or for specific policies. For instance, Italy's IRENCGE-DF estimates a given policy's indirect and economy-wide effects to assess multiple policy scenarios against effectiveness, efficiency, and equity principles. The Climate Policy Assessment Tool (CPAT) of the World Bank and IMF is an Excel-based tool that estimates price changes, energy consumption, revenue generation, GDP impacts, and emission changes. Tools are also available to analyze the fiscal effects of sector-specific objectives. Specifically, energy system models have been used to analyze the fiscal impacts of different energy transition scenarios. These include the TIMES, BUEGO, GAPTAP, and OSeMOSYS models. For instance, the Inter-American Development Bank assesses the financial and fiscal impacts of decarbonizing road transportation in a single framework via OSeMOSYS, augmented by a tax and a distributional impact module based on a CGE model. Finally, other tools can help MoFs assess the investment needs of these climate objectives.

Regarding data, the section explores the multiple needs and sources that exist. Country-specific data, usually hosted by governments, can provide detailed information to feed tools. Higher-level global or regional data is also available and hosted by different organizations. For example, MoFs can build climate change scenarios based on the IPCC's climate and emission data pathways. On the cost of climate-related disasters and slow-onset effects, the EM-DAT International Disaster Database or the IMF's 'Fiscal Costs of Contingent Liabilities' dataset (Bova et al., 2016), among others, can provide a useful starting point. Sector-specific information is also available for feeding into macroeconomic frameworks to analyze associated fiscal impacts. For instance, the International Energy Agency's World Energy Outlook 2024 provides a comprehensive starting point with multiple scenarios.

The tools described below generally provide a starting point for MoFs' analysis of different climate-related fiscal questions. Once sufficient understanding and capability have been developed in the use of sources like these, MoFs will naturally want to adapt tools and approaches so that they are progressively more aligned with their own national context, policy environment, and investment plans. That process of learning and refining approaches allows climate-focused tools and modeling to be integrated into core MoF processes like macro-fiscal forecasting, budget-setting, and multi-year investment planning.

a. What data, tools, and approaches are available for analyzing the fiscal implications of climate change?

Analyzing the fiscal implications of climate change is relevant to several core MoF processes. Climate-related disasters and their economic and fiscal costs are already becoming more frequent and more severe, so these questions are already relevant for macro-fiscal forecasts and for budget-setting (for example, in determining contingency reserves for disaster relief). These extreme climate events are expected to worsen further over time, making these questions relevant for longer-term analysis of fiscal sustainability, and the assessment and mitigation of fiscal risks. Many of the tools and approaches discussed below are also relevant to assessing the fiscal implications of adaptation policies, which are covered in the following subsection.

The first ingredient necessary to analyze the fiscal implications of climate change is appropriate country-specific **climate scenario data**.[10] While all climate models struggle to simulate earth system complexity and extreme risk around feedback loops, aggregated and cascading impacts, and tipping points, the IPCC attempts to supply a synthesis of the key risks emanating from the breadth of scientific analysis. IPCC-consistent scenarios can be accessed freely from the World Bank's Climate Knowledge Portal and its Climate Risk Country Profiles, which makes them particularly useful resources for MoFs. The Network for Greening the Financial System (NGFS) scenarios portal is another accessible source. Further guidance on using climate scenarios is provided in the accompanying HP4 Physical Risks and Adaptation Report.

[10] One challenge for users of climate scenarios is the length of time it takes international panels of experts to produce those scenarios, due to their enormous complexity. Recent advances made at the University of Oxford hold out the promise of faster scenario runs, which would be of great value to policymakers (Oxford Martin School, 2024).

Ideally, MoFs would utilize **data on the costs of climate-related disasters** from domestic sources—for example, from agencies responsible for civil contingencies or disaster relief, or processes that underpin the creation of national risk registers. Failing that, they can access higher-level data via the EM-DAT International Disaster Database that helps illustrate the broad trends at play as a starting point for analysis before more detailed and reliable country-specific data can be sourced. The IMF's Climate Change Indicators Dashboard also provides climate and weather-related indicators, and summary data from the EM-DAT dataset. These are good sources of information on macro-level 'mass disasters', with EM-DAT compiled rigorously from various sources, including UN agencies, non-governmental organizations, reinsurance companies, research institutes, and press agencies. It is, however, insufficiently detailed for micro-level analysis: for example, to inform within-country decisions about where the greatest climate risks lie and where investment in adaptation and risk mitigation should be focused (see following two subsections).

Climate hazard maps provide a more detailed source of information on these risks. For example, the Global Infrastructure Risk Model and Resilience Index (GIRI) describes itself as "the first publicly available, fully probabilistic risk model for infrastructure assets with respect to most major geological and climate-related hazards." Several more detailed hazard maps are being developed at the national level.

To analyze the fiscal costs of climate change, scenarios and datasets can be combined with information on:

1. The share of the costs of extreme weather events that fall to the public sector
2. The slow-onset costs of rising temperatures via productivity growth and knock-on implications for the fiscal position.

With regard to **the fiscal costs of extreme weather events**, there are no international datasets that are perfectly suited to MoF needs. The HP4 Physical Risks and Adaptation Report provides guidance on overall risk assessments, including contributions from the Global Risk Modelling Alliance. The IMF's 'Fiscal Costs Of Contingent Liabilities' dataset includes natural disasters among its categories, which provides a reasonable proxy (Bova et al., 2016). MoFs can also often interrogate their own country-specific data for the direct fiscal costs of disasters, for example through specific budget lines or emergency funds used during crises.[11]

The number of MoFs and other bodies that have brought these information sources and modeling tools together to analyze the fiscal implications of climate change is growing. Examples include fiscal risk statements produced by the MoFs of Georgia (Ministry of Finance of Georgia, 2022) and Rwanda (Ministry of Finance and Economic Planning, Rwanda, 2023a), and technical assistance reports produced by IMF teams in Georgia, Armenia, and Jamaica (IMF, 2022a; IMF, 2022b; Fisher and Grinyer, 2024). The Australian Treasury's Intergenerational Report 2023 focused on impacts of heat stress, lower precipitation, and environmental degradation on labor productivity, agricultural productivity, and tourism (Australian Government, 2023).[12] The U.S. Congressional Budget Office has also undertaken analysis of climate change with in-depth analyses of climate-related issues that have fiscal implications, ranging from the impact of climate change on macroeconomic outcomes (Herrnstadt and Dinan, 2020) to fiscal risks from wildfires, flooding, and hurricanes and severe storms (CBO, 2022; 2023; 2019).

