Assessing Top-Down Climate Finance Needs

Methodology

April 2025

CLIMATE POLICY INITIATIVE

CONTENTS

1. INTRODUCTION

While global climate finance has increased over the past decade, reaching a record high of USD 1.46 trillion in 2022,[1] much more is needed to keep global temperature rises within 1.5°C and avoid the worst impacts of climate change (CPI, 2024).

Based on Climate Policy Initiative's (CPI's) compilation of climate finance needs estimates, annual climate finance flows must increase by at least fivefold on current levels, reaching USD 7.5 trillion per year between now and 2030, and over USD 8.8 trillion per year from 2031 to 2050. Accurately assessing the size of this global climate finance gap can enable decision-makers to mobilize finance effectively, quickly, and to where it is most needed.

Since 2021, CPI has been building a collective understanding of the climate finance needed to reach net zero carbon emissions by 2050. To provide a clearer picture of global climate finance needs, CPI has developed a novel approach to capturing all these needs estimates in a clear and digestible manner. We compile and standardize data on climate finance needs from a wide variety of sources to provide the most comprehensive available overview of the current climate finance gap.

Updating and replacing our initial top-down needs methodology published in 2024, this document details our approach to estimating top-down climate finance needs, including improvements made since the last iteration. Coupled with CPI's wider tracking and analysis of climate finance flows, this can help identify the largest climate finance gaps, track progress against climate targets, and better inform decision-makers and financial institutions on how to increase the speed, scale, and quality of climate finance.

1 Investments for 2023 are expected to be higher than the 2022 record but are not yet available.

2. DEFINING CLIMATE FINANCE NEEDS

While there is not yet a globally accepted official definition of "climate finance needs", CPI distinguishes between two types of needs, based on the methodology used to calculate them:

- **Top-down climate finance needs:** The estimated climate finance required to fund the actions needed across different sectors to keep the average global temperature rise within 1.5°C by the end of this century. These needs are typically calculated using predictive models for different sectors. Climate-compatible scenarios developed by different institutions can differ widely in the data, assumptions, model used, and (geographic or sectoral) scope.
- **Bottom-up climate finance needs:** The climate finance required by countries to reach their national climate targets, as stated in official documents such as their Nationally Determined Contributions (NDCs). These needs include both the finance required to be raised domestically and the financial support required from international (public and private) sources. While some countries estimate their climate finance needs using predictive models aligned to a 1.5°C pathway, in most cases, bottom-up needs are derived from a list of costed mitigation and adaptation measures or projects countries aim to implement. Currently, total stated bottom-up needs are insufficient to keep global temperature rises within 1.5°C (UNFCCC, 2023).

Given their different calculation approaches, the top-down and bottom-up needs estimates each shed light on climate finance needs from a different perspective. Top-down needs take a technology perspective, outlining what would be technically required (and feasible) to put the world on a climate-compatible pathway. Bottom-up needs, on the other hand, take a country perspective, outlining domestic and international capital required to achieve national climate goals. Table 1 outlines differences in data coverage and complementarities between top-down and bottom-up needs estimates.

Table 1: Overview of top-down and bottom-up climate finance needs

	Top-down climate finance needs	Bottom-up climate finance needs
Net zero alignment	The scenarios analyzed outline climate finance required to align to a net-zero pathway. When compared with current climate finance flows, top-down estimates can help to track progress against the objectives of the Paris Agreement, and identify related investment gaps.	NDCs outline measures and finance required to reach each country's specific climate objectives. Globally, the cumulated commitments as per currently submitted NDCs are insufficient to align to a net zero pathway. As a result, bottom-up needs are materially lower than top-down needs.
Climate uses	Typically, the scenarios analyzed do not explicitly highlight whether the finance needs correspond to mitigation and/or adaptation measures. For this reason, the top-down approach does not analyze the split between mitigation, adaptation, and dual objectives.	While the level of granularity varies across countries, NDCs typically distinguish between finance required for mitigation, adaptation, and cross-cutting (dual objective) measures.
Sectoral/ subsectoral scope and granularity	Top-down needs estimates are usually provided at the sector and/or subsector level. As sector categorizations differ across scenarios, we match sectors/subsectors in the original scenarios with CPI's Global Landscape of Climate Finance (GLCF) taxonomy to standardize the data and be able to compare finance needs across different sources.	While the level of granularity varies across countries, NDCs typically include costed needs by sector. In several cases, granularity is also available at the solution or project level.
Geographical scope and granularity	Scenarios analyzed typically have a global focus and information provided at the level of the geographical breakdown might be less granular.	Costed needs are prevalent in non-Annex I countries' NDCs.[2] As a result, bottom-up data mainly focuses on EMDEs and is available at the country level.
Sources of finance	Scenarios analyzed do not provide any information on the sources of finance that would be able to fund the projected scenarios.	In their NDCs, countries typically specify whether finance will need to be raised domestically (unconditional needs) or internationally (conditional needs). As such, bottom-up estimates can give an indication of the magnitude of the international finance required.

This methodology document details CPI's approach to estimate top-down climate finance needs (referred to as "climate finance needs" from here on).

2 Annex I countries, as referenced in the Paris Agreement, are developed nations and economies in transition committed to reducing greenhouse gas emissions under international climate agreements. These include countries that were OECD members in 1992, plus countries with economies in transition in Central and Eastern Europe (UNFCCC, 2025). Under the Paris Agreement, non-Annex I Parties are eligible to receive international support (either financial, technological, or capacity-building). Hence, many of them include conditional needs in their NDCs.

3. CPI'S APPROACH TO ESTIMATING TOP-DOWN CLIMATE FINANCE NEEDS

CPI's climate finance needs are derived from a wide variety of sources (see Section 4.a). However, these existing estimates are inconsistent, as they are based on various scenarios and methodologies, each using different models, assumptions, sectors, geographies, and levels of detail.

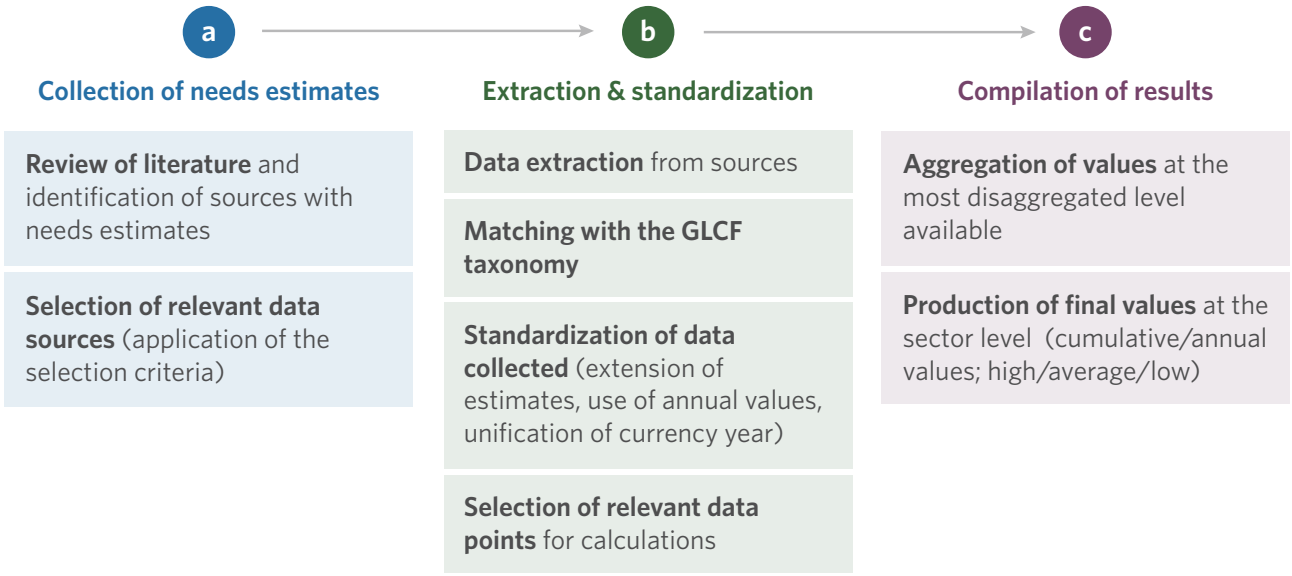
CPI's efforts have, therefore, been focused on compiling and standardizing existing needs estimates to ensure consistency and comparability of different scenarios, and on providing a comprehensive and unique understanding of the size of the climate finance gap.

As they use different assumptions, some of the scenarios covered in this exercise may be incompatible with each other (e.g., 100% renewable-based power sector vs inclusion of fossil fuel plants using carbon removal technologies). To reflect this variability, our top-down climate needs estimates are presented as ranges of investments needed, rather than single values. Our goal is not to validate the approach and assumptions used in each model, but rather to present a **comprehensive and impartial overview of available needs estimates to date** and provide a collective understanding of the order of magnitude of the finance required to align to a 1.5°C pathway.

4. METHODOLOGICAL STEPS

Figure 1 provides an overview and sequence of the methodological steps in our approach to estimating top-down climate finance needs. These are then detailed in the following subsections.

Figure 1: Methodological steps in CPI's approach to estimating top-down climate finance needs



a) Collection of needs estimates

Our research identified nearly 100 reports and publications that include assessments of future investment needs to meet climate and development goals, or estimates of costs and damages due to climate change. An additional 20 sources included regional or country-specific estimates.

