The Coalition of Finance Ministers for Climate Action

# A bottom-up approach to estimating climate-development investment needs


## World Bank

**Camilla Knudsen, Economist; Ammara Shariq, Climate Change Specialist; Stéphane Hallegatte, Senior Climate Change Advisor**



A contribution to the 'Compendium of Practice from a Global Community of Ministries of Finance and Leading Organizations: Economic analysis and modeling tools to assist Ministries of Finance in driving green and resilient transitions'

**Topic:** Specific analytical tools and approaches relevant to Ministries of Finance

June 2025


**Access the full Compendium at www.greenandresilienteconomics.org**


This contribution was prepared at the request of, and with guidance from, the Ministry of Finance of Denmark as Lead of the Coalition's Helsinki Principle 4 initiative 'Economic Analysis for Green and Resilient Transitions' and its Steering Group, with input from its Technical Advisory Group. The views, findings, interpretations, and conclusions expressed are those of the authors. While many Coalition members and partners may support the general thrust of the arguments, findings, and recommendations made in this contribution, it does not necessarily reflect the views of the Coalition, its members, or the affiliations of the authors, nor does it represent an endorsement of any of the views expressed herein by any individual member of the Coalition.

## Sector-level pathways in Country Climate and Development Reports

The World Bank Group's Country Climate and Development Reports (CCDRs), covering nearly 50 low- and middle-income countries, estimate the additional investments needed to shift toward a more resilient and lower emissions pathway. In practice, these assessments start from a set of sector-level pathways, describing the changes in supply and demand, productive capital, and technologies. The pathways are constructed using a variety of sectoral technoeconomic models, and they consider what is considered technically, economically, and politically feasible in each country. Using a combination of global datasets and local data, where available,[1] the sectoral models estimate the investments needed to boost resilience and enable low-carbon development. The required (public and private) investments and the economic costs and benefits (e.g., fuel cost savings associated with the lower operating costs of renewables compared with fossil fuel alternatives) from the sectoral models are then entered into macroeconomic models to assess the macroeconomic feasibility of the sectoral transitions.[2] As an example, Table 1 illustrates the additional investment needs and economic costs associated with resilient and low emissions development pathways in key sectors in Türkiye.

**Table 1. Additional investment needs and economic costs in Türkiye's resilient and net zero pathway**

| | 2022–30 ($, billions) | 2022–40 ($, billions) |
|---|---|---|
| **POWER** | | |
| Additional investment: new generation and storage capacity | +5 | +33 |
| Additional investment: transmission and distribution | +8 | +14 |
| Other economic costs: operational and fuel costs | -9 | -23 |
| Other economic costs: air pollution externality costs from coal[a] | -9 | -38 |
| Other economic costs: decommissioning of coal plants and mines | < +1 | +1.4 |
| **RESIDENTIAL** | | |
| Additional investment: energy efficiency, electrification, and resilience | +45 | +100 |
| Other economic costs: gas import | -11 | -46 |
| Other economic costs: lives lost and injuries | -1 | -3 |
| **TRANSPORT** | | |
| Additional investment: new resilient infrastructure | +8 | +15 |
| Other economic costs: fuel import | -12 | -36 |
| Other economic costs: cost of disruptions[b] | -3 | -11 |
| Other economic costs: air pollution, congestion, and road fatalities | -40 | -171 |
| **FOREST LANDSCAPES** | | |
| Additional investment: restoration, reforestation, and fire management | +2 | +3 |
| Other economic costs: loss of harvest revenues[c] | +1 | +5 |
| **AGRICULTURE** | | |
| Other economic costs: on-farm emissions reductions[d] | < +1 | – |
| **INDUSTRY AND MANUFACTURING** | | |
| Other economic costs: cement, iron, and steel[e] | – | +11 |
| **TOTAL INVESTMENTS AND ECONOMIC COSTS IN THEIR SECTORS** | | |
| Net economic costs | -15 | -146 |
| includes: additional investment | 68 | 165 |