In the EU, the PESETA IV project of the European Commission's Joint Research Centre (JRC) assesses climate change impacts using a bottom-up approach. It uses biophysical models, and its coverage includes agriculture, energy supply, human mortality, and riverine floods. It also provides a broader assessment of socioeconomic and welfare effects.

With regard to **slow-onset costs from the changing climate**, MoFs can access many studies (and models embodying them) that estimate the relationship between economic output and rising temperatures—the 'damage function'. The challenge for MoFs is that there is no single damage function estimate that is widely accepted as

[11] See, for example, Brazil's 'S2ID' disaster information platform and its digital atlas of historical disaster costs.

[12] See also 'Estimating the impact of selected physical climate risks on the Australian economy', contribution from the Australian Treasury to the HP4 Compendium of Practice.

the best to use. Indeed, the range of estimates available from different studies is uncomfortably large.[13] Some studies attempt to isolate only the slow-onset component of climate change costs, while others factor in the consequences of extreme events too, and some do not specify clearly which effects are being estimated.

The NGFS bases its scenarios on a paper by Kalkuhl and Wenz (2018); the IMF's new Q-CRAFT tool (described below) uses Kahn et al. (2021). A recent NBER Working Paper (Bilal and Kanzig, 2024) claims to have found the potential for much greater damage than previous studies. Forthcoming research from the World Bank seeks to overcome some of the challenges posed by damage functions by taking a 'vector' approach that allows climate risks to be considered at a more spatial level and different damage channels to be estimated in country contexts, which together mean that vulnerabilities and exposures can be described more explicitly (Abalo et al., forthcoming).

In a contribution to the HP4 Compendium of Practice, Lint Barrage outlines new approaches to quantifying the fiscal impacts of physical climate change.[14] Drawing on the example of her own recent paper on the fiscal costs of climate change in the U.S. (Barrage, 2024), she notes how more recent estimates of these costs are larger than those from earlier studies—but that they are still likely to be underestimates since they omit some potentially important effects (in this case, the health-related fiscal costs of wildfires).

The most fiscally focused modeling tool currently available for assessing the long-term chronic impact of climate change on fiscal outcomes via slow-onset damage to productivity is the IMF's new Q-CRAFT tool. Using this tool, MoFs can assess the impact of different IPCC climate scenarios on GDP and fiscal metrics relative to a baseline counterfactual of no further climate change. It provides a simple, user-friendly Excel tool to explore this channel. Given this simplicity, the results are stylized representations of potential macro-fiscal risks from climate change, reflecting partial equilibrium calculations derived from country-specific damage functions, a production function, and a debt dynamics equation. As with the example presented by Lint Barrage, the results are likely to be conservative since they do not explicitly account for tipping points, risk from rising sea levels, non-market damages, or other environmental risks (although users can manually add such considerations within the tool).[15]

b. What data, tools, and approaches are available for analyzing the fiscal implications of adaptation policies?

Adaptation policies refer to changes in processes, practices, and structures to moderate potential damages associated with climate change, for example by ensuring infrastructure is resilient to more extreme weather events. Assessing their implications is therefore closely linked to assessing the potential costs of climate change, described in the previous subsection. The HP4 Physical Risks and Adaptation Report documents the data and analytical tools available to assess adaptation needs, which it notes have improved over the past decade. These include open-source models like Climate Change Explorer and climAdapt, and platforms such as the Oasis Loss Modelling Framework and Resilient Planet Data Hub. One approach to considering the economic and fiscal implications of adaptation measures in aggregate has been set out by the German Development Agency GIZ in a handbook on modeling climate resilience (GIZ, 2023).

The World Bank's Country Climate and Development Reports provide in-depth assessments of climate risks and policy settings to quantify investment needs associated with resilient and low-emissions development pathways—covering climate risk, adaptation, and mitigation. These reports, which now cover more than 50 countries, reflect the reality that MoFs do not face a choice between pursuing development or climate resilience: they must achieve both in concert. Their value is described in a recent World Bank blog post (Hallegatte et al., 2024).[16]

[13] See, for example, Richard Tol's meta-analysis of the total economic impact of climate change (Tol, 2024).
[14] Contribution from ETH Zürich to the HP4 Compendium of Practice.
[15] The strengths and limitations of the tool are discussed in 'Fiscal risks of climate change: Quantitative Climate Change Risk Assessment Fiscal Tool (Q-CRAFT)', contribution from the IMF Fiscal Affairs Department to the HP4 Compendium of Practice.
[16] See also 'A bottom-up approach to estimating climate-development investment needs', contribution from the World Bank to the HP4 Compendium of Practice.

The Climate Policy Initiative maintains a wide range of estimates of climate finance needs, which include adaptation investment needs drawn from a variety of curated sources (Strinati et al., 2024), while the UN Environment Programme has published a detailed review of model-based estimates and estimates based on Nationally Determined Contributions (NDCs) of adaptation investment and financing needs (UNEP, 2023). The IMF's Fiscal Monitor of October 2020 included country-level estimates of investment needs based on assumptions that upgrading new investments adds an average of 15% to unit costs, while retrofitting existing assets can cost more than 50% of asset values (see Box 2.1 and Online Annex 2.7 in IMF, 2020).