We used internal criteria to select which of these sources to review. While we collected data from all of the selected sources, we only processed and used a subset of scenarios for our final calculations. This is to avoid double counting and exclude unclassifiable estimates, and is based on the following approach:

- **Prioritization of more recent data** when referring to the same sector/technology and coming from the same scenario by the same institution (e.g., using data related to avoided reforestation in UNEP's State of Finance for Nature 2023 report rather than from the 2022 edition of this report);
- **Prioritization of primary data sources** (e.g., if a report refers to another document, the data from the original document is used, unless more granular or additional information is presented in the secondary source);
- **Prioritization of more granular data** when available (e.g., country-level vs regional, subsector vs sector).

This approach helped to narrow down the amount of data to be processed from more than 2,000 datapoints to close to 500 in the pre-processed database ready for aggregation.

Table 2 summarizes the list of sources reviewed and used for our latest (2024) needs estimates in each sector.[3] As we update our estimates annually, the table specifies the data sources that were reviewed and used as part of our 2023 calculations and the new references added in our latest update.

Table 2: Data sources reviewed and used in our top-down needs estimations (in 2024 and 2023)

Sector	Sources reviewed	Sources used in CPI needs estimations – 2023 GLCF	Sources used in CPI needs estimations – 2024 GLCF
Buildings & infrastructure	**In previous editions:** Bhattacharya et al. (2022) IEA (2021, 2023a) IRENA (2022a, 2023c) LSE (2021) McKinsey (2022) Songwe et al. (2022) Vivid Economics (2021) **Added in 2024:** BNEF (2024) IEA (2024) I4CE (2024) I4CE (2023)	**IEA** (2023a) **IRENA** (2023c) **LSE** (2021) **McKinsey** (2022)	**BNEF** (2024) **IEA** (2024) **IRENA** (2023c) **McKinsey** (2022)
AFOLU	**In previous editions:** Bhattacharya et al. (2022) FOLU (2019) Harmsen et al. (2019) LSE (2021) McKinsey (2022) Paulson Institute (2020) Songwe at al. (2022) Thornton et al. (2023) UNEP (2022) Vivid Economics (2021) **Added in 2024:** FOLU (2024) Global Alliance for the Future of Food (2024) Laderchi (2024) UNEP (2023b) World Bank (2024a)	**FOLU** (2019) **LSE** (2021) **McKinsey** (2022) **Paulson Institute** (2020) **Thornton et al.** (2023) **UNEP** (2022)	**FOLU** (2019, 2024) **Global Alliance for the Future of Food** (2024) **Laderch**i (2024) **Thorton et al.** (2023) **UNEP** (2023b) **World Bank** (2024a)

3 That is, the needs estimates first presented in the 2024 edition of the Global Landscape of Climate Finance (GLCF) report, published in November 2024 (CPI, 2024).

Sector	Sources reviewed	Sources used in CPI needs estimations – 2023 GLCF	Sources used in CPI needs estimations – 2024 GLCF
Transport	**In previous editions:** Bhattacharya et al. (2022) BNEF (2021, 2022a, 2022b, 2022c) BP (2023) IEA (2019, 2020a, 2021, 2023a, 2023b, 2023c) IRENA (2022a, 2023c) LSE (2021) McKinsey (2022) Songwe at al. (2022) Vivid Economics (2021) World Bank (2019) **Added in 2024:** BNEF (2024) Global Maritime Forum (2020) IATA (2024) ICAO (2022) IEA (2024) I4CE (2023, 2024) World Economic Forum (2023)	**BNEF** (2022a) **IEA** (2023a) **IRENA** (2023c) **McKinsey** (2022)	**BNEF** (2024) **IEA** (2024) **IRENA** (2023c) **McKinsey** (2022)
Industry	**In previous editions:** BNEF (2022a) IEA (2021, 2023a, 2023b) IRENA (2022a, 2023c) McKinsey (2022) NGFS (2023) Songwe at al. (2022) Vivid Economics (2021) **Added in 2024:** BNEF (2024) IEA (2024) World Economic Forum (2023)	**BNEF** (2022a) **IEA** (2021, 2023a) **IRENA** (2023c) **McKinsey** (2022)	**BNEF** (2024) **IEA** (2024) **IRENA** (2023c)
Energy systems	**In previous editions:** Bhattacharya et al. (2022) BNEF (2021, 2022a, 2022b) BP (2023) IEA (2020b, 2021, 2023a, 2023b) IPCC (2022) IRENA (2022a, 2023c) LSE (2021) McKinsey (2022) NGFS (2023) TotalEnergies (2023) Songwe at al. (2022) Vivid Economics (2021) **Added in 2024:** BNEF (2024) IEA (2023d, 2024) IRENA (2020a, 2021, 2022b, 2022c, 2022d, 2022e, 2023a, 2023b, 2023c) I4CE (2023, 2024) World Economic Forum (2023)	**BNEF** (2022a, 2022b) **IEA** (2021, 2023a) **IPCC** (2022) **IRENA** (2023c) **LSE** (2021) **McKinsey** (2022)	**BNEF** (2024) **IEA** (2023d, 2024) **IPCC** (2022) **IRENA** (2023c) **McKinsey** (2022)

Sector	Sources reviewed	Sources used in CPI needs estimations – 2023 GLCF	Sources used in CPI needs estimations – 2024 GLCF
Adaptation	**In previous editions:** Baarsch et al. (2015) Bhattacharya et al. (2022) Chapagain et al. (2020) GCA (2022) LSE (2021) Markandaya and Eguino (2018) Songwe at al. (2022) UNEP (2021, 2022, 2023a) World Bank (2010) World Bank and GFDRR (2021)	**Bhattacharya et al.** (2022) **Chapagain et al.** (2020) **LSE** (2021) **Songwe et al.** (2022) **UNEP** (2023a)	

b) Data extraction and standardization

We extracted the available climate finance needs data from all sources listed in Table 2. Investment needs numbers were found in the following places:

- In the original source, explicitly mentioned in the publication body text;
- In the original source, included in a graph in the publication, in cases where no numbers were explicitly mentioned;
- As raw data directly available from open-access databases or upon request.

Original data extracted from different sources was very heterogeneous in terms of sector classification, timeframe considered, currency year, and type of value. To make needs estimates comparable, we standardized the data along these variables, as described in the subsections below.

SECTOR CLASSIFICATION

The sector/technology classification used varies significantly across sources, even within a single sector, depending on the internal scope and taxonomy used. Original sector/technology classification was also often inconsistent with the taxonomy used by CPI to categorize climate finance flows in our Global Landscape of Climate Finance (GLCF) analyses, making it hard to compare flows and needs data.

For example, electric vehicle (EV) chargers are classified differently in different energy-transition scenarios: the International Renewable Energy Agency (IRENA) includes EV chargers as: Energy sector – End uses – Electrification, while the International Energy Agency (IEA) classifies them as: Energy – Infrastructure. Given CPI's climate rather than energy-transition focus, our GLCF taxonomy categorizes EV chargers under Transport - Private Road Transport rather than Energy Systems.

In addition, some needs estimates included in the original sources refer to technologies that we do not consider to be climate solutions (e.g., fossil fuel generation, nuclear power). In our 2024 update, needs data for these technologies was also collected and processed (see Section 6), though we categorized these as either "High-carbon investment needs" (e.g., for fossil fuels) or "Other low-carbon investment needs" (e.g., for nuclear).

To improve comparability and consistency across needs estimates and against CPI climate finance flows, once the original data was extracted, we matched each data point with the sectors and subsectors included in CPI's GLCF taxonomy (see Appendix I).

TIMEFRAME

The timeframes of needs data collected also vary: All sources provide investment needs estimates up to 2030, while only some extend their models to 2040 or 2050. In our 2024 update, we harmonized the number of data sources used for annual needs estimates throughout the reference timeframe, i.e., 2024-2050. For data sources up to 2030, we extended values for 2031-2050. In one case (FOLU, 2024) the timeframe covered began in 2025, so we extended values for 2024 as well (see Table 3). In all these cases, we used average annual values available to extend estimations for the missing years.

Given that the required investment is expected to increase over time for many subsectors and solutions, our approach may lead to an underestimation of annual needs when extending these until 2050. Nevertheless, it allows us to reduce the impact of data gaps for the period after 2030 and use a consistent number of sources when aggregating needs data for 2024-30 and 2031-50, respectively.

Table 3: List of data sources extended to ensure coverage of estimates until 2050

Source	Original timeframe	Period for which extension was applied	Sectors covered
IEA (2023d)	Until 2030	2031-50	Energy Systems
IEA (2024)	Until 2030	2031-50	Energy Systems, Buildings, Industry, Transport
IPCC (2022)	Until 2032	2033-50	Energy
FOLU (2019)	Until 2030	2031-50	AFOLU
FOLU (2024)	From 2025-2030	2024 and 2031-50	AFOLU
Thornton et al. (2023)	Until 2030	2031-50	AFOLU
World Bank (2024a)	Until 2030	2031-50	AFOLU
Global Alliance for the Future of Food (2024)	Until 2035	2036-50	AFOLU

CURRENCY YEAR

Most needs estimates were expressed in nominal (current) USD, with different sources being published in different years. Where not stated in the original source, we assumed the currency year in which needs estimates were expressed to be the year of publication. To improve consistency and comparability of data, we standardized all investment needs estimates to 2022 USD, taking into account the inflation rates shown in Table 4.

Table 4: Inflation rates for currency conversion

Original currency year	Conversion rate to 2022 USD
2005	1.50
2010	1.34
2012	1.27
2015	1.23
2018	1.16
2019	1.14
2020	1.13
2021	1.08
2023	0.95
2024	0.93

Source: US Inflation Calculator, available here.