*Notes: Negative economic costs (shown in green) are economic benefits. All amounts are discounted using a 6 percent discount rate. a. This estimate applies a cost of $25/GJ in 2020 rising to $38/GJ by 2040; b. Assumes a reduction in growth rate damages from 3% in the BAU to 0% in the RNZP scenario; c. Applies a cost of $149/m$^3$, the weighted average of the November 2021 timber price across Turkish cities; d. Assumes $21/tCO$_2$e which is the weighted average net cost of 15 key emissions reduction measures (Ahmed et al. 2020); e. Assumes $120/tCO$_2$e as the cost of emissions reduction or capture. Source: World Bank Group (2022)*

1 See also separate contribution to the Compendium by the World Bank: *Data sources for the macro-modeling of climate change impacts and policies.*

2 See also separate contribution to the Compendium by the World Bank: *A new modeling approach combining bottom-up sectoral analyses with top-down macroeconomic models to understand the economic impacts of resilient and low-emissions development.*

## Translating climate-development objectives into sector-level investment needs

The CCDR approach to translating climate-development objectives into investment needs at the sector-level can be replicated by Ministries of Finance and can inform, for example, Nationally Determined Contributions or long-term strategies. The approach can help MoFs answer questions related to the transition such as:

(1) How much investment is needed to support a low-emission development path?
(2) Which development milestones and decarbonization ambition are realistic, considering macroeconomic and financing constraints?
(3) What can be a feasible sequencing of interventions across sectors?
(4) What are the best sources of finance (public, private, concessional) to meet investment needs, and what are the macroeconomic implications of different financing solutions?

The approach can, for example, help determine whether ambitious interventions in both buildings and the power sector can be made in parallel or whether a sequenced approach would be preferrable from a financing and macroeconomic perspective. Or it can help determine whether it is feasible to finance part of the public-finance needs through increased borrowing or through reallocation of public spending.

The CCDRs rely on a wide range of World Bank Group models[3], most of which can be made available to MoFs upon request for stress testing or other work. In many cases, the World Bank Group can also work with MoFs to adjust model assumptions to suit the specific needs of the analysis, or adapt MoF internal models, and help build modeling capacity and expertise.

## Determining the additional investments necessary to meet climate-related needs

Defining the share of investments that are *additional* can be challenging: in lower-income countries, in particular, development needs cannot be separated from climate-related needs, and the *total* investment needs for a resilient low-emission development are large. CCDRs in lower-income countries have often estimated not only the additional investments for climate-related needs but, more generally, the total investments needed to ensure resilient and low-emissions development. This is because in most cases, climate and development objectives are achieved in tandem. Building the resilience of people and the economy to the adverse effects of climate change, for example, requires more development (e.g., to provide people with access to improved drinking water or clean and modern energy). Similarly, for the mitigation of greenhouse gas emissions in low-income, low-emission countries the focus is not on current sources of emissions but rather on ensuring rapid development and universal access to energy without increasing emissions.

## Emissions estimates in upper-middle-income countries

In upper-middle-income countries, such as China and Türkiye, CCDRs calculate the additional investment needs as the difference between a resilient low-emissions scenario and a business-as-usual scenario, showing the *additional* needs for a resilient low-emission development path are manageable. Mitigation estimates include investments in greener solutions, such as renewable energy, as well as "negative costs" from avoided investments in coal or natural gas infrastructure. For adaptation and resilience interventions, estimates account for the incremental costs of building more resilient infrastructure rather than the full cost of the assets. The relatively modest additional investment needs identified in upper-middle-income countries for resilient and low-carbon

3 See also separate contribution to the Compendium by the World Bank: *World Bank Group climate aware macroeconomic models available for use by Ministries of Finance.*

development indicate that aligning development with climate goals only moderately increases their financing challenges.