These estimates provide MoFs with a starting point for considering the potential scale of adaptation investment needs, but they are insufficiently detailed to form the basis for adaptation strategies. Such strategies and individual investment plans require more conventional tools of cost–benefit analysis and public investment management, supplemented by disaster risk management tools and the results from analyzing the risks and costs of climate change (the avoidance of which is a key benefit of adaptation). These approaches are detailed in the HP4 Physical Risks and Adaptation Report. Some examples of country-specific investment plans are available in the Climate Prosperity Plans (CPPs) countries have produced with the V20.[17]

An IMF contribution to the HP4 Compendium of Practice discusses MoFs' role in investment in adaptation and the available analytical principles and tools.[18] It notes the importance of assessing the value for money of additional public expenditure and of ensuring there is a conducive environment for private adaptation investment. MoFs are well-placed to play a core role in this process because of the overlap between climate adaptation and broader economic development, for which MoFs already have a well-stocked toolbox.

c. What data, tools, and approaches are available for analyzing the fiscal implications of climate change mitigation?

Analysis of the fiscal implications of decarbonizing economies and achieving low-carbon growth should increasingly feature across MoFs' core processes. Ultimately, macro-fiscal forecasts need to be conditioned on assumptions about energy prices, investment, tax policies, and regulations that are consistent with domestic and global efforts to reduce emissions. Budgets need to reflect expenditure allocations for decarbonization and low-carbon growth, and the potential impacts of those on the economy and tax revenues. This mainstreaming of climate action into MoFs' day-to-day activities is critical to achieving the objectives set out in NDCs, net zero pledges, and long-term strategies.[19]

In many cases, conventional toolkits will be adequate, for example in analyzing the effects of a particular development on a specific tax base. But in the case of overarching strategic decisions, whether regarding infrastructure to reduce emissions and energy costs or investment in low-carbon sectors with export market potential, there are likely to be enhanced levels of risk and opportunity that cannot be assumed away by treating macro-fiscal projections as static or deterministic.

To achieve this mainstreaming, MoFs need to understand the sector-by-sector transitions that will influence all the variables of interest to them in their macro-fiscal forecasting and budgeting processes. This starts with emissions data and pathways, associated paths for energy use and prices, analysis of the economic and fiscal impact of climate policies, including overall and public investment needs, and effects on carbon prices, energy taxes, and fossil fuel subsidies, drawing where appropriate on estimates of marginal abatement costs. Some of the available data, tools, and approaches for each are discussed next.

[17] CPPs have so far been published for eight countries: Bangladesh, Barbados, Bhutan, Ghana, Haiti, Pakistan, Philippines, and Sri Lanka. See cvfv20.org/climate-prosperity-plans/

[18] See 'The critical role of Ministries of Finance in investment in adaptation and the analytical principles and tools available', contribution by the IMF Fiscal Affairs Department to the HP4 Compendium of Practice.

[19] See, for example, the Coalition Co-Chairs' Joint Call to Action: Finance Ministries are Key to Accelerated Climate Action through Ambitious NDCs from April 2024.

For **emissions data and pathways**, MoFs will ultimately need to condition their analysis on their country's own policy targets (for example, NDC commitments and net zero pledges). To get started in this area, it is possible to access the IPCC's Emissions Scenarios directly, with its Data Distribution Centre providing information on temperature and precipitation, emissions, and other socioeconomic indicators. The World Bank's Climate Change Knowledge Portal, the Climate Action Tracker, and UNEP's Emissions Gap Reports are alternative sources. Many of the fiscal scenario analysis reports we cite later in this report start from either the World Bank Climate Knowledge Portal or the Climate Action Tracker for their underlying climate and emissions assumptions.

For **energy sector information and analytical reports**, the International Energy Agency's World Energy Outlook 2024 provides a comprehensive starting point (IEA, 2024a). Three scenarios are presented—stated policies (STEPS); announced pledges (APS); and net zero emissions (NZE)—for energy transitions and associated investment in clean energy generation, energy efficiency, and end-use decarbonization. Section 5.5 of the report details the associated investment needs across power, buildings, transportation, and industry. Price projections are provided for fossil fuels, carbon, and electricity-generating technologies (Sections 2.2.3 and 2.2.4 and Annex B). Some data is provided in a free database, while the full dataset is behind a paywall.

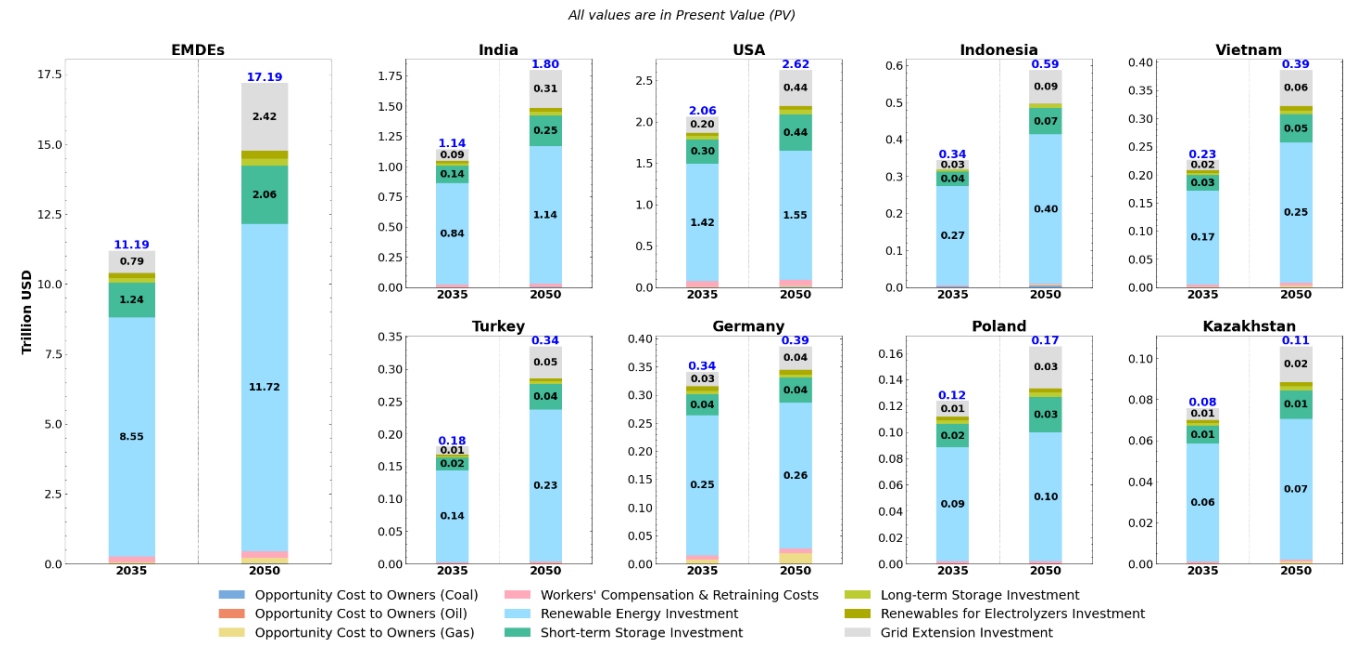
See Box 3.1 for a contribution to the Compendium of Practice focused on the power sector transition.