TYPE OF VALUE

In the original sources, investment needs values were expressed variously as (i) annual average needs over a period (e.g., annual investment of USD 2.3 trillion needed through 2030); (ii) annual average needs reached by a time limit (e.g., annual investments to reach USD 2.3 trillion by 2030); or cumulative needs over a period (e.g., cumulative investments of USD 64.4 trillion needed through 2030).

We converted all needs data collected to needs estimates for each year between 2024 and 2030/2050, as follows:

- **Annual average needs over a period:** In these instances, we took the average annual investment for each year as per the original sources.
- **Annual average needs reached by a time limit:** In these instances, we assumed a linear growth of annual investment between the start and the end of the period, using the amount indicated in the original source as the starting value.
- **Cumulative needs over a period:** In these instances, we extrapolated the average annual investment as the cumulative needs divided by the number of years, unless otherwise indicated in the original source.

Whenever an original source expressed a needs estimate as a range rather than as a single value, we collected data for both the low and high values, and added a mean value into our database.

c) Compilation of results

Once all data values were standardized, we aggregated them by sector, subsector, and solution based on CPI's GLCF taxonomy (see Appendix I), depending on the granularity of the original scenarios considered. Whenever possible, we aggregated data at the climate solution level.

For each solution, we calculated high, low, and average annual needs values for the periods 2024-30 and 2031-50, as below:

- **High and low needs values:** For each solution, these are simply the highest needs estimates across all scenarios included in the calculations. For example, if Source A, Source B, and Source C estimated the annual climate finance needs for renewables to be USD 150 billion, USD 350 billion, and USD 300-450 billion, respectively, we would present the annual finance needs for renewables as the range USD 150-450 billion.
- **Average needs values:** For each solution, these were calculated as the average of average needs estimates in each scenario included in the calculations. In the example above, we would present the annual average finance need for renewables as USD 291.7 billion (i.e., the average between USD 150 billion, USD 350 billion, and USD 375 billion).

As explained above, needs estimates included in CPI's analysis come from a variety of scenarios, using different assumptions and projecting technology pathways that may be incompatible with each other (e.g., 100% renewable-based power sector vs inclusion of fossil fuel plants using carbon removal technologies). This calls for a rigorous interpretation of the results and is the reason why CPI's needs estimates are expressed in ranges of and/or average values, rather than single values. This also reflects the variability in estimates, at all levels of the aggregation, and provides an impartial understanding of the order of magnitude of the investment required to reach net zero carbon emissions by 2050 and align to a 1.5°C pathway.

5. GEOGRAPHICAL BREAKDOWN OF NEEDS ESTIMATES

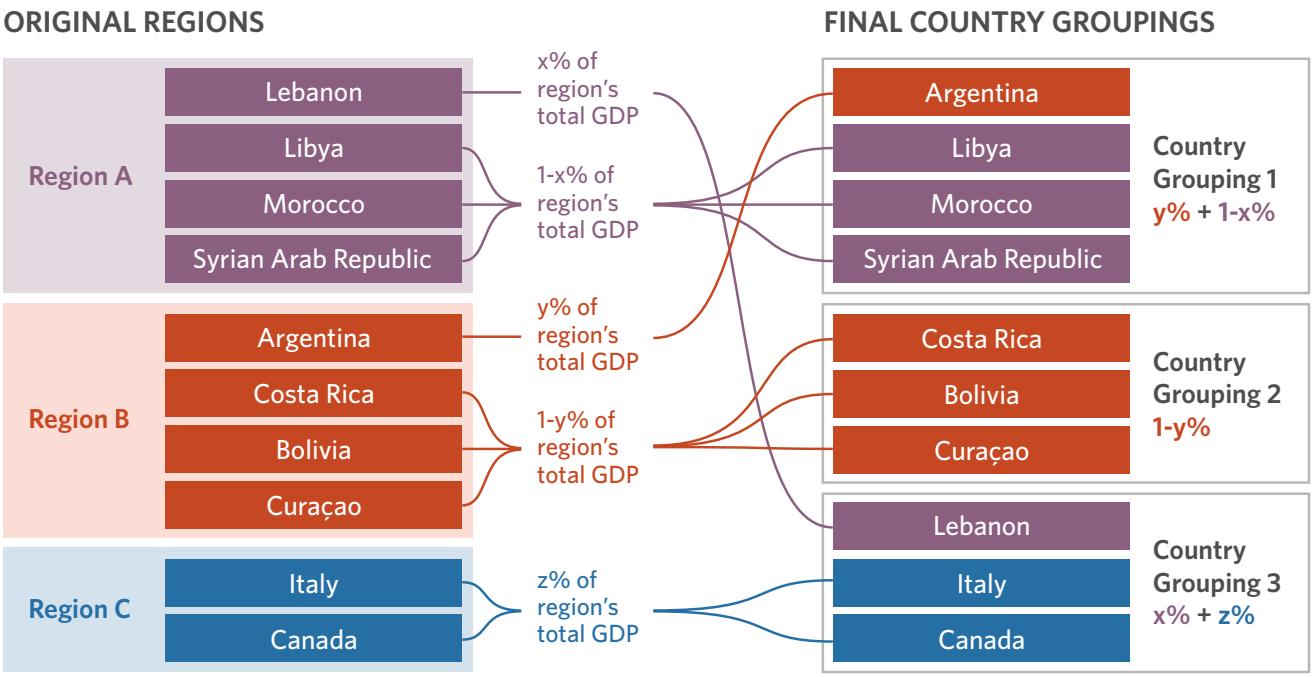
To improve the granularity of our needs estimations, our latest update includes regional values for buildings, energy systems, industry, and transport. The choice of scope was driven by data availability, as the six data sources used for these sectors—BNEF (2024), IEA (2024), IEA (2023d), IPCC (2022), IRENA (2023c), McKinsey (2022)—all include some level of geographical disaggregation in their needs estimates.

In some cases, we found inconsistencies between regional and global needs data. The following steps were taken to extract regional needs data from each data source:

- For **BNEF**, global and regional estimates were consistent with each other and no additional calculations were needed.
- For **McKinsey**, the regional split was only available at the sectoral level (i.e., for mobility, power, buildings, hydrogen/biofuels/heat, industry, agriculture, forestry, and fossil fuel supply) with no additional granularity at the subsector/solution level. In this case, for each subsector/solution we applied the same regional split as that of the relevant sector.
- For **IRENA**, as no regional breakdown was available in the latest report (IRENA, 2023c), we applied the same geographical breakdown as in IRENA (2020b), the most recent IRENA 1.5°C scenario for which regional needs estimates are publicly available.
- For **IEA**, regional data was provided at different levels of granularity and for different sectors, subsectors, and solutions in IEA (2023d) and IEA (2024). In this case we used a combination of regional split from the two reports, using data available at the most granular level possible (i.e., prioritizing regional data at the subsector/solution level over the sector level).
- For **IPCC**, no regional breakdown was available for fossil fuels power generation and nuclear so to maintain consistency with global values, we applied the same regional breakdown as in IEA and IRENA for these two solutions.

The specific regional breakdown varied significantly across data sources (e.g., Türkiye is categorized under "MENAT" in BNEF but falls under "Rest of Asia" in IRENA, and under "Europe" in IPCC). To standardize the data from different scenarios, we used the country groupings in Appendix II. Figure 2 illustrates the approach we used to reclassify some of the countries from the original regions to the final grouping. For example, to reclassify Lebanon from Region A to Country grouping 3, we would assume Lebanon's portion of Region A's investment needs to be proportional to its share of the region's GDP (using the most recent GDP data available from the World Bank [2024b]).

Figure 2: Approach used to reclassify countries from the original regions to the final grouping



Once all needs estimates are reclassified to match the final country groupings, the data aggregation process is similar to that used for global values, as described in Section 4.c.

Caution should be used when trying to compare final regional and global values. Minimum, average, and maximum estimates at the country grouping level are compiled separately from global estimates, and the range of values for the same country or region can vary significantly across different scenarios. Therefore, global values are not simply the sum of regional values, as they do not account for this additional level of variability.

6. NON-CLIMATE FINANCE SOLUTIONS

Most net zero scenarios model the evolution of non-climate solutions, alongside climate solutions. For example, all energy-transition models compatible with a 1.5°C pathway also include projections for fossil fuel deployment, though declining over time. To provide an overview of needs estimates under a net zero trajectory as comprehensively as possible, this year, we have included non-climate finance solutions in our data collection and compilation.

Table 5 lists non-climate solutions[4] for which we collected and processed investment needs data. While all high-emission and other low-emission activities in the table are outside the scope and definition of climate finance, other activities (e.g., Research & Development under AFOLU) overlap with climate finance and are therefore best categorized as partial climate finance.