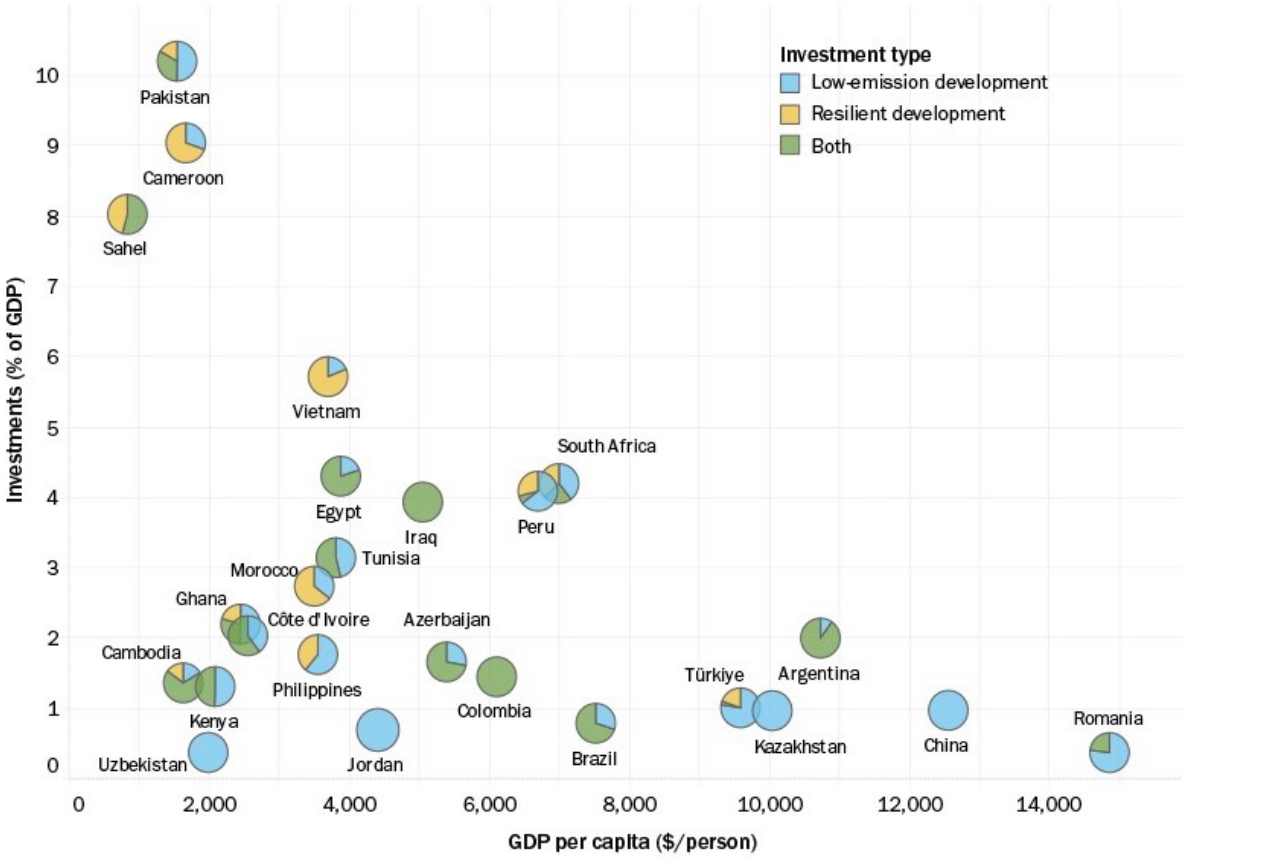
## Emissions estimates in low- and lower-middle-income countries

In low- and lower-middle-income countries, such as Pakistan and the Sahel countries, investments focus on closing development and infrastructure gaps using green technologies. CCDRs in these countries compare investment needs for a resilient low-emissions pathway against current levels, resulting in both better climate and better development outcomes. The additional investments include greener and more resilient solutions as well as the necessary development infrastructure. The substantial additional investment needs identified in low- and lower-middle-income countries highlight the significant financial challenges these countries face in achieving their development goals sustainably.