Box 3.1. Power transition investment estimates from the HP4 Compendium of Practice

In the contribution 'Climate Finance at Scale to Implement NDCs: Decarbonizing the Power Sector' in the Compendium of Practice, Patrick Bolton and Alissa Kleinnijenhuis of Imperial College London set out a methodology for estimating the cost of decarbonizing power sectors in individual countries, building on a global power-plant-level dataset. This covers both costs associated with phasing out fossil fuel plants before the end of their economic life, and the investment needed to phase in additional capacity in renewable energy, and associated storage and grid transmission capacity.

Once phase-out and phase-in assumptions have been set, investment and other costs are estimated using unit costs, including the ability to incorporate the latest learning curves in technology costs. The figure below, reproduced from the Compendium paper, shows the cost breakdown for a sample of countries. More comprehensive results, including, importantly, the benefits of these transitions and how they can be financed, can be found in the underlying contribution within the Compendium of Practice.

Total Costs: Opportunity costs and renewable energy investments



For MoFs using any international or domestic source of energy-sector modeling, a key analytical question is the relationship between the deployment of new technologies and their cost. It is well established that learning-by-doing effects for many clean technologies mean that as deployment rises, costs fall—as the rapid declines in the price of solar PV and battery storage attest to. This is challenging for MoFs that need to understand the cost implications of investment in faster deployment in order to allocate public resources efficiently. A global study by Way et al. (2022) is often used to help understand these issues. In a more recent report, the International Energy Agency has also shown how the additional investment necessary to put the world on track for net zero reduces operating costs for the global energy system by more than half over the next decade compared with a trajectory based on today's policy settings (IEA, 2024b).

For **climate policy analysis**, the IMF/World Bank Climate Policy Assessment Tool (CPAT) is an Excel-based model providing estimates of the effects of a range of climate mitigation policies for over 200 countries. It provides projections across "energy demand and prices, CO_2 and other GHG emissions, fiscal revenues, GDP, welfare, distributional impacts on households and industries, and development co-benefits like health benefits from reductions in local air pollution and road accidents." It is a reduced-form model based on elasticities drawn from extensive literature for the use of shadow carbon prices to proxy other policy measures.[20] This allows the tool to operate in Excel and makes it more user-friendly than more sophisticated models, but brings limitations, too. For example, it does not currently include cross-sector elasticities (such as the effect of higher fuel taxes on the purchase of electric vehicles as well as on the demand for fuel, though this is being built into future versions). The results from the tool should not, therefore, be considered definitive, but are helpful to inform policy choices, particularly over short-to-medium-term timeframes. The tool is not available freely online, but MoF officials can request access through their IMF Executive Director office.[21]

Macrostructural models are often used in tools to assess the effects of climate policy. The **World Bank's suite of climate-aware macroeconomic modeling tools** is described in a contribution to the Compendium of Practice. This includes: a macro-structural country-level model, 'MFMod CC', similar to the workhorse models used in many MoFs; two CGE models, 'MANAGE' and 'ENVISAGE'; an input-output model, 'MINDSET', and more. The World Bank has active programs for building country-specific versions of these models for client countries that include training programs on how to use, maintain, and revise the models.[22] In Denmark, the DREAM team developed the GreenREFORM model, a dynamic CGE model that assesses the combined effects of economic and environmental policy. It provides information on emission accounts, macroeconomic, fiscal, and financial variables, and land-use and livestock accounts. Sierra Leone, in collaboration with the World Bank, has developed a Macrostructural Standalone Model, which is a dynamic stochastic general equilibrium (DGSE) model that estimates short- and long-run impacts of climate change, along with fiscal and sectoral impacts of climate shocks.

There are also several examples of **sector-specific modeling of the fiscal implications of decarbonization**. For example, many studies assess the revenue impact of decarbonizing transportation, quantifying the effects of electric vehicles on fuel tax revenues (Elgouacem et al., 2020; OECD, 2019), and suggesting tax reforms to compensate for their loss (Jenn, 2018; van Dender, 2019). A broader assessment of the decarbonization of transport in Costa Rica is provided in Godínez-Zamora et al. (2020).[23] An approach to modeling the fiscal implications of decarbonizing the UK's residential buildings is provided in Box 4.1 later in this report. The ThreeME model, developed by the French Economic Observatory at Sciences Po, is an open-source, single-country CGE model designed to evaluate the short-, medium-, and long-term impacts of environmental and energy policies at macroeconomic and sectoral levels. It aids in analyzing fiscal risks of climate change mitigation, evaluating climate-aligned fiscal policies, stress-testing fiscal projections against climate scenarios, designing fiscally sustainable transition pathways, and assessing green fiscal reform potential.