Table 5: Partial or non-climate solutions for which we collected investment needs estimates

Sector	Subsector/solution	Covered investment needs	Type of activities
AFOLU	Biodiversity, land & marine ecosystems	For conservation and restoration of non-forested land, peatlands, wetlands, etc. (forested lands are included as climate finance under AFOLU)	Biodiversity and nature
AFOLU	Livelihood and poverty	For measures related to social and livelihood development around land and agriculture	Just transition
AFOLU	Sustainable crops, agroforestry, livestock production - urban agriculture		Extended solutions for agriculture
AFOLU	R&D: Climate-focused R&D in crops and livestock		Extended solutions for agriculture
Building & Infrastructure	Unspecified use of fossil fuels	For high-emission cooking and heating systems in buildings.	High emissions
Transport	Road transport – conventional vehicles	For internal combustion engine vehicles.	High emissions
Industry	Conventional industry	For the production of steel, cement, chemicals, and aluminum through conventional industrial processes.	High emissions
Energy Systems	Fuel production – High-emission fuels	For the extraction and production of coal, gas, and oil	High emissions
Energy Systems	Power generation – Use of fossil fuels without CCS	For the generation of electricity through unabated fossil fuel plants	High emissions
Energy Systems	Power generation – Nuclear power	For nuclear power generation (mainly conventional fission and small modular reactors)	Other low-emissions

4 High-carbon solutions or solutions related to other pillars of a net-zero transition (e.g., preservation of ecosystems) which do not fall under the definition of climate finance, based on CPI GLCF taxonomy (see Appendix I).

INTEGRATION OF FOSSIL FUEL-BASED ACTIVITIES

In every net zero scenario considered, the share of fossil fuels in the energy mix decreases over time to become residual—and almost negligible in some scenarios—by 2050. This is based on the need for a paradigm shift away from a fossil fuel-based economic system, progressively replacing high-carbon activities with low-carbon solutions.

For fossil fuel activities, we collected investment needs data from four data sources, namely BNEF (2024), McKinsey (2022), IEA (2023d, 2024), and IRENA (2023c).

For **BNEF** and **McKinsey**, annual values for fossil fuel investment needs, decreasing over 2024-2050 were available.

IEA estimations also show a decreasing annual investment required in fossil fuels but only up to 2030. In this case, we extended values until 2050, applying a decrease ratio calculated as the average decline over the past three years in each given year (e.g., the decrease ratio between 2030 and 2031 is the same average of the decrease ratios in 2027-28, 2028-29 and 2029-30).

Finally, IRENA only provides fossil fuel investment needs estimates as cumulative and average annual values until 2050, with no further details on the dynamic of investment over time. In this case, we applied an average decrease ratio calculated based on BNEF, McKinsey, and IEA extended values.

7. DATA COVERAGE AND GAPS

Original scenarios used for final needs calculations cover different technologies and sectors at different levels of granularity. This means that the availability of needs data may vary significantly across sectors, subsectors, and solutions. Table 6 provides an overview of data coverage for each sector/subsector/solution, summarizing the number of data sources used in the final calculations. This makes it possible to identify key sectors, subsectors, and solutions for which usable needs estimates are not available. The table also highlights the number of data sources that only covered the period up to 2030 and required an extension of needs estimates until 2050.

Table 6: Number of data sources included in the calculations for each sector, subsector, and solution

Sector/subsector	Number of sources 2024-50	Number of sources 2024-30[5]	Total number of sources
ENERGY SYSTEMS	**3**	**2**	**5**
Power and heat generation	**3**	**2**	**5**
Renewables	2	2	4
Renewables retrofit	-	-	-
Hydrogen fuel cells	1	-	1
Energy storage	3	2	5
Fossil fuels with carbon capture and storage	1	-	1
Power and heat transmissions and distribution	**1**	**1**	**2**
District heating	-	-	-
Power grids	3	2	5
Smart grids	-	-	-
Mini grids	-	-	-
Power grid retrofits	1	-	1
New power grids for renewables	1	-	1
Fuel production	**3**	**-**	**3**
Low-emission fuels	3	-	3
Biogas	-	-	-
Biofuels	2	-	2
Hydrogen from renewables	2	-	2
Synthetic hydrocarbon fuels from carbon capture and green hydrogen	1	-	1

5 For these sources, extension of values to 2050 was required.

Sector/subsector	Number of sources 2024-50	Number of sources 2024-30[5]	Total number of sources
Fuel transmission and distribution	**1**	**-**	**1**
Infrastructure for green hydrogen	1	-	1
Green hydrogen transport	1	-	1
Green hydrogen storage	1	-	1
Infrastructure for other low-emission fuels	-	-	-
Policy and national budget and support and capacity building	**-**	**-**	**-**
INDUSTRY	**2**	**1**	**3**
Industrial, extraction, and manufacturing processes	**2**	**1**	**3**
Energy-use improvements and other greenhouse gas cuts	1	-	1
Cement industry	-	-	-
Steel industry	-	-	-
Substitution with hydrogen from renewables	-	-	-
Renewables and electrification	2	1	3
Renewables	1	-	1
Electrification	1	-	1
(heat pumps only)	1	-	1
Carbon capture utilization and storage	2	-	2
Non-energy and fugitive greenhouse gas reduction	-	-	-
Industry infrastructures and warehouses	**-**	**-**	**-**
Energy efficiency	-	-	-
Resilient Infrastructure	-	-	-
Upstream and midstream renewables	**-**	**-**	**-**
Raw material extraction and transformation	-	-	-
Manufacturing	-	-	-
Policy and national budget and support and capacity building	**-**	**-**	**-**
TRANSPORT	**3**	**1**	**4**
Private Road Transport	**3**	**1**	**4**
Low-emission vehicles	3	-	3
Plug-in hybrid electric vehicles	-	-	-
Battery electric vehicles	-	-	-
Fuel cell electric vehicles	-	-	-
Electric vehicles chargers	2	-	2
Infrastructure for low-emission vehicles	-	-	-
Energy efficiency	-	-	-
Rail and public transport	**-**	**-**	**-**
Modal shift policy support	-	-	-
Energy efficiency - retrofit	-	-	-

Sector/subsector	Number of sources 2024-50	Number of sources 2024-30[5]	Total number of sources
New bus, light or heavy rail fleet and related infrastructures	-	-	-
Waterway	**-**	**-**	**-**
Energy efficiency - retrofit	-	-	-
New low-carbon fleet and related infrastructures	-	-	-
Aviation	**-**	**-**	**-**
Energy efficiency - retrofit	-	-	-
Modal shift policy support	-	-	-
Transport-oriented urban development and infrastructures	**-**	**-**	**-**
Policy and national budget and support and capacity building	**-**	**-**	**-**
AFOLU	**2**	**5**	**7**
Crop & Livestock systems	**2**	**4**	**6**
Sustainable crops, agroforestry, livestock production	2	4	6
Crop diversity & resiliency	-	3	3
Soil health & erosion control	1	1	2
Soil carbon storage management	2	1	3
Post-harvest management	-	-	-
Bioenergy	-	-	-
Supply chain	-	1	1
Energy efficiency & renewable energy	-	-	-
Reduction of non-CO2 GHG emissions from agricultural practices & technologies	-	1	1
Nutrients & pest control	-	1	1
Water management	-	1	1
Weather forecasting	-	-	-
Supporting infrastructure	-	1	1
Livestock management for GHG mitigation	1	2	3
Resilient livestock breeds	-	-	-
Manure management	-	1	1
Grassland management	1	-	1
Waste management	-	-	-
Urban agriculture	-	-	-
Supply chain management (commercialization, primary processing & storage)	-	-	-
Alternative proteins production	-	-	-
Supply chain	-	-	-
Energy efficiency & renewable energy	-	-	-
Post-harvest management	-	-	-

Sector/subsector	Number of sources 2024-50	Number of sources 2024-30[5]	Total number of sources
Forestry	**2**	**2**	**4**
Afforestation, reforestation, forest conservation, sustainable management of existing forest, including extraction of non-timber products	2	2	4
Reforestation	-	-	-
Afforestation	-	-	-
Sustainable forest management	1	1	2
Production of non-timber forest products	-	-	-
Forest conservation	1	1	2
Forest restoration and rehabilitation	1	1	2
Projects seeking to reduce emissions from the deforestation or degradation of ecosystems	-	1	1
Supporting infrastructure	-	-	-
Bioenergy	-	-	-
Supply chain management (commercialization, primary processing, and storage)	-	-	-
Fisheries	**-**	**1**	**1**
Sustainable fish production	-	1	1
Supporting infrastructure	-	-	-
Aquaculture	-	1	1
Energy & resource efficiency	-	-	-
Water management	-	-	-
Supply chain management (commercialization, primary processing and storage)	-	-	-
Food & diet	**1**	**4**	**5**
Reducing food waste and loss	1	4	5
Low-carbon diets	1	4	5
Local loops & linkages between urban consumers & farmers	-	2	2
Biodiversity, land, & marine ecosystems	**1**	**2**	**3**
Rehabilitation of degraded land	1	1	2
Peatland restoration	1	-	1
Reduce degradation & conversion of wetlands & coastal wetlands	1	-	1
Wetlands & coastal wetlands restoration	1	1	2
Reduce degradation & conversion of peatlands	1	-	1
Riparian habitat restoration	-	-	-
Conservation of non-forested land	1	-	1
Restoration or rehabilitation of non-forested land	-	1	1

Sector/subsector	Number of sources 2024-50	Number of sources 2024-30[5]	Total number of sources
Policy and national budget and support and capacity building	**1**	**2**	**3**
Financial services for sustainable production, commercialization, storage & processing	-	-	-
Policy instruments	1	2	3
R&D	-	1	1
Training & monitoring	-	1	1
BUILDINGS & INFRASTRUCTURE	**3**	**1**	**4**
Building and infrastructure construction work	**2**	**-**	**2**
Energy efficiency - new construction	-	-	-
Energy efficiency - retrofit	2	-	2
Heating, ventilation, & air conditioning (HVAC) & water heaters	**3**	**-**	**3**
Energy-efficient HVAC	-	-	-
Direct use of renewables	1	-	1
Solar thermal	-	-	-
Other renewable energy-based	-	-	-
Heat pumps electrification	2	-	2
Appliances and lighting	**-**	**-**	**-**
Renewables	-	-	-
Electrification	-	-	-
Energy efficiency	-	-	-
Policy and national budget and support and capacity building	**-**	**-**	**-**
ADAPTATION	**5**	**1**	**6**

Table key: **SECTOR** | **Subsector** | **Solution** | Technology

8. DATA AND METHODOLOGY LIMITATIONS

To provide a clearer picture of global climate finance needs, CPI has developed a new approach to systematically compile and present existing estimates in a clear and accessible way. We apply a rigorous and impartial method to standardize these estimates, but some limitations affect the completeness and effectiveness of our approach. Our needs estimates should, therefore, be interpreted with the following data and methodology limitations in mind.