## Climate-development financing needs are larger as a share of GDP in countries that have contributed least to global warming and have limited access to capital markets

On average, financing needs for climate action in CCDR countries are estimated at 1.4% of GDP by 2030. However, as indicated above, there are substantial differences across income levels (Figure 1): 1.1% of GDP in upper-middle-income countries, 4.4% in lower-middle-income, and 8.0% in low-income countries. A recent CCDR for Romania (World Bank Group, 2023b) also offers one data point on high-income countries: 0.4%.

**Figure 1. The required increase in annual investment for selected CCDR countries.**




*Source: World Bank Group (2023a)*

## Despite the need for large upfront investments, resilient and low-carbon pathways generate benefits that partially or completely offset costs

Some of the CCDRs estimate the net economic impact of aligning development with climate-oriented goals. As shown in Table 1, the major benefits from reduced energy imports and reduced air pollution are estimated to lead to a net gain of US$146 billion (1% of GDP) in Türkiye over 2022–40. In Peru, savings in operations and maintenance costs in the transportation sector and ecosystem services from reduced deforestation could amount to more than US$400 billion (9% of GDP) in net benefits by 2050. And in Ghana, improvements in public health, fuel import savings, and boosting timber extraction through increased plantation in a resilient and low-carbon scenario could amount to US$35 billion in net benefits by 2050 (around 2% of GDP over the same period).

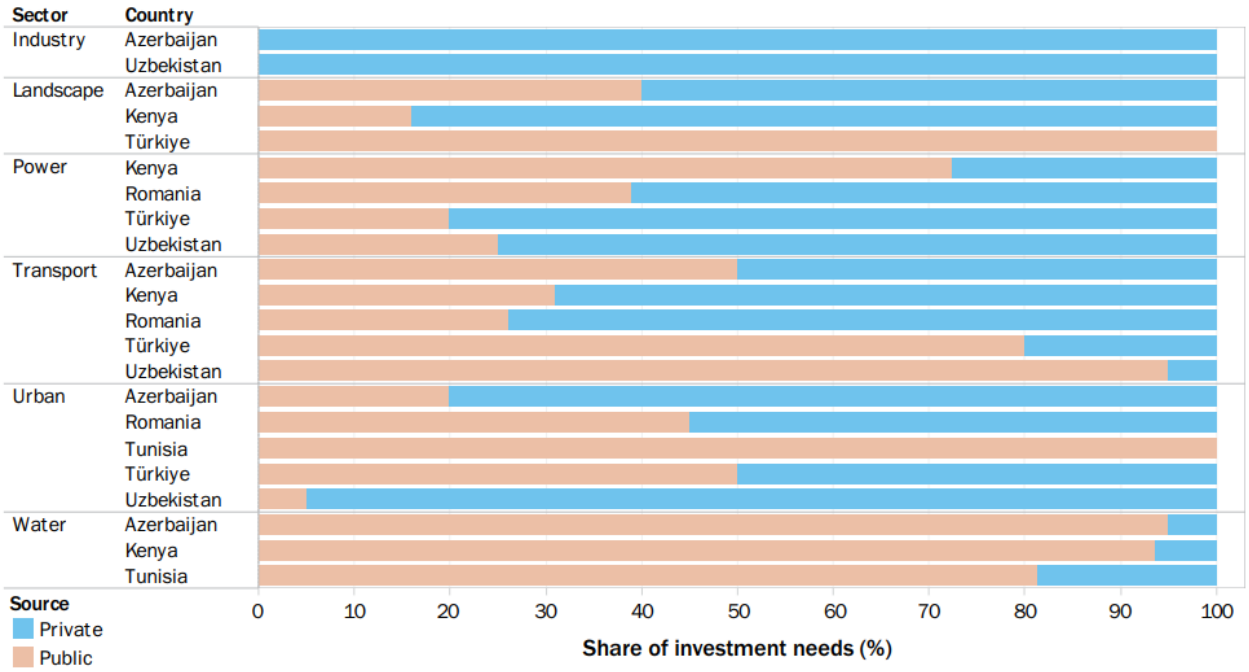
## Global estimates of climate finance needs cannot be directly compared with CCDR estimates