[20] Full documentation is available at https://cpmodel.github.io/cpat_public/.
[21] See also 'The Climate Policy Assessment Tool (CPAT)', contribution from the World Bank/IMF Fiscal Affairs Department to the HP4 Compendium of Practice.
[22] See 'World Bank Group climate aware macroeconomic models available for use by Ministries of Finance', contribution from the World Bank to the HP4 Compendium of Practice.
[23] These examples are taken from 'Managing the fiscal impacts of electric vehicles, public transportation, and cycling', contribution from the Inter-American Development Bank, French Development Agency, and University of Costa Rica to the HP4 Compendium of Practice.

Sectoral models can also be used to assess climate objectives. For example, energy system models have been used to analyze the fiscal impacts of different energy transition scenarios. These include the TIMES, TIAM-UCL, BUEGO, GAPTAP, and OSeMOSYS models. For instance, the Inter-American Development Bank (IDB) utilized a combination of TIAM-UCL, BUEGO, and GAPTAP models to integrate global energy demand forecasts and economic and geological data at the project level and represent different tax regimes that apply to each field in 12 Latin American countries.[24] The results highlight that climate action could reduce cumulative government revenue in Latin America and the Caribbean to US$1.3–2.6 trillion by 2035, compared with $2.7–6.8 trillion if oil demand followed historical trends. Similarly, the IDB also assesses the financial and fiscal impacts of decarbonizing road transportation via OSeMOSYS, augmented by a tax and a distributional impact module, as previously mentioned. Switzerland has developed a Budget impact model by combining an energy system model and a CGE model to assess the impact of reaching net zero on public finances as measured by, for instance, the debt ratio, income taxes, and profit taxes.

For **total and public investment needs**, there is a lack of freely available country- and sector-specific estimates that would facilitate MoFs' analysis of the fiscal implications of transitions in their own countries. The IEA's paid-for version of the World Energy Outlook database provides some detail (see above). The IMF's 2021 paper Reaching Net Zero Emissions compiles estimates of public investment needs to reach net zero based on IEA estimates of total investment needs (from IEA's Net Zero by 2050 roadmap [IEA, 2021]) and historical shares of public investment in total investment (which it suggests is likely to represent a lower bound). Table 1 in the IMF's report summarizes the results from four studies, including the IEA one used in the fuller analysis. In Figure 9, it provides splits by public and private sectors for various energy-related investments in advanced and emerging economies. In the EU, the latest European Commission Impact Assessment on achieving net zero estimates that investment in the energy system would need to reach around 3.2% of GDP a year in 2031–2050.[25]

For **carbon prices, energy taxes and subsidies**, the OECD's Pricing Greenhouse Gas Emissions tracks how explicit carbon prices, energy taxes, and subsidies have evolved between 2021 and 2023 across 79 countries (OECD, 2024). Explicit carbon prices, as well as energy taxes and subsidies, are detailed by country, sector, product, and instrument. The latest edition of Effective Carbon Tax Rates was published in December 2023 (OECD, 2023). For **fossil fuel subsidies**, the OECD's Fossil Fuel Support data provides country-level estimates of support for fossil fuels.[26] More generally, the OECD's Inclusive Forum on Climate Mitigation Approaches aims to deliver "better data and information sharing, evidence-based mutual learning and inclusive multilateral dialogue."

The IMF's Climate Change Indicators Dashboard also includes country-level indicators on environmental taxes, COFOG-based[27] expenditure on environmental protection, and fossil fuel subsidies. It is, however, worth noting that the mapping from COFOG's 'environmental protection' to expenditure on climate priorities is not strong. Indeed, recommendations 6 and 7 of the third phase of the G20 Data Gaps Initiative seek to improve upon COFOG-based expenditure classifications to identify current and capital expenditure devoted to mitigation and adaptation, and the extent to which climate-impacting subsidies affect climate change (IMF, 2022c).

[24] For a fuller discussion, see 'How fossil-fuel-reliant Ministries of Finance can assess the fiscal risks of global climate action', contribution from the Inter-American Development Bank, French Development Agency and University College London to the HP4 Compendium of Practice.

[25] For a fuller discussion of EU climate-related modeling, see 'Determining investment needs to decarbonization and adaptation: the challenge and opportunity for Ministries of Finance in the EU', contribution by the European Union/European Commission to the HP4 Compendium of Practice.

[26] For a fuller discussion of fossil fuel subsidy reform, see CFMCA (2024b).

[27] 'COFOG' is the UN's statistical 'Classification of the Functions of Government'.

4. Featured analysis in practice

This section identifies examples of the approaches and specific data and tools outlined above being used in practice at the country level by MoFs and by national economic decision-makers, and by the various international agencies that work closely with MoFs. It aims to provide examples of MoF-led assessments that can help MoFs seeking to learn from the experiences of entities facing similar challenges to their own. It is worth noting that most work to date has focused on the fiscal impacts of decarbonization, but efforts are increasing to understand and address the fiscal implications of climate change and adaptation policies.

a. Featured analysis of fiscal impacts of climate change and adaptation

Georgia's December 2022 Fiscal Risk Statement assessed long-term fiscal risks from climate change (building on technical assistance provided by the IMF, described below) (Ministry of Finance of Georgia, 2022). It also draws on the EM-DAT database to present an analysis of the fiscal risks from natural disasters.

Rwanda's Fiscal Risk Statements for 2023/24 and 2024/25 assess long-term fiscal risks from the adverse effects of climate change on productivity using the IMF's Q-CRAFT tool. In 2024, the analysis was extended to consider climate-related fiscal risks to state-owned enterprises and power-purchase agreements (drawing on the experience of the severe floods in Rwanda in May 2023).