DATA LIMITATIONS

As described in Section 8, needs data for some sectors, subsectors, and solutions are missing or unusable. This includes data for many essential solutions, which we had to remove from the final calculations, such as supply chain needs included in IEA (2023b), sustainable infrastructures needs in Batthacharya et al. (2022), and energy supply and demand needs in BNEF (2024).

For some solutions (e.g., energy efficiency of waterway transportation) we could not find any data on estimated needs. These solutions were either outside of the scope of the scenarios we reviewed, or they were included as part of broader sectors or subsectors with no additional detail or granularity available in the original reports and/or accompanying methodologies.

Where data was available, we sometimes faced the following challenges when trying to include, process, and standardize it. These challenges, in some cases, limited our ability to use the data for the final calculations.

- **Data format.** Only a limited number of sources disclosed their needs estimates as raw data (in a dataset format), so in most cases, we extracted data in a text format from analytical reports. This is a highly time-consuming process that increases the possibility of mistakes and omissions.
- **Data standardization.** Different data sources use different sector taxonomies. Thus, the way technologies and solutions are categorized under each sector may differ greatly from one data source to another. In many cases, the original source only provides a brief description of what is included under each sector and/or subsector and no accompanying methodology document exists that could provide more detail. This may affect our ability to correctly standardize data collected based on CPI's GLCF taxonomy (see Section 4.b).
- **Insufficient granularity.** Building upon the previous point, the lack of a common categorization of sectors and technologies across data sources is further aggravated by the limited availability of granular needs data. Many data sources provide needs estimates at the subsector level (e.g., renewables) rather than the solution level (e.g., solar PV, onshore wind). This creates two possible challenges:
    - Risk of overlaps. E.g., Source A provides an estimate for "solar and wind" and Source B provides an estimate for "wind and storage": the two cannot be averaged together as they do not have the same coverage.

    - Incomplete categories. E.g., Source A provides an estimate for "solar and wind", Source B provides an estimate for "wind" but no estimate "solar": In this case, the estimate for "wind" cannot be averaged with the estimate for "solar and wind" as the scope is narrower, and Source B does not provide an estimate for "solar."

  Increased data granularity would enable categories to be reconfigured as needed, which would significantly simplify calculations by overcoming the issues of overlapping and unexhaustive categories.

- **Variation in disaggregation.** Some data sources present investment needs estimates for the same subsector or solution multiple times within a report or database, using different levels of detail or different sector categories. In these cases, we performed additional calculations to check for consistency, identify any overlaps, and determine potential complementarities. For example, in IRENA (2023), Figure 3.1 shows "Energy conservation and efficiency" investments as 29% of cumulative energy sector investments from 2023 to 2050 (USD 43.5 trillion). However, Table 3.1 in the same report lists annual investments in "Energy efficiency" broken down by sector, showing USD 1.5 trillion per year (or USD 42.2 trillion from 2023 to 2050). When collecting this data point, we spent time understanding where the discrepancies arose, what solutions are included in each category, and how the two categories overlap.

METHODOLOGY LIMITATIONS

Our needs estimates compile and standardize data from a wide variety of scenarios. Our goal is to provide a comprehensive and impartial understanding of the order of magnitude of the investment required to reach net zero carbon emissions by 2050. Nevertheless, comparing and aggregating data from different scenarios brings several challenges that should be kept in mind when interpreting top-down climate finance needs estimates.

- Existing models typically integrate both climate and non-climate solutions (e.g., fossil fuels) into net zero transition scenarios. Each model considers climate and non-climate solutions interdependently, where the projected evolution of the former affects that of the latter and vice versa. Climate and non-climate solutions under each model cannot be considered in isolation. **When focused only on climate solutions, our results should not be interpreted as the total investments required to align with a net zero pathway but rather as the investment required for climate mitigation (and adaptation) solutions as part of the broader capital requirements under a net zero scenario.** For all sources included in this work, the achievement of net zero scenarios relies on the reduction of investments in fossil fuels and other high-carbon solutions. Simply increasing climate investments will not be enough to align with a 1.5°C trajectory if no substantial efforts are made to reduce high-carbon investments. Therefore, climate investment needs should not be viewed in isolation. Rather, they should be considered alongside non-climate investment needs to more accurately reflect the reality of transition scenarios.

- As they use different assumptions, some of the scenarios included in our calculations may be incompatible with each other (e.g., 100% renewable power vs inclusion of fossil fuel-based generation using carbon removal technologies). This is why our climate needs estimates are typically presented as ranges, reflecting the variability of scenarios and assumptions behind the numbers. **Our results should, therefore, be interpreted as a comprehensive and**

impartial indication of the order of magnitude of the investment required, reflecting all existing scenarios rather than a single absolute value of reference.

- Our total needs estimates for mitigation (respectively, high, average, and low values) are calculated as the sum of estimated needs for each mitigation sector: AFOLU, buildings, energy systems, industry, and transport). However, the interdependency of solutions mentioned above implies an interdependency of sectors, as well. For example, if the investment required for a specific sector in a predictive model is low, this can be due to higher efforts (and, therefore, investments) to reduce greenhouse gas emissions in another sector. Thus, a low investment required, e.g., in Sector A, would be assumed to be coupled with a high investment in Sector B. **Therefore, CPI's high, average, and low needs values should not be interpreted as related to one single scenario but rather as reflecting the variability of scenarios used for the calculations and compiled together.**
- The data sources used for our top-down investment needs estimates were published at different times. While they may all project annual investment requirements up to 2030 or 2050, they use different starting points and baseline investment levels for their transition models. For example, McKinsey (2022) starts modeling from 2021 and estimates annual investment requirements over the 29-year period from 2021 to 2050. In contrast, more recent reports—e.g., BNEF (2024)—project investments starting from 2024, covering from 2024 to 2050. Our most recent top-down estimates begin in 2024,[6] and, for simplicity, we do not count any investment needs projected before that year. However, since actual financing has consistently fallen short of the required annual investments, most of the estimated investment needs before 2024 have likely not been met. This suggests that our estimates may slightly understate the total investment needs by excluding pre-2024 requirements. **Our results should, therefore, be interpreted with this potential underestimation in mind.**

6 This is the first year for which we do not have baseline investment flows data from CPI's Global Landscape of Climate Finance (GLCF).

9. HOW TO INTERPRET THE DATA

DO...	DO NOT...
Use CPI's top-down needs estimates as a general guideline for the scale of investment required rather than as precise predictions. CPI's investment needs estimates are derived by aggregating values from multiple sources and scenarios, each based on different—sometimes highly divergent— assumptions and models. As a result, CPI's average estimates should not be seen as precise figures for achieving 1.5°C alignment but rather as a general indication of the scale of investment required. Presenting a range of values (minimum and maximum estimates) provides a more complete picture, capturing the variability across data sources and scenarios, as well as the uncertainty of future projections.	**Do not consider investment needed under a 1.5°C pathway as additional to a BAU scenario.** Closing the funding gap for 1.5°C alignment is not just about adding new investments—it also requires redirecting capital that would otherwise go toward high-carbon activities in a BAU scenario.
View needs estimates as investment opportunities in the global transition toward a 1.5°C development pathway rather than as costs. Climate investments not only generate returns for investors but also help develop and strengthen climate-friendly infrastructure, practices, and systems across multiple sectors. This drives long-term economic, health, and social benefits, which are expected to be greater than those under a business-as-usual (BAU) scenario.	**Do not assess progress toward net zero based solely on a single year's improvement compared to a BAU scenario.** Progress should be measured cumulatively over time. Even if investment levels eventually reach the required targets in the future, any shortfall in previous years represents a gap in alignment with the net zero pathway. These missed investments will need to be compensated for later to stay on track.
	Do not view investment needs estimates in isolation, but rather as part of the wider context of measures needed to align to a 1.5°C pathway. Top-down (technology-based) models estimating the investment needed for a 1.5°C pathway often focus on capital expenditures (CAPEX) and may overlook key interventions necessary for achieving net zero alignment. For example, policy measures and behavioral changes—e.g., efforts to reduce energy intensity—are frequently underrepresented or entirely unaccounted for in technology-based models, often included as assumptions to build the models but not reflected in the final needs values.
	Do not view investments in climate solutions alone as a guarantee that the net zero target will be met. Achieving net zero requires ensuring that these investments drive meaningful transformations. Climate investments will be effective only if (i) they enable physical targets to be reached and (ii) the climate solutions supported are replacing high-carbon activities (aiming for substitution and not addition).