Global estimates of climate finance needs—such as those from the Independent High-Level Expert Group (IHLEG) on Climate Finance (Songwe et al., 2022) and the World Bank's Beyond the Gap report (Rozenberg and Fay 2019)—cannot be compared directly with CCDR estimates due to differences in the scope, baseline, ambition of the scenarios, and timing of investments. However, extrapolating CCDR results using the average investment needs per income group yields some interesting results. With this simple approach, and being mindful of the differences in methodologies, annual climate-related investment needs for all low- and middle-income countries other than China are estimated at US$574 billion per year (2.8% of GDP) between 2024 and 2030 (Hallegatte et al., 2024). This is close to the IHLEG estimate for 2025 (US$600 billion), but significantly lower for 2030 (US$1.2–1.7 trillion). It is also lower than Beyond the Gap estimates (US$1.5 trillion by 2030). But these estimates cannot be directly compared with CCDR estimates because they are global, while the sample of CCDR countries is still not representative of global needs; they also use different scopes, baselines, and mitigation and adaptation scenarios. Multiple CCDRs, for example, conclude that retrofitting all existing assets would not be economical and suggest retrofitting should be limited to the most critical assets, whereas global assessments tend to include systematic retrofitting of all assets (see also Hallegatte et al., 2023).

## The private sector is essential in closing the climate financing gap, but different countries will rely to different extents on private resources, depending on their existing institutions and practices

CCDR estimates suggest that with appropriate policy reforms, the private sector could provide most of the financing across multiple sectors. CCDRs also assess the potential for private investment across sectors, with significant variability (see Figure 2). For example, private sector participation is higher in industry and energy than in water infrastructure, where public finance is expected to play a large role in any scenario.

**Figure 2. The public-private split of future investments in resilient and low-emissions development scenarios for selected CCDR countries**




*Source: World Bank Group (2023a)*

## References


Hallegatte, Stéphane, Groves, David, and Knudsen, Camilla (2023) *What You Need to Know About How CCDRs Estimate Climate Finance Needs*. CCDR Explainer Series. https://www.worldbank.org/en/news/feature/2023/03/13/what-you-need-to-know-about-how-ccdrs-estimate-climate-finance-needs.

Hallegatte, Stéphane, Groves, David, Knudsen, Camilla, and Shariq, Ammara (2024) *What You Need to Know About CCDR Investment Estimates and the Role of the Private Sector*. CCDR Explainer Series. https://www.worldbank.org/en/news/feature/2024/05/01/what-you-need-to-know-about-ccdr-investment-estimates-and-the-role-of-the-private-sector.

Rozenberg, Julie, and Fay, Marianne (2019) *Beyond the Gap: How Countries Can Afford the Infrastructure They Need While Protecting the Planet*. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/189471550755819133/Beyond-the-Gap-How-Countries-Can-Afford-the-Infrastructure-They-Need-while-Protecting-the-Planet.

Songwe, Vera, Stern, Nicholas, and Bhattacharya, Amar (2022) *Finance for Climate Action: Scaling Up Investment for Climate and Development*. London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science. https://www.lse.ac.uk/granthaminstitute/publication/finance-for-climate-action-scaling-up-investment-for-climate-and-development/.

World Bank Group (2022) *Türkiye Country Climate and Development Report*. Washington, DC: World Bank Group. http://hdl.handle.net/10986/37521.

World Bank Group (2023a) *The Development, Climate, and Nature Crisis: Solutions to End Poverty on a Livable Planet—Insights from World Bank Country Climate and Development Reports Covering 42 Economies*. Washington, DC: World Bank Group. http://hdl.handle.net/10986/40652.

World Bank Group (2023b) *Romania Country Climate and Development Report*. CCDR Series. World Bank. http://hdl.handle.net/10986/40500.