IMF Technical Assistance reports for Georgia and Armenia (IMF, 2022a; 2022b) were produced with the authorities in those countries to present long-term fiscal projections that incorporated the cost of climate change adaptation. They focused on chronic economic costs of climate change, using Kahn et al. (2021), acute costs from more frequent and severe natural disasters, and other risks.

As described in the HP4 Climate Risks and Adaptation Report, examples of bottom-up modeling that explicitly represent adaptation options and their costs and benefits include the **U.S. EPA Coastal Property Model**, which optimizes adaptation strategies for each location and year for buildings threatened by sea-level rise (see U.S. EPA, n.d.). This approach can also capture feedback effects like moral hazard and fiscal impacts, such as the moral hazard effect of **Jakarta's sea wall** delaying migration inland to lower-risk places (Hsiao, 2023) and the fiscal costs and benefits of **U.S. coastal investments** (Barrage, 2024).

The **UK Office for Budget Responsibility's Fiscal Risks and Sustainability report** of September 2024 explored the fiscal impacts of climate change in the UK (OBR, 2024). It explored the consequences of different warming scenarios, including indirect fiscal costs from economic damage and the direct fiscal costs of extreme heat events, and coastal and river flooding. To do so, the OBR built on the scenarios prepared by the NGFS, with some adjustments of its own. The report tested the sensitivity of its results to variations in key assumptions, finding the most important to be the 'damage function' underlying the estimated economic damage from additional warming.

b. Featured analysis of fiscal impacts of decarbonization

The 2023 report **The Economic Implications of Climate Action prepared for the French Prime Minister** explored decarbonization scenarios for France (Pisani-Ferry and Mahfouz, 2023). It assumes significant government support to households and firms for green investments, especially in the buildings sector, economic costs from higher carbon prices in the medium term, and the erosion of the existing fuel tax base. The report also contains an intuitive assessment of the likely shorter-term costs and longer-term benefits for the French economy's

growth potential of the transition to clean technologies, reflecting in part the loss of embedded innovation in fossil-fuel technologies that will build up again over time in their clean successors. Ultimately, this is a key driver of fiscal implications since it determines long-term growth in tax bases.

A March 2023 **World Bank Working Paper on The Macroeconomic Implications of a Transition to Zero Net Emissions** was calibrated using data and projections for Türkiye (Hallegatte et al., 2023). The paper shows how different models and underlying assumptions can be combined with expert insight to illustrate potential paths for macroeconomic and fiscal variables based on plausible assumptions about emissions targets, technological pathways, and wider factors. It sets out how to overcome some of the pitfalls of CGE modeling (i.e., by replacing the typical assumption that decarbonization moves the economy away from equilibrium, so it must, by definition, be costly). It also illustrates the particular importance of modeling assumptions about whether net zero investment can be financed in addition to other productive investments or whether it crowds out some baseline investment. In the scenario where baseline investment is crowded out, the benefits of the transition are significantly less in the medium term and turn into net costs in the longer term. Finally, it shows how filling gaps in policy plans and analysis with simple assumptions can enable policymakers to benefit from the insights of economic modeling while information is still incomplete.

The **UK Office for Budget Responsibility's Fiscal Risks Report** of July 2021 presented detailed bottom-up fiscal scenarios that quantified the fiscal risks associated with the transition to net zero under different assumptions (OBR, 2021). A key enabler of the analysis was being able to build on the UK Climate Change Committee's Sixth Carbon Budget pathways to net zero (CCC, 2020–dataset), which assessed investment needs for decarbonizing different sectors. These sectoral pathways provided a useful starting point for fiscal analysis thanks to a complete set of sector-specific estimates in a user-friendly Excel format. See Box 4.1 below for how the OBR used it in respect to decarbonizing residential buildings (a particularly challenging aspect of the transition in the UK).

Box 4.1. A case study on estimating investment needs and fiscal implications of a sectoral transition: residential buildings in the UK

Heating residential buildings is one of the largest sources of emissions in the UK, thanks to the dominance of gas-fired boilers in the existing housing stock. The Office for Budget Responsibility (OBR) assessed the possible fiscal implications of reducing emissions by layering its own assumptions on top of those made by the Climate Change Committee (CCC) (OBR, 2021).

In its 2019 report on how the UK could reach net zero, the CCC determined that it was technologically feasible for residential buildings to be very largely decarbonized through behavioral change, fabric efficiency, and fuel-switching to low-carbon heating (CCC, 2019). The following year, the CCC assessed different pathways for the transition to net zero (CCC, 2020), which relied on assumptions about unit costs of different technologies (drawing on external and internal analysis) and the pace at which they would be deployed (reflecting judgments about supply-chain development and consumer preferences). The largest cost related to installing heat pumps in homes to replace gas boilers. This was estimated at £140 billion (in 2019 prices) between 2020 and 2050, which in turn reflected installation in 26 million homes at an average marginal unit cost of £5,500 (in 2019 prices). The CCC's published 'dataset' breaks down these figures by tenure and fuel poverty status, while also reporting emissions abatement and energy demand implications in detail (CCC, 2020–dataset). Its methodology report sets out the underlying evidence and assumptions (in Chapter 3, CCC, 2020–methodology report).

The OBR took this data and made its own assumptions about the proportion of investment costs that might be borne by the public sector in high, central and low scenarios. For example, in the central scenario it assumed the state met all heating-related costs for those in the bottom 15% of the income distribution, none for those in the top 15%, and half for those in the middle 70%.

This process was repeated for other aspects of the residential buildings transition (such as insulation, district heating, and so on) and for public and commercial buildings. This meant the OBR could estimate the fiscal implications of the transition across all buildings, which it calculated at £165 billion (in 2019 prices), 46% of the whole-economy cost of getting to net zero, but equivalent to less than 0.2% of GDP a year.

These analyses informed the Government's October 2021 Heat and Buildings Strategy (HM Government, 2021).