10. IMPROVING OUR GLOBAL UNDERSTANDING OF CLIMATE INVESTMENT NEEDS

A global and just transition to a net zero, climate-resilient pathway requires a common understanding of the investment needed in different sectors and geographies. **Timely and accurate information on climate investment flows and needs is key to creating awareness among public and private investors as well as policymakers and ensuring that climate investments are channeled toward those sectors and countries that display the largest funding gaps.**

Institutions modeling future climate finance requirements have an important role to play in supporting evidence-based decision-making in this transition. Further action is, however, needed to improve the understanding of climate investment needs, such as:

1. **Expand sectoral coverage.** As laid out in Section 7, several data gaps still exist in investment needs estimates available. While some sectors, such as energy systems and AFOLU, are well covered under existing models, for others, needs estimates are partial or unavailable. Needs data for transport, for example, is usually limited to private road transport—primarily focusing on EVs and EV charging infrastructure—while no recent or granular estimates are available for rail and public transport, aviation, or waterways. For some climate-relevant sectors, such as waste and wastewater, we found no recent study modeling investment needs under a net zero scenario. More work is needed to:
    - Develop models for sectors, subsectors, and technologies/solutions not currently covered (e.g., waste and wastewater and aviation within the transport sector).
    - Improve granularity of needs estimates within sectors, where possible, providing data at the technology/solution level (e.g., solar PV, onshore wind, etc.) rather than the subsector level (e.g., renewable energy).
    - Estimate the investments needed to support the transition to a net zero pathway across all sectors. This includes funding for policies and incentives, sector planning, capacity building, education and workforce retraining, GHG monitoring, and research and development, among others. Most models primarily estimate the CAPEX for a specific mix of net zero-compatible technologies. However, a successful transition requires a broader range of interventions to support and implement each technology mix effectively.
    - Estimate the investment required at each stage of the technology supply chain, from resource extraction and raw material production to component manufacturing, assembly, installation, operation, maintenance, and end-of-life activities.
2. **Develop regional and country models.** Most top-down models only provide investment needs estimates at the global level. These models typically rely on regional and/or country-level assumptions and estimations, which are then aggregated to produce global values. While current global estimates provide a useful sense of overall investment requirements, more detailed regional and country-level data could clarify where the largest needs are and

significantly improve evidence-based decision-making to close investment gaps. Better regional or country-level data can also help policymakers set more precise climate goals and strategies (e.g., in each new round of NDCs), enabling them to better assess the investment needed to align with a net zero pathway.

3. **Develop alternative scenarios to net zero.** Only a minority of institutions have so far developed alternative scenarios to net zero, including *Base Case* scenarios based on BAU trajectories or *Policy Pledges* scenarios projecting existing country commitments. Developing alternative models alongside 1.5°C scenarios is crucial for understanding the full range of possible futures and can help to inform more effective decision-making. BAU scenarios, in particular, can help quantify the gap between current trajectories and the pathways needed to meet the 1.5°C target, highlighting not just the scale of funding but also shifts in investment required. BAU scenarios can also highlight the consequences of climate inaction, such as higher adaptation costs, greater economic disruption, and more severe environmental and social impacts. Including BAU scenarios, therefore, ensures that transition plans are grounded in a realistic understanding of current trends while reinforcing the urgency of accelerating climate action.
4. **Include long-term needs projections.** As highlighted in Section 4b, not all studies provide long-term estimations (that is, beyond 2030) of climate investment. Many data sources offer projections only until 2030, and longer-term projections are more commonly available for energy transition models, covering sectors such as energy systems and transport. With 2030 just five years away—and considering the long-term and multi-generational nature of climate change—it is essential for all top-down, technology-based models to incorporate long-term trajectories and climate investment requirements through 2050, with milestones for 2030 and 2040 to support shorter-term planning and climate targets setting (e.g., in the NDCs).
5. **Improve transparency around scenario assumptions and methodologies.** All net zero scenarios use very different models and assumptions, cover different sectors and geographies, and have different levels of granularity. The biggest difficulty in comparing needs estimates across scenarios is the limited transparency around the model inputs and assumptions. Institutions developing top-down climate investment needs estimates need to improve the transparency of their methodology, focusing on:
    - Detailing the model inputs and assumptions of the models and scenarios used.
    - Improved clarity around definitions of climate investment needs, for example, clarifying whether this includes only CAPEX or also financing costs.
    - Improving the transparency around what is included behind needs estimates in terms of e.g., technologies. Ideally, all scenarios would align to a common taxonomy (e.g., the EU Taxonomy). In the absence of this, providing needs estimates at the most granular level possible and providing clarity around solutions and measures included under each scenario could facilitate the comparability of different scenarios.

WHAT NEXT?

A common understanding of climate finance is needed in different sectors and geographies, and it is essential to take direct action for those areas where finance is needed the most. Top-down needs estimates represent a key starting point to assess funding gaps and build a **better understanding of actors, financial instruments, and policy and market interventions required to mobilize and redirect capital to achieve net zero.**

Building on our assessment of top-down needs, CPI has developed a methodology framework to inform the development of Climate Finance Roadmaps and identify:

- **Most suitable investors** in different markets, based on investors' preferences and characteristics, the risk profiles of each sector and geography, as well as availability of private capital;
- **Financial instruments required** to close the investment gaps most effectively, based on technology and financial market maturity;
- **Policy and regulatory measures needed** to overcome investment barriers and attract climate investments at the scale required; and
- **Robust methodology** for closing climate finance gaps that can be applied by various actors in local and regional contexts.

Depending on the scope and depth of the analysis, CPI Climate Finance Roadmaps can be used by different types of stakeholders (Table 7).

Table 7: How CPI Climate Finance Roadmaps could be used by different actors

Public and private capital allocators	Policymakers and regulators
• Understand their potential role in closing the funding gap and identify investment opportunities in different sectors and geographies. • Think through their various investment challenges. • Identify potential co-investors and coordinate action. • Ultimately direct capital more effectively to collectively achieve a net zero pathway.	• Assess investment needs and identify the most suitable investors to close gaps • Understand investors' challenges in the market. • Identify interventions needed to mobilize the right type of capital at scale. • Develop more accurate net zero investment plans which can be integrated in NDCs and other national strategies and plans.

CPI is currently piloting this methodology framework to develop a Climate Finance Roadmap analysis for the sustainable livestock sector in Latin America and the Caribbean region. Moving forward, we plan to test the approach—together with partners—across various sectoral and geographical scopes, with a focus on country-level analyses.

APPENDIX I: CPI CLIMATE FINANCE TAXONOMY

Table 8 includes CPI's taxonomy of climate finance activities used to match investment needs data collected and processed.

Table 8: Climate finance taxonomy used in the CPI's GLCF analyses

Sector	Subsector	Mitigation or adaptation solution	Additional information and examples
Energy Systems	Power & Heat Generation	Biofuel/Biomass-fired	If a project's GHG emissions reductions are demonstrated compared with technically and economically viable alternatives
		Geothermal	
		Hydropower[7]	If a project's GHG emission reductions are demonstrated compared with technically and economically viable alternatives
		Hydrogen fuel cell	Using green hydrogen only
		Off-grid (renewables only)	Renewables only
		Other marine	Wave, Tidal, etc
		Solar – concentrated solar power	
		Solar – photovoltaic	Utility-scale and distributed
		Wind – offshore	
		Wind – onshore	
		Carbon capture use and storage in fossil fuel power plants	Incremental costs of CCUS technology only
		Waste-to-energy	E.g., incineration, gasification, pyrolysis, and plasma with clear mitigation benefits
		Multiple	Unspecified renewable energy projects or projects that combine multiple energy sources
		Renewable retrofit	Energy efficiency in existing renewable power assets
		Resilient infrastructure and infrastructure for resilience	E.g., reduction in river flows leading to loss of generation from a hydroelectric plant
	Power & Heat Transmission & Distribution	District heating	Fueled by renewable energy only
		Smart grids	
		Mini grids	
		Power Grids – Retrofit	Retrofits that lead to clear energy efficiency gains
		Power Grids – New	That enable the integration of renewable power capacity
		Resilient infrastructure and infrastructure for Resilience	E.g., undergrounding of power lines

7 CPI does not count finance for large hydro projects from the private sector, or public sector finance for projects that do not demonstrate mitigation potential.

Sector	Subsector	Mitigation or adaptation solution	Additional information and examples
	Fuel Production	Biogas	Production of biogas connected to natural gas pipelines
		Biofuel	Biofuel production
		Hydrogen from renewables	
	Fuel Transmission & Distribution	NA	E.g., green hydrogen pipelines
	Policy & National Budget Support & Capacity Building	NA	
	Other/Unspecified	NA	Other energy projects, including general energy access development with clear mitigation and/or adaptation benefits
Industry	Industrial, Extraction, and Manufacturing Processes	Non-energy and fugitive GHG reduction	E.g., substitutions in industrial processes with associated GHG cuts
		Carbon capture use and storage	Excluding Energy sector – Incremental cost only
		Energy-use improvements and other GHG cuts	Energy consumption and GHG cuts in industrial processes
		Substitution with hydrogen from renewables	Industrial processes using hydrogen shifting from FF-based Hydrogen to RE-based hydrogen
	Industry Infrastructure & Warehouse	Energy efficiency	Low-consumption warehouses and light industry buildings
		Resilient infrastructure and infrastructure for resilience	E.g., improve the resilience of existing industrial plants, provide flood protection, etc.
	Policy & National Budget Support & Capacity Building	NA	
	Other/Unspecified	NA	
Waste	Solid Waste	Infrastructure and management (including recycling)	
	Policy & National Budget Support & Capacity Building	NA	
	Other/Unspecified	NA	
Water & Wastewater	Water Supply & Sanitation	Efficient large infrastructure	
		Basic water access	
	Waste Water Treatment	Infrastructure and management	Greenfield or brownfield projects that reduce methane or nitrous oxide emissions through wastewater, fecal sludge, or septage management
		NA	
	Policy & National Budget Support & Capacity Building	NA	Ex. Improved catchment management planning and regulation of water abstraction
	Other/Unspecified	NA	