The **Irish Fiscal Advisory Council** has also produced detailed bottom-up fiscal projections of the potential fiscal impacts of a net zero transition (Casey and Carroll, 2023). Its report considered different assumptions, including technological optimism and a lower burden of adjustment on certain sectors. Similar to the UK experience, the report was able to build successfully on the work of others, including Department of Finance (2023). The Council drew on detailed least-cost optimization modeling for different pathways to net zero from the MaREI Research Centre based at University College Cork. The research center provided information on impacts across different sectors consistent with achieving pathways to net zero. This included detailed Excel files on key variables such as total investment costs, vehicle fleet numbers, and information related to building upgrades. Again, this type of information provides an invaluable and comprehensive foundation on which to build fiscal analysis.

Brazil's National Treasury Secretariat has completed the initial phases of a project to quantify the fiscal risks of climate change, and fiscal pressures and opportunities from decarbonizing different sectors. This work built on experiences described elsewhere in this section (in particular, those in Georgia on climate change and the UK on decarbonization) to build two simple but comprehensive Excel models to estimate potential fiscal consequences of, first, worsening climate change and, second, the government's forthcoming NDC update and Climate Plan. As a provisional analysis pending further policy development, this work is currently internal to the government. Initial views are that the consistent framework it provides for estimating the fiscal implications of several factors will be valuable in ongoing fiscal risk analysis and policy planning.

The **OECD's secretariat for its network of independent fiscal institutions** (IFIs) has developed an analytical tool, Edison, that further builds on the approaches adopted by both the UK's OBR and the Irish Fiscal Advisory Council. The tool harmonizes these two approaches with a view to providing a common framework that other IFIs can use to kickstart their work in this space and shed more light on the extent of climate action's fiscal impacts. Edison is an Excel-based tool that includes a lot of pre-populated data, such as for economic projections, estimated climate damage costs, and weather-related growth impacts. It guides users through the key steps in calculating the long-term implications of climate change and climate action for fiscal sustainability via effects on relevant spending and revenue streams. In promoting a shared understanding of the challenges faced, Edison aims to help inform policy decisions and build public support for climate action.

The latest Fiscal Sustainability report by the **Swiss Federal Department of Finance** uses a model-based pilot study to analyze the long-term fiscal impact on all levels of government of achieving net zero emissions by 2050 (Federal Department of Finance, Switzerland, 2024). The analysis deploys a budget-impact model that builds on sectoral energy system models and a CGE model from the Swiss Federal Department of the Environment, Transport, Energy and Communications. The study finds that mitigation policies are likely to put pressure on the public finances. On the revenue side, that reflects slower economic growth during the energy transition because of carbon taxes and regulation. On the expenditure side it reflects the cost of green subsidies. To compensate for the loss of revenue from fuel taxes, the analysis assumes the introduction of a replacement levy on electric vehicles. The report stresses that these results are subject to significant uncertainty given the complex processes involved but highlights the need to balance rising fiscal pressures from transition risks with a commitment to credible fiscal frameworks.[28]

The **Inter-American Development Bank's** study on decarbonizing Costa Rica's economy (Groves et al., 2020) develops baseline and net zero emissions pathways and estimates the associated benefits and costs. The methodology behind the cost estimates is a useful guide to filling information gaps where there are no existing studies or models to use, for example the approach to estimating whole-economy costs of decarbonizing the building stock.

The **IMF's** Fiscal Monitor of October 2023 brings together much of the IMF's recent analysis to look at the fiscal costs of different policy mixes to deliver net zero pledges across advanced and emerging economies (IMF, 2023). It does this by modeling a stylized advanced economy (calibrated to the average of the G7 economies) and a stylized large emerging market (calibrated to the weighted average of Argentina, Brazil, China, India,

[28] For a fuller discussion, see 'Modeling the fiscal impacts of the net zero target within fiscal sustainability analysis', contribution by the Swiss Federal Department of Finance to the HP4 Compendium of Practice.

Indonesia, Mexico, South Africa, and Türkiye). It aims to address the policy trilemma of achieving climate goals, fiscal sustainability, and political feasibility (since levying a progressively higher carbon tax, which is the economically most efficient policy tool, has repeatedly been shown to be politically unpopular).

In **How Does Decarbonization Change The Fiscal Equation?**, De Mooij and Gaspar (2023) examine the fiscal consequences of global decarbonization, including, for example, carbon taxes and the erosion of existing fuel tax bases, green public investment and green subsidies, and support for vulnerable households and businesses. It provides a good example of what can be achieved using the IMF/World Bank CPAT tool, though it also warns with respect to calibrating public spending on net zero that "Estimates of these spending needs vary considerably, however, and depend on speculative assumptions about the (changing) role of government in several countries."

The **IMF's Fiscal Implications of Global Decarbonization** working paper (Black et al., 2024) builds on the previous two analyses to use CPAT and other tools to model the fiscal implications of internationally coordinated global mitigation policies. As with the paper by De Mooij and Gaspar, it shows how the CPAT tool can help policymakers understand the choices and trade-offs involved with different emissions mitigation policies. It also explores the importance of financing needs for compensating vulnerable households and industries, and low-income countries.

An **OECD paper on public finance's resilience in the transition** analyzes the fiscal implications of net zero using the OECD's global CGE model, 'ENV-Linkages' (Fouré et al., 2023). It illustrates the trade-off between fiscally beneficial and costly policy instruments, along with indirect effects from decarbonization. But it does not provide country-specific results, "since doing so would need a careful consideration of country characteristics and policy roadmaps"; nor are direct public investment costs modeled.

5. Gaps and challenges: where should researchers and data-providers focus their efforts?

To aid researchers and data-providers seeking to enhance the ability of MoFs in all settings to play a greater role in supporting climate action through robust analysis of its macro-fiscal implications, this section summarizes the key gaps and challenges faced by MoFs.

In broad terms, MoFs are faced with two types of information gap:

- **Information that is not available at all**. For climate change and adaptation, in many countries that includes estimates of future costs and risks of climate-related disasters at detailed, within-country geographical levels. For decarbonization and low-carbon growth, top of the list is often the detailed country-specific, sectoral estimates of the investment needed to achieve a given emissions pathway that form the starting point for assessing the potential fiscal implications of the transition. In these areas, MoFs would benefit from the creation of new data sources and modeling tools, especially where those tools are open-source, succinctly explained for users, and provided by trusted sources.
- **Information that is difficult or expensive to access**. For climate change, this includes the fact that macroeconomic evaluation of adaptation and resilience interventions is still at an early stage, so gaps are particularly large. For decarbonization and low-carbon growth, this includes the country-specific projections and other more detailed elements of the IEA's World Energy Outlook scenarios that sit behind a paywall. In these areas, MoFs would benefit from data providers and model owners being funded to convert paid-for resources to open-source.

There are many reporting processes under the Paris Agreement that could support fulfilling MoFs' information needs for modeling the fiscal implications of climate-related issues. These include the new Biennial Transparency Reports, and the periodically updated Nationally Determined Contributions and Low-Emission Development Strategies. Most countries are working on these or have done so in the past. There is likely to be value in MoFs reviewing the analysis that other parts of government have undertaken to populate these reports, which would enable them to assess remaining gaps in their information sets.

At the April 2024 Forum on the Macroeconomics of Green and Resilient Transitions, a common theme across the six sessions was problems faced accessing data, with many MoF participants calling for more open sourcing of data and models to enhance accessibility and accelerate dissemination and usage across MoFs.

Where information is available, the challenges that MoFs face are likely to vary with the resources, capabilities, and expertise that can be devoted to climate issues. These fall into two broad categories:

- **Not knowing what is available**. The information necessary to analyze and model climate action is relatively novel for many MoFs. This can result in MoFs that want to make progress finding it difficult to take the first analytical steps because they do not know where and how to find the information to get started. The forthcoming HP4 guide to addressing challenging policy questions provides one potential solution to this problem (CFMCA, 2025d). Others include central data repositories and modeling tools that guide users to simpler starting points for analysis, plus the steps that can be taken when more sophisticated tools and refined analysis are required.
- **Knowing what is available but not having sufficient capability to use it**. Some MoFs will have a reasonable view of what information is available, perhaps because a peer country has undertaken analysis of the kind

they would like to pursue, but may still struggle to bring it all together in a way that they are confident in using with Ministers for policy discussions or presenting to the public in official reports. Common challenges include understanding which climate scenarios are appropriate to their analytical task or whether information being drawn from several sources is sufficiently consistent to paint a coherent picture. This is an area where international organizations may be able to do more to help users by harmonizing input assumptions (to an appropriate degree) so that it is simpler for MoFs to select 'reasonable worst case' scenarios for climate risk assessments, 'current policy' scenarios as conditioning assumptions for macro-fiscal budget forecasts, and 'net zero' scenarios for assessing investment gaps and options to close them. It is striking that MoFs in all contexts can start macro-fiscal analysis from the IMF's comprehensive World Economic Outlook dataset, whereas by contrast, starting climate-fiscal analysis requires gathering data from many sources.

These information-related challenges are closely linked to broader challenges associated with climate-related skills and capabilities within MoFs, which are discussed in an accompanying report on building capabilities (CFMCA, 2025f). For strategic policy choices, this includes the need to deploy different approaches to decision-making, notably the risk–opportunity approach that leverages both quantitative and non-quantitative approaches.

6. Emerging developments, opportunities, and recommendations for action

This report's review of MoFs' needs, the data, tools, and approaches currently available, and the examples of modeling in practice, points to several recommendations:

- **There is a wealth of data, tools and approaches available and an ever-growing number of examples of their use by MoFs and other institutions**. This suggests there would be considerable value in MoFs engaging with each other to share and learn from their experience, which would be consistent with the broader aim of the HP4 workstream: to develop a community of practice with discussions facilitated by an annual forum that brings together practitioners and researchers.
- **MoFs need a repository of information and data sources that have been curated sufficiently well for MoFs, as users, to feel confident that they are pulling together consistent and reliable information for use in analysis of climate change and climate action in their country**. It is costly for each MoF to have to carry out due diligence on the many data sources on many related topics to identify the ones most appropriate for assessing the fiscal implications of climate change and climate action.
- **MoFs would benefit from more open-source modeling toolkits, such as the IMF/World Bank CPAT tool**. Such models should be accompanied by assessments of what the model can or cannot do and the main assumptions and caveats behind them. This should start from the economic theory underpinning such models to specific aspects, such as assumptions about the costs and deployment associated with new technologies, or the scenario adopted to forecast relevant energy prices.
- **MoFs need researchers to focus on filling gaps as well as pushing the frontier of existing research**. A priority example of this gap-filling is the need for country-specific investment requirements by sector with transparent assumptions, including about assumed policy mixes, that MoFs can adjust for their own fiscal analysis, such as volumes and unit costs for individual transitions (as illustrated by the example of the electrification of residential heating in the UK in Box 4.1).
- **MoFs would benefit from international organizations coming together to provide global, regional, and country-level baselines for climate-related fiscal analysis**. This could adopt the three-scenario approach already used in the IEA's World Energy Outlook and UNEP's Emissions Gap Reports, which would help MoFs to quantify the impacts of different global pathways and the impact of domestic policy choices relative to appropriate baseline scenarios. It could be something equivalent to the IMF's World Economic Outlook database, which MoFs are familiar with using as the starting point for their economic analysis—and which for many MoFs also features in macro-fiscal forecasting processes via annual Article IV discussions with the IMF. It would build on the steps the IMF is already taking to mainstream climate issues into Article IV consultations[29] and to support capacity development.

[29] See www.imf.org/en/About/Factsheets/IMF-Surveillance for information about this process.

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