Sector	Subsector	Mitigation or adaptation solution	Additional information and examples
Buildings & Infrastructure	Building & Infrastructure Construction Work	Energy efficiency - new construction	
		Energy efficiency - retrofit	
		Resilient infrastructure and infrastructure for resilience	
	HVAC & Water Heaters	Renewable energy-based HVAC	
		Solar thermal water heaters	
		Energy-efficient HVAC	Efficient cooling, etc.
	Appliances & Lighting	Efficient lighting systems (incl. public lighting)	E.g., LEDs
	Policy & National Budget Support & Capacity Building	NA	E.g., more robust building regulations and improved enforcement
	Other/Unspecified	NA	
Transport	Private Road Transport	Battery EVs	
		EV chargers	
	Rail & Public Transport	Modal shift policy support	
		Energy efficiency retrofits	Fleet Retrofit with clear energy efficiency gains
		New bus, light or heavy rail fleet, and related infrastructure	With associated modal shifts from a higher-carbon transport mode. FF-powered rail engines are excluded
	Waterway	Energy efficiency - retrofit	Fleet Retrofit
		New low-carbon fleet and related infrastructure	
	Aviation	Energy efficiency - retrofit	
		Modal shift policy support	
	Policy & National Budget Support & Capacity Building	NA	
	Transport-oriented Infrastructure and Urban Development	Infrastructure for non-motorized transports	
		Resilient Infrastructure and Infrastructure for Resilience	E.g., Use of revised codes for infrastructure design that consider increased frequency or severity of extreme events
	Other/Unspecified	Modal Shift with Associated GHG Emission Cuts	

Sector	Subsector	Mitigation or adaptation solution	Additional information and examples
Information and Communications Technology	Data Centers	NA	New highly energy-efficient centers or energy-efficient retrofits
	Telecommunication Networks	NA	New highly energy-efficient networks or energy-efficient retrofits
		Resilient Infrastructure and Infrastructure for Resilience	
	Policy & National Budget Support & Capacity Building	NA	
	Other/Unspecified	NA	
Agriculture, Forestry, Other land uses, and Fisheries	Agriculture	Sustainable crops, agro-forestry, livestock production	E.g., investments in crops that are more resilient to climate extremes and change
		Supply chain management (commercialization, primary processing, and storage)	
		Financial services for sustainable production, commercialization, storage, and processing	
	Forestry	Afforestation, Reforestation, Forest Conservation, sustainable management of existing forest, including extraction of non-timber products	
		Supply chain management (commercialization, primary processing, and storage)	
	Fisheries	Sustainable fish production	
		Supply chain management (commercialization, primary processing, and storage)	
	Food & diet	Food waste and low-carbon diets	
	Policy & National Budget Support & Capacity Building	NA	
	Unspecified / Multiple	NA	

Sector	Subsector	Mitigation or adaptation solution	Additional information and examples
Others & Cross-sectoral	Policy & National Budget Support & Capacity Building	NA	
	Biodiversity, Land & Marine Conservation	NA	
	Disaster-risk Management	NA	E.g., integration of climate change scenarios and climate risk assessments into disaster-risk plans and preparedness
	Other/Unspecified	NA	

APPENDIX II: COUNTRY GROUPINGS FOR THE GEOGRAPHICAL BREAKDOWN

Table 9 shows the country groupings used for our top-down climate finance needs estimates.[8] Given the significant variation in regional breakdowns across data sources, the country groupings used for CPI's top-down needs estimates aim to strike a balance between minimizing country reclassification and maintaining a clear distinction between emerging markets and developing economies (EMDEs) and non-EMDEs, in line with CPI's GLCF analysis (2024).

Table 9: Country grouping used for CPI top-down climate finance needs estimates

Country grouping	Countries and territories included
EMDEs (excl. China)	
Brazil	Brazil
India	India
Latin American and Caribbean (excl. Brazil)	Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Bonaire, British Virgin Islands, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands, French Guiana, Grenada, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Montserrat, Navassa Island, Nicaragua, Panama, Paraguay, Peru, Pitcairn Islands, Puerto Rico, Saba, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint-Pierre and Miquelon, Saint Vincent and the Grenadines, Saint-Barthélemy, Sint Eustatius, Sint Maarten, South Georgia and the South Sandwich Islands, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands, Uruguay, Bolivarian Republic of Venezuela
Middle East and North Africa	Algeria, Egypt, Iran (Islamic Republic of), Iraq, Israel, Jordan, Lebanon, Libya, Morocco, Syrian Arab Republic, Tunisia, State of Palestine, Yemen
Other EMDEs	Afghanistan, Bangladesh, Bhutan, Democratic People's Republic of Korea, Maldives, Mongolia, Nepal, Pakistan, Sri Lanka
Sub-Saharan Africa	Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cabo Verde, Central African Republic, Chad, Comoros, Côte d'Ivoire, Democratic Republic of the Congo, Djibouti, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia (Republic of The), Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Republic of the Congo, Rwanda, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, South Sudan, Sudan, Togo, Western Sahara, Saint Helena, Sao Tome and Principe, Uganda, United Republic of Tanzania, Zambia, Zimbabwe
Southeast Asia	Brunei, Cambodia, Federated States of Micronesia, Fiji, Indonesia, Kiribati, Lao People's Democratic Republic, Malaysia, Marshall Islands, Myanmar, Nauru, Palau, Papua New Guinea, Philippines, Samoa, Singapore, Solomon Islands, Timor-Leste, Thailand, Tonga, Tuvalu, Cook Islands, Niue, Vanuatu, Viet Nam
China	
China	China

8 The designations employed here do not imply the expression of any opinion on the part of CPI concerning the legal status of any region, country, territory, city, or area or of its authorities, or concerning the delimitation of frontiers or boundaries.

Country grouping	Countries and territories included
Non-EMDEs	
Central Asia and Eastern Europe	Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Estonia, Georgia, Hungary, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Lithuania, Moldova, Montenegro, North Macedonia, Poland, Romania, Russian Federation, Serbia, Slovakia, Tajikistan, Türkiye, Turkmenistan, Ukraine, Uzbekistan
Western Europe	Andorra, Austria, Belgium, Czech Republic, Denmark, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Ireland, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Slovenia, Spain, Sweden, Switzerland, Jersey, Guernsey, United Kingdom
Other non-EMDEs	American Samoa, Australia, Bahrain, Canada, French Polynesia, Guam, Hong Kong, Japan, Kuwait, New Caledonia, New Zealand, Northern Mariana Islands, Oman, Qatar, Saudi Arabia, South Korea, Macau, Norfolk Island, Tokelau, United Arab Emirates, United States of America

REFERENCES

Baarsch F. et al. 2015. Impacts of low aggregate INDCs ambition. Available at: https://www-cdn.oxfam.org/s3fs-public/file_attachments/rr-impacts-low-aggregate-indcs-ambition-251115-en.pdf

Bhattacharya A. et al. 2022. Financing a big investment push in emerging markets and developing economies for sustainable, resilient and inclusive recovery and growth. Available at: https://www.lse.ac.uk/granthaminstitute/publication/financing-a-big-investment-push-in-emerging-markets-and-developing-economies/

BNEF (Bloomberg New Energy Finance). 2024. New Energy Outlook 2024 (registration required).

BNEF. 2022a. New Energy Outlook 2022 (registration required).

BNEF. 2022b. Investment Needs of a 1.5°C World. Available at: https://about.bnef.com/blog/investment-needs-of-a-1-5c-world/

BNEF. 2022c. Investment Requirements of a Low-Carbon World: Energy Supply Investment Ratios. Available at: https://assets.bbhub.io/professional/sites/24/BNEF-EIRP-Climate-Scenarios-and-Energy-Investment-Ratios.pdf

BNEF. 2021. New Energy Outlook 2021 (registration required).

BP. 2023. Energy Outlook 2023 edition. Available at: https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2023.pdf

Chapagain D. et al. 2020. Climate change adaptation costs in developing countries: insights from existing estimates. Available at: https://www.tandfonline.com/doi/full/10.1080/17565529.2020.1711698?needAccess=true

CPI (Climate Policy Initiative). 2024. Global Landscape of Climate Finance 2024. Available at: https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2024/

FOLU (The Food and Land Use Coalition). 2024. Future Fit Food and Agriculture: The financial implications of mitigating agriculture and land use change emissions for businesses. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2024/03/FOLU-Future-Fit-paper-2_compressed.pdf

FOLU. 2019. Growing Better: Ten Critical Transitions to Transform Food and Land Use. Available at: https://www.foodandlandusecoalition.org/wp-content/uploads/2019/09/FOLU-GrowingBetter-GlobalReport.pdf

GCA (Global Commission on Adaptation). State and Trends in Adaptation Report 2022. Available at: https://gca.org/reports/sta22/

Global Alliance for the Future of Food. 2024. Annex - Cultivating Change: Accelerating and Scaling Agroecology and Regenerative Approaches: A Philanthropic Theory of Transformation. Available at: https://futureoffood.org/wp-content/uploads/2024/01/annex-cultivating-change2.pdf

Global Maritime Forum. 2020. The scale of investment needed to decarbonize international shipping. Available at: https://globalmaritimeforum.org/insight/the-scale-of-investment-needed-to-decarbonize-international-shipping/

Harmsen et al. 2019. The role of methane in future climate strategies: mitigation potentials and climate impacts. Available at: https://pure.iiasa.ac.at/id/eprint/15949/1/Harmsen2019_Article_TheRoleOfMethaneInFutureClimat.pdf

IATA (International Air Transport Association). 2024. Net Zero CO2 Emissions Roadmap. Available at: https://www.iata.org/contentassets/8d19e716636a47c184e7221c77563c93/finance-net-zero-roadmap.pdf

ICAO (International Civil Aviation Organization). 2022. Report on the feasibility of a Long-Term Aspirational Goal for international civil aviation CO2 emission reductions. Available at: https://www.icao.int/environmental-protection/LTAG/Documents/REPORT%20ON%20THE%20FEASIBILITY%20OF%20A%20LONG-TERM%20ASPIRATIONAL%20GOAL_en.pdf

IEA (International Energy Agency). 2024. World Energy Investment 2024. Available at: https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf

IEA. 2023a. World Energy Investment 2023. Available at: https://iea.blob.core.windows.net/assets/8834d3af-af60-4df0-9643-72e2684f7221/WorldEnergyInvestment2023.pdf

IEA. 2023b. Energy Technology Perspectives 2023. Available at: https://iea.blob.core.windows.net/assets/a86b480e-2b03-4e25-bae1-da1395e0b620/EnergyTechnologyPerspectives2023.pdf

IEA. 2023c. Global EV Outlook 2023. Available at: https://www.iea.org/reports/global-ev-outlook-2023

IEA. 2023d. World Energy Outlook 2023. Available at: https://www.iea.org/reports/world-energy-outlook-2023

IEA. 2021. Net Zero by 2050 A Roadmap for the Global Energy Sector. Available at: https://iea.blob.core.windows.net/assets/deebef5d-0c34-4539-9d0c-10b13d840027/NetZeroby2050-ARoadmapfortheGlobalEnergySector_CORR.pdf

IEA. 2020a. Global EV Outlook 2020. Available at: https://www.iea.org/reports/global-ev-outlook-2020

IEA. 2020b. Outlook for biogas and biomethane: Prospects for organic growth. Available at: https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth

IEA. 2019. The Future of Rail Opportunities for energy and the environment. Available at: https://iea.blob.core.windows.net/assets/fb7dc9e4-d5ff-4a22-ac07-ef3ca73ac680/The_Future_of_Rail.pdf

IPCC (Intergovernmental Panel on Climate Change). 2022. Sixth Assessment Report. Chapter 15: Investment and Finance. Available at: https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_Chapter15.pdf

IRENA (International Renewable Energy Agency). 2023a. Renewable Energy Roadmap: Nigeria. Available at: https://www.irena.org/Publications/2023/Jan/Renewable-Energy-Roadmap-Nigeria

IRENA. 2023b. Malaysia Energy Transition Outlook. Available at: https://www.irena.org/Publications/2023/Mar/Malaysia-energy-transition-outlook

IRENA. 2023c. World Energy Transitions Outlook 2023: 1.5°C Pathway. Available at: https://www.irena.org/Publications/2023/Jun/World-Energy-Transitions-Outlook-2023

IRENA. 2022a. World Energy Transitions Outlook 2022: 1.5°C Pathway. Available at: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Mar/IRENA_World_Energy_Transitions_Outlook_2022.pdf?rev=6ff451981b0948c6894546661c6658a1

IRENA. 2022b. Renewable Energy Roadmap for Central America: Towards a Regional Energy Transition. Available at: https://www.irena.org/Publications/2022/Mar/Renewable-Energy-Roadmap-for-Central-America

IRENA. 2022c. Republic of Palau: Renewable Energy Roadmap 2022-2050. Available at: https://www.irena.org/Publications/2022/Jun/Republic-of-Palau-Renewable-Energy-Roadmap

IRENA. 2022d. Renewable Energy Outlook for ASEAN: Towards a Regional Energy Transition. Available at: https://www.irena.org/Publications/2022/Sep/Renewable-Energy-Outlook-for-ASEAN-2nd-edition

IRENA. 2022e. Indonesia Energy Transition Outlook. Available at: https://www.irena.org/Publications/2022/Oct/Indonesia-Energy-Transition-Outlook

IRENA. 2021. Antigua and Barbuda: Renewable Energy Roadmap. Available at: https://www.irena.org/Publications/2021/March/Antigua-and-Barbuda-Renewable-Energy-Roadmap

IRENA. 2020a. Renewable Energy Outlook: Lebanon. Available at: https://www.irena.org/Publications/2020/Jun/Renewable-Energy-Outlook-LebanonIRENA.

IRENA. 2020b. Global Renewables Outlook: Energy transformation 2050. Available at: https://www.irena.org/publications/2020/Apr/Global-Renewables-Outlook-2020

I4CE (Institute for Climate Economics). 2024. European Climate Investment Deficit report. Available at: https://www.i4ce.org/wp-content/uploads/2024/02/20240222-i4ce3859-Panorama-EU_VA-40p.pdf

I4CE. 2023. Landscape of Climate Finance in France. Available at: https://www.i4ce.org/wp-content/uploads/2024/02/Landscape-of-Climate-Finance-Edition-2023_V1.pdf

Laderchi, C. et al. 2024. The Economics of the Food System Transformation. Food System Economics Commission (FSEC), Global Policy Report. Available at: https://foodsystemeconomics.org/wp-content/uploads/FSEC-GlobalPolicyReport-February2024.pdf

LSE (London School of Economics). 2021. G7 leadership for sustainable, resilient and inclusive economic recovery and growth. Available at: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2021/06/G7_leadership_for_sustainable_resilient_and_inclusive_economic_recovery_and_growth_full_report.pdf

Markandaya and Eguino. 2018. Integrated Assessment for Identifying Climate Finance Needs for Loss and Damage: A Critical Review. Available at: https://link.springer.com/chapter/10.1007/978-3-319-72026-5_14

McKinsey. 2022. The net zero transition What it would cost, what it could bring. Available at: https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/

our%20insights/the%20net%20zero%20transition%20what%20it%20would%20cost%20what%20it%20could%20bring/the-net zero-transition-what-it-would-cost-and-what-it-could-bring-final.pdf

NGFS (Network for Greening the Financial System). 2023. Scenarios Portal. Available at: https://www.ngfs.net/ngfs-scenarios-portal/explore

Paulson Institute. 2020. Financing Nature: Closing the Global Biodiversity Financing Gap. Available at: https://www.paulsoninstitute.org/conservation/financing-nature-report/

Songwe V., Stern N., Bhattacharya A. 2022. Finance for climate action: scaling up investment for climate and development. Available at: https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2022/11/IHLEG-Finance-for-Climate-Action-1.pdf

Thornton P. et al. 2023. Perspective: What might it cost to reconfigure food systems? Available at: https://www.sciencedirect.com/science/article/pii/S2211912422000591

TotalEnergies. 2023. Energy Outlook 2023. Available at: https://totalenergies.com/sites/g/files/nytnzq121/files/documents/2023-11/TotalEnergies_Energy_Outlook_2023_EN.pdf

UNEP (United Nations Environment Programme). 2023a. Adaptation Gap Report 2023. Available at: https://www.unep.org/resources/adaptation-gap-report-2023

UNEP. 2023b. State of Finance for Nature 2023. The Big Nature Turnaround – Repurposing $7 trillion to combat nature loss. Available at: https://wedocs.unep.org/20.500.11822/44278

UNEP. 2022. State of Finance for Nature 2022. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/41333/state_finance_nature.pdf?sequence=3

UNEP. 2021. State of Finance for Nature 2021. Available at: https://www.unep.org/resources/state-finance-nature-2021

UNFCCC (United Nations Framework Convention on Climate Change). 2025. Parties & Observers (accessed April 2025). Available at: https://unfccc.int/partiesobservers#:~:text=Annex%20I%20Parties%20include%20the%20industrialized%20 countries%20that,States%2C%20and%20several%20Central%20and%20Eastern%20 European%20States

UNFCCC. 2023. Nationally determined contributions under the Paris Agreement. Synthesis report by the secretariat. Available at: https://unfccc.int/documents/632334

Vivid Economics. 2021. Net Zero Financing Roadmaps. Available at: https://assets.bbhub.io/company/sites/63/2021/10/NZFRs-Key-Messages.pdf

World Bank. 2024a. Recipe for a Livable Planet: Achieving Net Zero Emissions in the Agrifood System. Available at: https://www.worldbank.org/en/topic/agriculture/publication/recipe-for-livable-planet.

World Bank. 2024b. GDP (current US$) (database). Available at: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?end=2023&start=2020

World Bank. 2019. Beyond the Gap: How Countries Can Afford the Infrastructure They Need while Protecting the Planet. Available at: https://openknowledge.worldbank.org/entities/publication/95801508-1130-5ed0-843a-113b50285006

World Bank. 2010. Economics of Adaptation to Climate Change. Available at: https://documents1.worldbank.org/curated/en/646291468171244256/pdf/702670ESW0P10800EACCSynthesisReport.pdf

World Bank and GFDRR (Global Facility for Disaster Reduction and Recovery). 2021. Enabling Private Investment in Climate Adaptation & Resilience. Available at: https://openknowledge.worldbank.org/server/api/core/bitstreams/127de8c7-d367-59ac-9e54-27ee52c744aa/content

Word Economic Forum. 2023. Net-Zero Industry Tracker 2023. Available at: https://www.weforum.org/publications/net-zero-industry-tracker-2023/

climatepolicyinitiative.org